Contents

CEU

65088 - Data Storytelling

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 5:00 PM
Start Date: 6/13/2023	Start Time: 10:00 AM	End Time: 12:00 PM
Authors: Mr. Brian Morgan; Karen Richey Mislick		
Abstract: The Data Storytelling course is tailored to early- to mid-career practitioners in the national security analytic profession who utilize operations research techniques to enhance decision-making. The practitioner must clearly and logically communicate their analysis for the decision maker to trust the insights and/or act upon the recommendations; analysis will only make a difference if it is communicated well. Attendees will learn tenets of visual perception, to include Gestalt Principles and pre-attentive attributes, and how humans interact with and create order out of visual stimuli. Special attention is given to practical skills and considerations necessary to logically construct a presentation that aligns with storytelling and data visualization instructional concepts. At the conclusion of this course, the analyst will have the skills to construct an informative, compelling narrative of their analysis appropriate for an executive-level forum and provide constructive, insightful comments on a presentation in peer review discussions. Location: TH322		

Classification: UNCLASSIFIED Working Group: CEU

Demo

66667 - JMP 17® Software for Data Visualization, Exploration and Discovery

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Thomas A. Donnelly		
Abstract: This is the 34th year JMP® software has been bringing dynamic data visualization and analytics to the desktop. Using short case studies this demo will highlight powerful data visualizations in JMP such as animating data on maps (now able to record as GIFs), including images in the data table, analysis of unstructured text data, analysis of streams of sensor data (Functional Data Analysis) as well as showcase enhancements in JMP 17. With the new Graphlets and Hover Labels visually drill down through a data hierarchy such as a work breakdown structure (WBS) to see graphical summaries at each step. Do in minutes what takes hours in spreadsheet programs. JMP reduces the drudgery of data cleanup - including outlier detection, imputing missing data, and recoding messy data. Watch your graph instantly emerge as you click and drag variables, add data filters, images, maps, and animation. Grab data from almost anywhere – Excel, databases, text, the internet, or import tables (even across multiple pages) in PDF documents. Beyond data exploration and visualization JMP has cutting edge capabilities for Design of Experiments, Reliability, and Data Mining. JMP offers solutions for Real-World DOE problems, efficient computer simulation, and software quality assurance. Machine Learning methods include decision trees, neural networks, and linear, logistic and penalized regression methods. Get near machine learning accuracy with more interpretable models with confidence intervals. It will be shown how JMP's "graphic for every statistic" can easily be moved into PowerPoint presentations and interactive HTML5 web reports so that viewers can ask "what if?" questions and get immediate answers without having JMP software. Location: TH328 Classification: UNCLASSIFIED Working Group: Demo		

68046 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Benjamin G. Thengvall; Dr. Jennifer Blum; Dr. Michael Deskevich; Khalida Hendricks; Jon Vigil		
Abstract: OptDef software greatly increases simulation analyst effectiveness and efficiency by providing optimization, design of experiments (DoE), and analytics capabilities for constructive Department of Defense (DoD) simulation tools. OptDef wraps simulations and provides an intuitive user interface to set up, execute, and analyze the results of a simulation study. It is free for US government use. OptDef is a cross-platform, Java application with a plug-in interface that is already integrated with AFSIM (Advanced Framework for Simulation, Integration and Modeling), STORM (Synthetic Theater Operations Research Model), EADSIM (Extended Air Defense Simulation), SEAS (System Effectiveness Analysis Simulation), JMPT (Joint Medical Planning Toolkit), MDASim (Missile Defense Advanced Simulation, and a number of other DoD simulation models. Its architecture allows integration with additional simulation tools with limited effort.		

OptDef allows an analyst to choose multiple simulation inputs to vary and then apply one or more objectives and constraints. OptDef combines advanced metaheuristic search methods, AI/ML, and mathematical programming techniques to drive iterative simulation runs with different simulation input combinations. After the completion of the search, the tool automatically applies different statistical and data mining techniques to provide insight into the influence of the variables on the objectives and to identify good and bad regions of the design space.

In this demo we will describe uses of OptDef and demonstrate product features including automating single and multi-objective optimization, DoE, and batch runs, post-run statistical and graphical analysis tools, and parallel simulation execution.

Location: TH326
Classification: UNCLASSIFIED
Working Group: Demo

65801 - Space Wargaming Analysis Tool (SWAT) Version 1.0 - Demo

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Mr Steven Toler

Abstract: This demonstration will highlight a new wargaming tool that provides space entities and effects. The Space Wargaming Analysis Tool (SWAT) is easy to use, generates quick scenarios, and enables high-level analysis of single or multiple platforms supporting space, air, and ground maneuver (red & blue) forces in a wargaming environment, while facilitating quick looks of courses of action.

Warfighters make and revise strategies on a continual basis resulting in the need for a tool that develops multidomain scenarios to provide situational understanding of the potential impacts of strategic and tactical decisions. SWAT simulates the battlefield in a rapidly deployable quick-scenario generation and execution tool that enables high-level analysis of single or multiple platforms supporting the armed forces in a wargaming environment. SWAT is used to gain a real-time understanding of the effects of its actions against an adversary. This government-off-the-shelf tool is available to all DoD organizations wanting to visualize a space-enabled wargaming environment.

SWAT's primary function is to generate red-team versus blue-team wargames, where two sides battle each other virtually with planned or dynamically injected interactions and the effects of those actions play out against each other. SWAT can enable the dynamic deployment of battle assets — divisions, brigades, battalions, companies, platoons and fire teams — in real time or faster than real time, providing further insight into potential scenarios. These scenarios can include uncommon events, such as degradation or jamming of communications, which force users to adjust strategies on the fly.

SWAT imports satellite flight paths and satellite constellations so that all domains, including space, are included in the wargaming analysis. A comprehensive understanding of all outcomes requires a comprehensive input of scenarios, and SWAT achieves just that.

The program is accessible on a laptop and tablet in both Windows and Linux.

Location: TH325

Classification: UNCLASSIFIED Working Group: Demo

66666 - Moving from Data to Decision FASTER with JMP Pro 17 – Machine Learning for NON-Coders

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Thomas A. Donnelly		
Abstract: This demo will show how to quickly and robustly create and test Machine Learning models using JMP Pro 17. The focus isn't just on cranking out the best predicting model fast, but also on looking at competing models that may better help decision makers understand the data, process, and risks. Interactive visualization with multiple models helps decision makers appreciate the sensitivities of factors, the trade-space among responses, and the uncertainty quantification of the final prediction(s). Creating "Honest Assessment" data subsets (train, tune, & test) whenever possible, or using penalization criteria protects you from overfitting the data. Cycling through actual vs predicted plots – for the held out "test subset" – for the array of fit models visually shows their relative performance as does the provided table of statistical metrics. The Model Screening platform - new in JMP 17 - allows the simultaneous fitting of more than a dozen machine learning models including the popular XGBoost algorithm with built in DOE to optimize the tuning of parameters. And, when you are satisfied with your model, share it with the coders in your organization. JMP can output the model in any of these computer codes: Python, C, SQL, JavaScript, or SAS. Although not flashy, data prep is often 60-95% of the analytic workload! Pulling data from a wide range of file formats, seamlessly drawing in structured tables across multiple pages in PDFs, connecting to databases or REST APIs, pulling tables off webpages - JMP can get data in from virtually anywhere. Data cleanup of outliers (multivariate?), missing data (imputation?), recoding of typos/merged-field-values (automate w/scripts), exploring suspicious data patterns (hacking? fraud?), automating repetitive drag-and-drop steps with JMP 17's new workflow builder, ALL allow users to do in minutes what previously took them hours or even days! Whether you are an engineer, scientist, tester, or analyst, whether you work in a lab, on a range, or in the program office, if you have data that needs to be turned into information, knowledge, and understanding –so it can be presented to decision makers quickly – so they can take action sooner – then come see how JMP Pro 17 can help your organization move from data to decision faster. Location: TH344 Classification: UNCLASSIFIED Working Group: Demo		

68047 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Benjamin G. Thengvall; Dr. Jennifer Blum; Dr. Michael Deskevich; Khalida Hendricks; Jon Vigil		
Abstract: OptDef software greatly increases simulation analyst effectiveness and efficiency by providing optimization, design of experiments (DoE), and analytics capabilities for constructive Department of Defense (DoD) simulation tools. OptDef wraps simulations and provides an intuitive user interface to set up, execute, and analyze the results of a simulation study. It is free for US government use. OptDef is a cross-platform, Java application with a plug-in interface that is already		

integrated with AFSIM (Advanced Framework for Simulation, Integration and Modeling), STORM (Synthetic Theater Operations Research Model), EADSIM (Extended Air Defense Simulation), SEAS (System Effectiveness Analysis Simulation), JMPT (Joint Medical Planning Toolkit), MDASim (Missile Defense Advanced Simulation, and a number of other DoD simulation models. Its architecture allows integration with additional simulation tools with limited effort.

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In this demo we will describe uses of OptDef and demonstrate product features including automating single and multi-objective optimization, DoE, and batch runs, post-run statistical and graphical analysis tools, and parallel simulation execution.

Location: TH343
Classification: UNCLASSIFIED
Working Group: Demo

DWG01 Emerging Operations Research

65620 - Developing a Holistic Systems Understanding of Production Capacity and Demand for the Army

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: MAJ Sam Yoo; Dr. James T. Treharne		
Abstract: The war between Ukraine and Russia initiated the most significant US military aid deliveries to a foreign nation since the Marshall Plan in World War II. The sheer amount of military support has strained the US industrial base and its own stockpiles of both munitions and weapons systems. The Assistant Secretary of the Army for Acquisitions, Logistics, and Technology ASA(ALT) executed a key role along with other partners in delivering US Army military aid to Ukraine. The war highlighted the lack of a centralized and integrated system that provided senior decision makers the necessary holistic view of production capacity and demand related information. This study discusses the relevant stakeholder analysis, data sources, and potential solution design to develop an improved process for updating, reporting, and visualizing data to support rapid decision-making within the ASA(ALT). Location: TH319 Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research		

66238 - Developing the Army Continuum of Analysis Dashboard

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Candice Farney; Maxine Drake; Sean Eskew; James Jablonski; Brian Wade		
Abstract: The Army Continuum of Analysis (ACA) is a multi-agency effort across the Army Analytic Community to identify analytic coverage gaps, synchronize analysis, and ensure that the community is		

addressing the most important Army Senior Leader decision needs. To enable this goal, a small working group with representatives from six analytic agencies developed a database and dashboard to capture all the studies and analysis across the Army. Each entry in the database outlines the study title, purpose, sponsor, timeline, phase, and primary and supporting analytic organizations. Additionally, each effort is aligned to the Army Campaign Plan (ACP) and Army Analytic Guidance. Currently, there are over 600 analytic efforts in the database. In order to coordinate these efforts, each month the analytic community holds the Synchronization of the Army Analytic Community (SAAC) meeting and uses the dashboard to visualize the data, discuss each study effort, and share updates for cross coordination. The overall development of the database and dashboard was split between two primary agencies: the Futures and Concepts Center (FCC), who developed the database, and The Research and Analysis Center (TRAC), who created the dashboard. Both projects are available through the cloud with a Common Access Card (CAC) and are hosted within the AFC Modernization Application Data Environment (MADE) but are pending transition to c-Army. This presentation will cover the creation of the dashboard and visualizations, from developing requirements with limited guidance, to creating new visualizations, and connecting the dashboard to the live database. A second MORSS talk by FCC will cover the database development.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

65938 - Distributional Attrition Combat Modeling Framework

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Michael Yereniuk

Abstract: As we develop models for long-term combat simulations, uncertainty becomes a dominant factor to consider in our ability to deliver rigorous analysis. This uncertainty may encompass data, behaviors, capabilities, and terrain. Much work is in progress developing high-fidelity combat modeling tools and incorporating artificial intelligence to answer difficult study questions. However, a problem arises in how to account for uncertainty within a combat simulation without incurring an exaggerated expense in time or computational resources. The Research and Analysis Center (TRAC) is developing a mid-fidelity Distributional Attrition Combat Modeling (DACM) framework and dashboard tool to address this uncertainty and help scope measurement space for further high-fidelity investigations or provide initial capability and framing analysis exploration.

Leveraging techniques from Biomathematics, TRAC developed a system of Partial Differential Equations (PDE) to model simple combat situations. These PDEs differ from spatial Lanchester models in that at each time along a simulation, DACM accounts for all possible outcomes weighted by their probability of occurring, and then propagates each outcome. Essentially, the spatio-temporal distribution of forces approximates the aggregate solution of an infinite number of stochastic agent-based model simulations. Unit locations, routes, and effector data are initialized as distributions. The deterministic equations account for the stochasticity along the combat simulation by propagating the distributions in time and integrating all the possible interactions of forces at range. Currently, we model a maneuver force traveling through an area with emplaced threat entities. Further work is progressing to model additional tactics, where appropriate for distributions, and to enable analysis for future studies.

Short model run-time allows for increased analytic effort in parameter exploration. TRAC is developing an analysis-minded dashboard environment within Python to integrate, conduct design of experiments, run the model, and provide visualizations. This ensures that analysts of varying backgrounds can use the DACM model efficiently and effectively for their study needs. Moreover, the graphical user interface environment allows analysts to visually explore the raw data within terrain context and explore hypothetical vulnerabilities before running the PDEs. The dashboard includes built-in tools for investigating parameter sensitivity with respect to attrition metrics to help answer study scoping questions or explore future capabilities.

This presentation will provide an overview of the DACM model methodology and current progress of the analytic dashboard tool.

Location: TH319
Classification: UNCLASSIFIED // FOUO
Working Group: DWG01 Emerging Operations Research

65535 - A More Efficient Method for Capturing and Modeling Binary Penetration Data using Residual Velocities

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Christopher Drake; Kenneth H Hohnecker

Abstract: Limit velocities are the impact velocities at which a penetrator has a certain probability of perforating a given target. These limit velocities are often used as performance metrics to evaluate the effectiveness of targets at stopping a given penetrator.
Limit velocities typically need to be determined experimentally, especially for new designs or concepts for which there is little or no pre-existing data. In small arms development, these limit velocity tests often employ an adaptive binary data gathering algorithm (3POD, Langley, etc.), where the data will then be modeled using binary logistic regression to create a model which accurately and precisely predicts limit velocities. One issue encountered when modeling binary data (perforation/no perforation in this case) is that one needs a relatively large sample size to develop a model with reasonable confidence bounds (precision) due to the information-sparse nature of binary data. In recent years, the ability to capture the residual velocity of these penetrators after impacting the target has become more prevalent through the use of high-speed cameras or other modern instrumentation. The new methodology being developed by the authors outlined in this paper demonstrates that the inclusion of this additional continuous data significantly improves both precision and efficiency with regard to the modeling of limit velocities.
The paper will discuss the development of the equation for residual velocities that was sufficiently generic to apply to a wide range of penetrators and targets, while also remaining amenable to a tractable and computationally efficient statistical analysis. Also discussed is the solution devised for the inclusion of non-perforated samples by extending the residual velocity equation to allow for "negative" residual velocities. The authors go on to demonstrate the improvement to efficiency and precision using various Monte Carlo and re-sampling comparisons to traditional binary testing and modeling methods. Finally, the authors discuss future work to validate and refine the new methodology using live fire testing, and the development of a partner adaptive data gathering algorithm to further optimize efficiency.

Location: TH319

Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research

66158 - Modeling Qualitative and Quantitative Data in Campaign Analysis Models: A Mixed-Methods Study

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Donald Williams, Jr.		
Abstract: This abstract describes an ongoing unclassified, three-phase, 12-month study that examines how to effectively model qualitative inputs in campaign analysis. The study explores the research question, “How can an operations research model best represent qualitative inputs in predominantly quantitative campaign analyses?” Qualitative inputs impact quantitative, campaign analysis because some inputs are force multipliers. Joint force doctrine, such as Joint Publication 1-0, Joint Publication 3-0, and the Joint Warfighting Concept introduce qualitative effects into campaigns, including diplomacy, strategic deterrence, risk calculation and mitigation, information operations, “perfect” command and control, signaling, and other government efforts that further military outcomes to achieve strategic objectives. However, it is unknown how military professionals account for specific qualitative actions and their effects because no model exists that draws relationships between tools with quantitative military outcomes and subjective, qualitative effects. This study has one of three phases complete. Phase one was the exploration of joint warfighting functions and identifying qualitative inputs into command and control, information, intelligence, fires, movement and maneuver, protection, and sustainment. The phase yielded a list of 302 qualitative inputs that related to joint warfighting functions. The researcher is using that list for phase two, which is ongoing, and involves finding ways that qualitative inputs relate to quantifiable outcomes. The researcher is using a combination of four qualitative methods to identify applicable relationships between quantitative and qualitative inputs: content analysis, narrative analysis, discourse analysis, and thematic analysis. Phase three is a list of relationships between quantitative military outcomes and qualitative inputs, as well as how operations research models may represent mixed-method data. This study is relevant to operations research because it potentially increases the confidence researchers place in campaign analysis. Models that include qualitative inputs allow analysts to account for all the contributions to joint warfighting functions, which conserves resources, and ultimately serves as force multipliers for planning and contingencies. This research is relevant to this year’s symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it integrates traditional operations research approaches with peer-reviewed, reputable qualitative data analysis. The presentation will include a detailed summary of phases one and two, as well as preliminary findings from phase three. The study will conclude in September 2023. Location: TH319 Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research		

65970 - Visualizing Meta-Analysis to Support a Portfolio Review

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Ms. Nikki Lee Gorrell; Dr. Robert A Kirgan		
Abstract: The U.S. Secretary of the Army, the Under Secretary of the Army, and the Army Futures Command Commanding General have stated on numerous occasions that all “essential functions will be underpinned by a strong analytical foundation.” The Under Secretary of the Army tasked The		

Research and Analysis Center (TRAC) and DA G4 to conduct a comprehensive review of the existing analytic body of work through the lens of the sustainment warfighting function. TRAC developed a methodology to identify, link, map, and measure the strength of linkages between key document conclusions and recommendations across supporting operational context, such as investments, requirements, challenges, gaps, and analysis by using customer-informed rubrics and subject matter expert-informed models. TRAC developed a Secret Internet Protocol Router Network (SIPRNet) Microsoft SharePoint application to empower result visualization. This presentation describes the G-4 Contested Logistics use case to demonstrate the methodology used to synthesize, structure, and visualize a large body of work with relational data across various forms, including experimentation, wargames, studies, planning scenarios, and exercises. The presentation further reflects on lessons learned and recommendations for future use cases.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66170 - A framework for designing and certifying complex operations research tasks

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Daniel Bilusich; Dr. Fred DJ Bowden; David Cox; Nikoleta Tomecko

Abstract: This presentation describes a proposed framework for quality assurance for large and complex Military Operations Research (OR) studies. Most large and complex scientific and engineering endeavors have appropriate tools for quality assurance, while the quality assurance function within a large, complex Military OR study is typically done by an experienced study leader. The Military OR literature contains many documents that describe how to conduct studies. Most notable of these is the TTCP Guide to Experimentation, which describes how to eliminate common experimentation pitfalls. What is missing from these documents is a pragmatic guide to managing the trade-offs that a study team has to make. These can include managing considerations such as the completion of a study within a time frame, data availability or resource. The study team typically captures the impact of these perceived shortcomings as a set of caveats that appear in the team's reports.

A framework that enables the study team to consider the choices made regarding the conduct of a study, and convert them into a standardized way of communicating caveats associated with those choices, should enable the study lead to better ensure the right level of quality is designed into activities, managed throughout the execution of the study, and communicated to the decision-makers.

The proposed framework describes a multi-level rating scale of experimental rigor for key attributes of a Military OR study. Five point scales are commonly used in maturity models and have been adopted in the framework. The key attributes are:

1. Identification and selection of Decision variables (options) to match client questions and theory construct, and that they minimize bias, and uncertainty.
2. Test context (scenario) links to strategic guidance, ability to test the decision variables and minimizing environment bias.
3. A Measurement process that is accurate by being fit for purpose, documented, consulted, and unbiased, and uncertainty is represented and analyzed.
4. Outcome measure and Synthesis method selection.

The key attributes are further broken down into a series of sub attributes, each with a five point scale, a description of the impact of these attributes and a sample caveat. These are tabulated for ease of use.
A study lead can use the framework to design their study quality by choosing points in the table that meet their quality requirements and in doing so, determine time, resource and data trade-offs where necessary. They can then tailor the default caveats to communicate with key stakeholders in advance of the study commencing. During and at the completion of the study, the framework can be revisited as part of a quality control function.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66045 - Extracting structured information from contract documents

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Ryan Trottier; Ojustwin Naik

Abstract: Immense value can be gathered by having current and historical contract information available in digital form. This value comes in the form of aggregations, comparisons and various other analysis that can be performed at scale only if important contract elements are available in structured, or at least semi-structured form. These elements exist in the contract document in various formats: including fillable forms, line items, sections of text and more. While “structured” for human inspection these elements are not easily machine interpretable. Currently, an important transition is underway where this contract data is being digitalized and structured immediately upon contract creation. Adopting this approach is important, as it is perhaps the most reliable way to capture this type of data. However, this approach unfortunately fails to capture historical data, and even some portion current contract data which does not correctly upload data to the appropriate systems.

To remedy this, the DART team has developed various contract element extraction techniques to make available both current and historical contract data within the same data set. The common thread of these techniques is their dependence on the original contract .pdf document, not an external supplement or database. Even with a common .pdf source, the different layouts, formats, etc. of these disparate contract elements necessitate different tools and techniques for reliable extraction. In this presentation we will detail how various techniques from simple regex, to computer vision, and machine learning are used by the DART team’s extraction pipelines to identify and extract various contract elements in a structured format amenable to analysis. We will demonstrate the benefits and pitfalls of instantiating these data pipelines in two different environments, including a high-performance computing (HPC) environment and in a cloud environment hosted on Amazon web services (AWS).

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66156 - This is SPARTA

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr. Marissa Miller; Megan Armbright; Christina Ciola

Abstract: This is SPARTA!
Authors: Megan Armbright, Christina Ciola, Dr. Marissa Miller
Systems Planning and Analysis, Inc.
Reviewing documents to identify key information is a challenging, time-intensive process. While there are shortcuts to use a word or phrase to search through a single document, these shortcuts are often not sufficient when it comes to large projects and programs encompassing extraordinarily large amounts of data and a myriad of documents.
To support a much more time-efficient approach to document review, SPA is developing a tool that automates the review process while searching simultaneously for several pieces of information. SPARTA, created in Python, can be easily modified and adapted to changing information searches and addition of new source materials. This tool searches multiple documents for a user-defined set of words and phrases and quantifies each document's relevancy. After the user inputs the materials to be reviewed, the algorithm processes a digital read-through of the documents. It then generates a report on the applicability of the content of the information identified within the source materials to the information of interest.
This presentation discusses the implementation and application of SPARTA and how it supports SPA's developing text analytics capabilities. Analysts can use this capability to identify which documents are most relevant to their inquiry and are worth reviewing more closely and which documents are not, saving the analyst's time and allowing them to focus on what they do best: analyzing the data.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66430 - Development of a body-on-body impact methodology for analysis of active protection systems using the advanced joint effectiveness model

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Douglas Howle

Abstract: An active protection system (APS) uses sensors and countermeasures to protect an armored combat vehicle and its occupants from ballistic threats. When a countermeasure interacts with an incoming threat, multiple outcomes can occur. One of these outcomes is a body-on-body (BoB) impact where a duded munition (or part of a munition) called a residual threat strikes components on the exterior of the vehicle. Ballistics analysts supporting the live-fire test and evaluation (LFT&E) community require a new methodology to predict the damage to and loss of function of vehicle components struck by residual threats.
The methodology must be integrated into the framework for analyzing active protection systems that is currently being developed at the DEVCOM Analysis Center and implemented in the Advanced Joint Effectiveness Model (AJEM). AJEM is used to quantify the level of ballistic protection afforded to vehicles and their occupants by these active protection systems.
An overview of the new methodology for AJEM will be presented. The overview will include a discussion of the expected damage mechanisms and the equations used to evaluate damage. Experimentation completed to generate data that inform the methodology development will be discussed. A plan to develop and execute high-fidelity physics-based models and simulations which expand upon the experimental data will be shared.

Location: TH353 Classified

Classification: CONFIDENTIAL Working Group: DWG01 Emerging Operations Research

66248 - End-to-End Kill Chains for Mission Analysis A Complete Approach to Evaluation for Technology Development

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Ryan Samuelsen		

Abstract: ABSTRACT
End-to-End Kill Chains for Mission Analysis – A Complete Approach to Evaluation for Technology Development

Submitted by: AFRL/RQSA
2180 8th St. Bldg. 145, WPAFB 45433
February 15, 2022

Authors: J. Scott Thompson, Ryan Samuelsen

Affiliation: 1Corporate Model Analyze (CMA), 2AFRL/RQSA WPAFB

ABSTRACT: A prioritization on complete end-to-end kill chain analysis directed by the Deputy Secretary of Defense has been the catalyst for redesigning traditional modeling, simulation, and analysis (MS&A) approaches. Often during MS&A for technology assessment there are broad assumptions made in attempts to isolate targeted analysis objectives. Broadly applied assumptions are frequently driven by but not limited to lack of data, insufficient subject matter expertise (SME), and scope limitations imposed by schedule or funding constraints. An incomplete or even insufficient representation of a multi-domain scenario can lead to mission analysis products that are biased and uninformed. Decision authorities of technology investors rely on accurate, well informed, and wholly represented studies that are derived from classified intelligence sources, and which require an extensive end-to-end representation for all involved domains in a kill chain. The development effort to support end-to-end mission analyses requires an increased scope and objective over traditional approaches. The simulation environment to support the kill chain analysis must be constructed from a multi-domain system of systems perspective where SMEs from partnering services identify and bring forth technology concepts of interest to the specific kill chain. This presentation will describe how the AFRL Corporate Model Analyze (CMA) team of cross-directorate and partner service MS&A analysts, developers, and technical SMEs are developing and executing these digital experiments to support rapid technology assessment. This approach also includes a process for continuous improvement and collaboration designed to enable sustainable, efficient, and iterative analysis efforts that are capable of quickly incorporating emerging red and blue capabilities.

Location: TH353 Classified
Classification: SECRET//REL TO FVEY
Working Group: DWG01 Emerging Operations Research

65980 - The Art of Quantitative Analysis for Defense

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Mark A. Gallagher, FS; Dr. Mark A Brown		

Abstract: Analysts face many challenges, among these is determining how to apply analysis to complex issues. We propose and discuss an analysis process that proceeds through various stages including:
- Identifying key stakeholders and their values
- Developing a problem statement
- Constructing a framework (review past studies, build a network)
- Diagramming major factors
- Conducting simple modeling to focus analysis (data, scope)
- Determining appropriate resolution
- Assessing existing models and selecting an analytic approach
- Evaluating alternatives and ideas
- Communicating insights

This presentation provides a short overview of these stages and provides additional resources for more information.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66099 - Quantifying Offensive Security Expertise and Target Vulnerability with Item Response Theory Models

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr. Richard Callahan

Abstract: Quantifying attacker efficacy and target vulnerability to exploitation is an important problem in cyber security. This research uses statistical models from educational assessment (Bayesian multidimensional IRT models) for the first time in the cyber-security domain, in order to identify the number of distinct skill dimensions required for success in two cyber-security competitions, and then to interpret what those dimensions are. IRT models benefit decision makers by transparently relating generalizable characteristics of the attackers and defenders to estimates of the probability that an attack would succeed. As a result, practitioners can use them to evaluate the performance of both human operators and algorithms and predict their performance in a hypothetical scenario, train human teams and AI-enabled systems, and empirically evaluate the contribution of new technologies to risk mitigation. Metrics for assessing model fit indicate how many distinct categories of attacker skill the models can identify. One competition tracked solutions submitted at the team level, and the second at the individual level. The research identifies two dimensions of ability at the team level: one most associated with web exploitation and forensics challenges and the other more strongly reflected by cryptography, binary exploitation, and reverse engineering challenges. The analysis at the individual level identified five dimensions of ability from four categories of questions: a dimension each for web exploitation, cryptography, and reverse engineering, and two separate dimensions for the binary exploitation category. As a theory-building exercise, we discuss the relationship between the challenge content and how well each question is measured by the corresponding dimension of expertise. The research plausibly leads to connecting the skills of attackers with their preferred methods of exploitation.

Location: TH319
Classification: UNCLASSIFIED // FOUO
Working Group: DWG01 Emerging Operations Research

65484 - Systems Thinking ; A Force Multiplier of Analytics

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Michael Woudenberg; Mr. Carl J. Unis		
Abstract: No matter how advanced, how novel, or how tech-enabled, compartmentalized analytics cannot solve increasingly complex and emergent wicked problems. Join us as we explore the roots of systems thinking underpinning Operations Research through a combination of insatiable curiosity, humility, and an intentional reframing of the problem to ensure perspective. We'll demonstrate a simple, yet powerful framework we use to decompose problems based on the systems views of physical, logical, and persona applied to case studies on cyber, autonomy, and supply chain resilience. Systems thinking is the force multiplier of analytics and when properly aligned provides the keys to innovation, wicked problem reduction, and complex systems solutions. Location: TH319 Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research		

66100 - Adopting a Data Science Paradigm: Merging Traditional Cost Estimating Methodologies with Advanced Computational Analysis

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Kyle Connor Ferris		
Abstract: In today's world, the availability of large unstructured datasets facilitated through autonomous data collection and warehousing makes the application of data science methodologies a critical necessity. Emergent methodologies leveraging automated data extraction, mining, clustering, cleaning, modeling and visualization are increasingly important for effectively estimating the lifecycle costs of federal government acquisition programs. Incorporating these data science methodologies can yield significant improvements to cost analysis by streamlining data collection and normalization, promoting effective data governance, and providing systematic processes for automated analysis. Continued adherence to legacy paradigms of manual data collection and processing inhibit cost analysts from maximizing on the computational power of programming languages such as SQL, Python, and R, which in turn inhibits accessibility to complex and diverse datasets found in unstructured repositories. Traditional cost estimating methodologies – such as the manual assignment of uncertainty/risk parameters or subject matter expert elicitation – can result in highly subjective inputs and unsubstantiated results. In comparison, statistical models using programmed algorithms can collect and process vast amounts of raw data and utilize these larger datasets for more defensible predictive analysis. By encouraging the adoption of a data science paradigm, this presentation will evaluate the tools and skillsets required for advanced computational modeling and analysis, as well as planning considerations for data science curriculum and training development. Location: TH319 Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research		

66426 - Machine Learning and Network Management

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Jayashree Harikumar; Dr. Oscar Antonio Perez		
Abstract: DEVCOM Analysis Center (DAC) has built several collaborations with universities to analyze and develop methodologies and tools to assess systems that use Artificial Intelligence (AI) algorithms developed using Machine Learning (ML) techniques. One such effort is in intrusion and anomaly detection of AI enabled network systems. The current approach to detect intrusion and anomaly in AI-enabled network systems is done by analyzing the data used to train the network. This data is usually stored at a central logical location, the cloud, and consequently access to this data suffers from unacceptable latency, high communication overhead, and lack of consistent connectivity. A promising new approach, Federated Learning (FL), has been proposed in literature to address these challenges. While FL does largely address the above challenges its use of ML models makes it vulnerable to adversarial attacks, such as data/model poisoning and inference. If deceptive inputs are used for training local ML models or adversarial manipulation of the model weights are performed at the network devices, it becomes very difficult for the aggregator to identify such attacks both at node level and region level. Thus, it is critical that the FL framework used in the networking scenario be resilient to adversarial manipulation so that it can either adapt to thwart the attack or be robust enough to continue its operation despite the deceptive inputs. Working with the Universities, DAC is exploring (a) the use of FL to improve the network security by monitoring the network status to detect attacks and anomalies; and (b) an approach where systems on the network will share local ML model updates instead of training data with a central aggregator entity. In DAC's approach, at the aggregator entity level, the model parameters generated independently at the node/entity level are compared against those generated by co-located entities to identify entity compromise. At the same time, since no training data will be exchanged in the proposed FL framework, we provide a methodology to maintain data privacy for all the network devices and reduce load on the network. Location: TH319 Classification: UNCLASSIFIED Working Group: DWG01 Emerging Operations Research		

65585 - Critical Technology Area Mapping and Analysis

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Alexander Davis		
Abstract: The Critical Technology Area Mapping and Analysis presentation is an overview of how data from the Research, Development, Test, and Evaluation (RDT&E) portion of the President's Budget can be used to understand technology areas that are critical to our military and defense capabilities. Using natural language processing techniques, the President's Budget can be used to build a comprehensive budget portfolio for any given technology area. These portfolios help track activity and give insight into what developments are being made for that technology. These portfolios not only provide the landscape of technologies in the Department, but enable the ability to map programs to these technology areas. Most programs are relevant to several technologies and cannot be labeled by just one. Mapping these programs to technology areas and conducting analysis across portfolios enables the Department to understand existing relationships between technologies, how they integrate with or support one another, and how these relationships		

have changed over time. Understanding these relationships can inform investment priorities and opportunities for collaboration within the Department.

Portfolios also enhance technology road-mapping capabilities that support comparative analysis at the SECRET level by identifying programs that help meet pressing operational warfighting needs. These roadmaps help form a basis for assessing the health of the Department's RDT&E investment portfolio.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

65054 - Weaving the [x]BOM Fabric

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Erica Dretzka; Dr. Nathaniel Junior Fuller; Mr. Brent Smith		

Abstract: Today's systems are composed of a hybrid of proprietary and open-source elements with supply chains extending geographically, temporally, technically, and organizationally. Consumers struggle to evaluate compliance with security standards, licensing regulations, and vulnerability analysis. Recent motivating examples with material impacts include (1) malicious code infiltration into SolarWinds' Orion, (2) remote code execution vulnerabilities in Apache Log4j, and (3) the discovery that a component in the F-35 fighter jet originated from China caused the Pentagon to temporarily halt delivery.
Legacy Bills of Materials (BOMs) remain relevant for modern supply chain illumination for all asset types. The authors are designing an eXtensible Bill of Material ([x]BOM) pattern with accompanying reference architecture to digitize BOMs. Importantly, the 'x' represents a variable, or type of BOM, versus the extensibility of the BOM's content. The resulting [x]BOM fabric flattens the narrative between boardroom and edge operations by superseding domain specificity, using malleable metadata patterns and data structures.
Working across industry, academia, and government, the authors are prototyping [x]BOMs, thus demonstrating universality from definition to implementation, and, ultimately, germaneness across mission use cases, at scale, in space, and across missions. Embedded in a supporting enterprise architecture, it enables agile, scalable, and secure transparency by privileged parties. The resulting [x]BOM Fabric is the infrastructure underlying Artificial Intelligence and Modeling & Simulation (M&S) analyses, threat vector predictions, and decision causality analyses. Responding to both direct demand signals for software BOMs, it is built to scale to lesser-known areas in support of flexible research and analysis.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

66141 - Classifying Historical Airworthiness Directives to Inform Military Aircraft Maintenance Strategies and Sensor Solutions

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Max Hsieh Xu; Mr. Kyle Blond		

Abstract: The Federal Aviation Administration (FAA) maintains an open source database called the Dynamic Regulatory System (DRS) which contains decades of Airworthiness Directives (AD) for commercial aircraft and their major assemblies. These ADs issued by the FAA notify operators about unsafe conditions found on aircraft components. Such unsafe conditions degrade operational performance (i.e., availability, reliability, and maintainability) and increase costs for the operator. Similarly, military aircraft sustainment engineering continues to face airworthiness challenges resulting in decreased readiness and increased weapon system costs.
The U.S. Department of Defense (DoD) also must comply with these ADs for its Commercial Derivative Aircraft (CDA) fleets (e.g., the KC-46A as a Boeing 767 CDA). The presented research will include (1) extracting AD information from the DRS database, (2) classification of ADs by aircraft system, failure mode, and cost using Natural Language Processing (NLP) and (3) discussion of subsequent recommendations for process improvement to DoD CDA fleets. These findings present opportunities for the DoD to proactively address airworthiness challenges and mitigate their impact on CDA. Future work is proposed to prescribe apt maintenance strategies and sensor solutions based on the classification results for DoD CDA fleets to improve sustainment engineering actions.

Location: TH319
Classification: UNCLASSIFIED
Working Group: DWG01 Emerging Operations Research

DWG02 Unmanned Systems

66428 - Dynamic Infographics (DIG): A Concept for Transparency of AI and Autonomous System Behaviors and Battlefield Attributes for Situation Awareness

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Gina Hartnett		

Abstract: The future battlefield is becoming an exceedingly complex environment that is often difficult for a soldier to digest. Multi-domain operations paint a canvas with infinite combinations of entities working together to defeat an equally complex enemy. In this environment, a soldier will need to understand their environment as quickly as possible with the help from autonomous and Artificial Intelligence (AI) systems that can perform or aid in rapid decision-making to ensure mission success. The Army is also growing towards a heavy reliance on autonomous and AI systems, providing soldiers aid or replacement with complex and rapid decision-making that becomes extremely difficult for humans to decipher. Without an interface to provide the user with a level of system transparency, it becomes nearly impossible for the user to understand the 'what' and the 'why' of an Intelligent Agent (IA) system's behavior. This gap of information leaves operators with decreased Situational Awareness (SA) and decreased user trust of these systems, especially if the system makes an error)"Information is only useful when it can be understood" (Muriel Cooper)). Vast amounts of information and the relationship between that information can be easily gathered by IAs– the problem is presenting that information in a way that it can be easily understood, which can cause a bottleneck. Many liken this problem to showing a completed jigsaw puzzle, which is more easily interpreted rather than a jumble of jigsaw pieces. Having an IA understand and share that understanding to build insight should be the goal for the future. The concept of Dynamic InfoGraphics (DIG) (patent pending) is to provide the user rapid understanding of battlefield and mission-relevant entities and transparency of autonomous or IA systems' actions and decisions, thereby increasing user effectiveness and trust in automation leading to enhanced human-agent teaming.

Novel heads up displays (HUDs) and augmented/virtual reality (AR/VR) concepts should provide aircraft crew members with enhanced SA of data, spatial location, threat level, battlefield movement, etc. and keep them heads-up/eyes-out during flight. DIGs can be used to display key data from entities and events that occur over the course of a mission. Mission information such as Forward Armed/Refueling Points (FARP), Nine-Line Medical Evacuation (MEDEVAC), casualties, Operator State Monitoring (OSM), and friendly/enemy identification with meta-data can all be displayed using DIG concepts. Current studies in the DAC AR lab will determine the usefulness (subjectively and objectively) of DIG concepts in the cockpit, explore information-based visualization concepts, and influence design requirements in support of the Army's Future Vertical Lift (FVL) program and will suggest design requirements for future Army system displays. These results will serve to inform the decisions about what display features to refine and test further in future studies.

Location: TH322
Classification: UNCLASSIFIED
Working Group: DWG02 Unmanned Systems

66413 - DAC Team's 2022 Deep Green Challenge Phase I Competition Artificial Intelligence Model

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Matthew Banta; Craig Andres; Ryan Barker; Dr. Paul Soper; William Zimmerman, Jr.		
Abstract: The Army Research Laboratory (ARL) Artificial Intelligence for Maneuver and Mobility (AIMM) Essential Research Program (ERP) created the 2022 Army Deep Green Challenge (DGC) Autonomous All-Terrain Model Computer Vision (CV) Competition so that teams from across the Department of Defense could compete in the creation of novel algorithms designed to identify the terrain type based on sensor information collected by Robotic and Autonomous Systems (RAS). The U.S. Army Combat Capabilities Development Command (DEVCOM) Analysis Center (DAC) registered a team and competed in the 2022 DGC Phase I competition. In phase I, the team developed models to estimate the terrain type based on sample images collected by the RAS. The images were supplied to the participants by ARL. Because the DAC Team's model was able to estimate the terrain type with the highest degree of accuracy during the competition's final test, DAC achieved first place for this phase of the competition. This presentation provides a DGC background and overview, a description of 2022 DCG Phase I competition, an overview of the models analyzed and scored for the competition, and a summary of the model results that led to achieving first place in DCG Phase I. Location: TH322 Classification: UNCLASSIFIED Working Group: DWG02 Unmanned Systems		

65599 - Quantitative Analysis for Autonomous Systems

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Ryan E Fitzgerald; Tom B Apker		
Abstract: The US Department of Navy (DoN) has seen significant Congressional cuts against its uncrewed systems (UxS) programs in recent years. There are countless news articles about entrenched thinking and hesitancy in fully developing and employing UxS. While the purported cause of the cuts and this thinking is often cited as reliability concerns, the DoN, and the Department of Defense (DoD) as a whole, suffers from not having a compelling, data-based case to invest in development and proceed with employment of UxS and autonomous systems. Discussion		

surrounding investment often involves anecdotes about single use cases, aspirational cost savings not supported by analytics, and varying thoughts about how best to use these systems.
The DoD must present a better case for development of, investment in, and employment of UxS. While culture is a difficult thing to change, using data can begin to reshape it. Quantitative Analysis for Autonomous Systems, aka Quokka, is a tool that does just this. Given a mission, locations for desired effects, information about the targets, and a database of platforms and their key characteristics, Quokka quantitatively computes dozens of effects chains of nested systems capable of creating the desired effect. The best of breed chains are then modeled and the mission is simulated via Advanced Framework for Simulation, Integration, and Modeling (AFSIM) to generate key measures of effectiveness (MOE) such as probability of mission success, number of adversary countermeasures expended, time to neutralize targets, etc. These are compared to conventional effects chains for which the identical M&S is performed and MOEs generated. Finally, a holistic cost assessment is completed, calculating both mission and total cost, to produce a cost per effect metric. The tool provides data on several factors of effectiveness for new and novel effects chains and associated cost, perhaps for the very first time.
Quokka provides the data the DoD is lacking and which it desperately needs to make a case for development of, investment in, and employment of UxS and autonomous systems. Quokka can help develop, design, and explore effective methods of employing UxS and autonomous systems and provide the data that makes clear the advantage in doing so.
Quokka determines systems which are most effective when nested together and can steer investment towards physical integration and interoperability for systems of systems. It executes analysis on platforms that operate in any and all domains. Its current exemplar capabilities focus on developing kinetic effect chains involving UAVs, USVs, and UUVs. Non-kinetic effects are currently being incorporated into the tool to increase the effects chains Quokka can posit.
Quokka shows new and novel uses for new and existing platforms that provide asymmetric advantage when stitched together into effective warfighting capabilities at lower cost and much sooner than new Program of Record platforms will be delivered.

Location: TH322
Classification: UNCLASSIFIED
Working Group: DWG02 Unmanned Systems

65459 - The Aerial Refueling Asset Basing and Assignment Problem

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Camryn Elizabeth Deames; Dr Brian Joseph Lunday, Ph.D.; Col Jason A. Anderson

Abstract: Since the Cold War, there has been a gradual reduction in the size of the air refueling fleet as well as a more recent increase in demand due to growing tensions in the European and Indo-Pacific theaters. The constraints of aerial refueling threaten the missions of Air Mobility Command and USTRANSCOM in their execution of both the National Security Strategy and National Defense Strategy. Introducing and integrating semi-autonomous aerial refueling aircraft is a logical next step due to advantages in endurance, survivability, runway requirements, and fuel offloading capacity. This research frames the Aerial Refueling Asset Basing and Assignment Problem with two modeling approaches: a baseline model and a fuel shuttle concept model. Whereas the former model considers only semi-autonomous refuelers, the latter model examines them working in coordination with manned aircraft. Given a realistic scenario, a set of refueling locations, a set of available tanker bases, a set of available tanker types; both models minimize the number of tankers and their corresponding transit distance while meeting fuel demand and operational constraints of tankers and tanker bases.

The models identify ideal basing and tanker refueling assignments for a 24-hour period of operations. The selection of basing, routes, and assignments provide operational performance metrics such as sorties per day, fleet size, fuel burned, and fuel offloaded:burned ratios that inform the subsequent analysis and insights.

Location: TH322
Classification: UNCLASSIFIED
Working Group: DWG02 Unmanned Systems

66713 - Verification and Validation of Simulation Tools for Autonomous Vehicle Systems

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dr. Jeff Durst

Abstract: Modeling and simulation (M&S) are critical in engineering and basic research processes. However, M&S is only useful if the model and simulation outputs are accurate. As such, the broader engineering community has conducted significant research to establish what "accurate" means for simulations and what subsequent level of "trust" should be given to M&S outputs. The primary means of establishing trust in models and simulations across M&S applications is verification and validation (V&V) testing. Verification ensures that a model or simulation outputs the correct type of data, while validation ensures that a model or simulation outputs realistic data.

The concept of V&V of simulation models became formalized in the 1970s as theoretical frameworks and methods for V&V were introduced. The concept of V&V became necessary once M&S was applied to practical engineering problems. V&V is a critical step in the model development process; assurances must be made that the simulation provides accurate results before a model/simulation can support practical engineering problems. While a significant amount of research focuses on V&V for traditional M&S, more research needs to be done to define a methodology for the V&V of simulations of complex, intelligent, and autonomous systems.

Specifically, no methodology for V&V of simulations of autonomous vehicles (AVs) has been developed to date. To that end, this presentation proposes a new framework for the V&V of simulation environments for autonomous systems, focusing on unmanned ground vehicles. The new V&V framework is built on the theories and frameworks already established and used by the simulation community. The new framework proposes a sequential, layered approach to V&V, with V&V taking place over multiple steps within the simulation environment. The proposed verification starts by validating the most basic components of an AV: its sensors and mobility platform. After verifying and validating these "building blocks," autonomous perception outputs are validated by comparing perception algorithm outputs using simulated and real-world sensor data.

The proposed presentation starts with a brief overview of the current V&V methods used for traditional simulations. Next, in light of this review, a novel framework for the V&V of simulations for predicting the behaviors of AVs will be presented in detail. Also presented will be the application of this V&V framework to the use-case of an autonomous unmanned ground vehicle driving along a roadway. The framework is applied for model validation of Global Positioning System (GPS), inertial measurement unit (IMU), and RGB camera sensor models. The framework is further applied to validate these sensor models for a camera-based autonomous navigation algorithm, stop sign detection.

Location: TH322 Classification: UNCLASSIFIED Working Group: DWG02 Unmanned Systems

FG01 Process and Performance Improvement

65514 - Establishing a Strategic Management and Performance Improvement Framework for the Department of Defense's Enterprise: Challenges and Opportunities

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr. Silvana Rubino-Hallman		
Abstract: The Department of Defense is the largest organization in the world, with a budget exceeding US$ 800 billion and an extremely complex portfolio for both executing and enabling the warfighting mission. In exploring how to face the challenge of ensuring American taxpayers' dollars are well invested, we focused our efforts on designing and implementing a strategic management and performance improvement framework for the DoD enterprise to articulate how the Secretary of Defense's strategic management priorities are implemented by the DoD enterprise, consistent with the National Defense Strategy's "building enduring advantages" approach. This paper will explore how the Department strengthened the Performance Improvement Officer's role and its portfolio, to include the revamping of DoD's Strategic Management Plan and the approval of a new Defense Performance Improvement Framework, and how it plans to measure DoD performance through "Pulse", the Department's authoritative executive analytics platform for performance management. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

66699 - Deploying a Continuous Process Improvement Program across TRADOC

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Michael (Mike) Prevou		
Abstract: When deploying a Continuous Process Improvement program across a major Army command like Army Training and Doctrine Command (TRADOC), it is important to make it a "commanders' program" that enables each echelon to identify, select and conduct process improvement initiatives that lead to measurable improved performance outcomes. The CPI program at TRADOC performed a major pivot during the COVID 19 pandemic and is now refocusing on ways to help TRADOC achieve a sustainable path in an era of diminished resources. Our thesis attempts to solve the problem of balance between the training of green belts and black belts across the command (capacity) while allowing commanders at echelon to deploy CPI initiatives to address many of their most wicked processes (outcomes). This presentation will look at the results of TRADOC CPI program in the past few years, its integration into the Knowledge Management function of the command, how it adapted during COVID 19, how it is integrated in a local MBA program for TRADOC sponsored officers at the College of William & Mary Graduate school, and how we are operationalizing CPI to empower TRADOCs ability to "see itself" and achieve a strategic sustainable path to 2030. Classification: UNCLASSIFIED Working Group: FG01 Process & Performance Improvement. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

68697 - Process & Performance Improvement Senior Leaders Panel

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Dr. Steven Lagan		
Abstract: This session will include a panel discussion with senior process & performance improvement leaders from the Office of the Secretary of Defense (OSD), US Army, US Air Force, US Navy, US Marine Corps, and Department of Homeland Security. This facilitated discussion will focus on opportunities and challenges for process & performance improvement throughout the defense / national security community, critical skills and skill gaps for process & performance improvement practitioners, and answering questions from the audience. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

65262 - Delivering Results for the Marine Corps Cyberspace Command

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: John Schirrippa		
Abstract: Spoiler alert: Clearance processing at a Marine Corps Forces Cyberspace Command dropped from 290 days to 60 days and leadership's trust in security personnel increased. How? In December 2018, a Marine Corps command based out of Ft. Meade, Maryland was struggling. A security clearance, which was rare for many Marines, was required for all incoming personnel. The process to obtain this clearance was arduous and woefully time consuming. Leadership was frustrated and an internal investigation was conducted. The Commander realized that with a wave of new people coming to the command, the organization needed to get really adept at processing these clearances. A Lean Six Sigma Black Belt project, led by the Marine Corps Forces Cyberspace Command Information and Knowledge Manager, Mr. John Schirrippa, launched to analyze the "as-is" state of affairs, make recommendations for improvement, and implement change. The story of the project was shared with several Green Belt and Black Belt classes as a model project and something for those pursuing certification to aspire to. Mr. Schirrippa will provide a first-hand, high-level summary of the project including forming the team, creating the project charter, Gemba, quantifying improvement relatable to senior leadership, lessons learned, and how the results were positively received. Mr. Schirrippa will also describe standing up a Continuing Process Improvement program at a 4-Star Combatant Command and navigating some of the initial challenges. The brief will conclude with the way ahead. Where does US Cyber Command's Lean Six Sigma program go from here? How do we sustain Green Belt training, build a Black Belt bench, and help Green Belt graduates begin a project. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

66281 - Generating Value Through Process Automation

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Paul Robert Schauer; Mr. Stafford R. Maheu		
Abstract: In January 2022, the Air Force Inspection Agency (AFIA) undertook an initiative to introduce process automation to key activities which it manages for Air and Space Force Inspectors General (IGs) worldwide. From routine, but required, administrative functions to confidential surveys which shape the planning and execution of inspections; this initiative utilized a methodology which consistently assessed the value of information collected against the time required for collection. The scaled application of this approach achieved efficiencies within AFIA as well as for IGs at every echelon. The time savings freed AFIA analysts to spend more of their available work-hours on value producing activities, reduced Major Command HQs survey administration time by 30%, and increased survey participation and completion by 25%. This presentation describes the application of this methodology across the DAF IG Enterprise and the future planning for actions to achieve more meaningful inspection results without further burdening the inspected unit or the IG team. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

65719 - Orchestrating Inspiration: A Framework for Enabling Better Decisions from Information Theory and Live Performance

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: SGM Denver D Dill; Brandon Michael Podojil		
Abstract: In an era of abundant statistics, AI, and interactive dashboards, why do leaders and decision-makers still rely on their gut? To what end do performers move audiences to tears and cheers? We submit that the under-explored intersection between the performing arts and data analytics offers insights into shared commonalities between these endeavors. Having sifted through numerous examples to curate a select collection, we offer a ”Feel, Know, Do” framework to create exceptional experiences that inspire decision-makers to act. We began this journey as an unlikely tag team of a military data analyst and a Juilliard-trained professional musician who shared a passion for understanding exceptional experiences. Undaunted by our disparate backgrounds we developed a shared approach, language, and understanding grounded in the tenants of information theory. As we describe our journey, a framework begins to emerge. To this, we add the panache of performance, sharing insights In an era of abundant statistics, AI, and interactive dashboards, why do leaders and decision-makers still rely on their gut? To what end do performers move audiences to tears and cheers? We submit that the under-explored intersection between the performing arts and data analytics offers insights into shared commonalities between these endeavors. Having sifted through numerous examples to curate a select collection, we offer a ”Feel, Know, Do” framework to create exceptional experiences that inspire decision-makers to act. We began this journey as an unlikely tag team of a military data analyst and a Juilliard-trained professional musician who shared a passion for understanding exceptional experiences. Undaunted by our disparate backgrounds we developed a shared approach, language, and understanding grounded in the tenants of information theory. As we describe our journey, a framework begins to emerge. To this, we add the panache of performance, sharing insights garnered from live experiences, such as theme park design, comedy routines, magic arts, poker		

playing, and improvisational music. Studying world-class live experiences enables advisors to consider the psychosocial and environmental variables that enhance an experience and get decision-makers to ”yes.”

We all know that good analysis does not always win the day and that compelling arguments are rarely alone sufficient to shape decision-making. Humbly, we believe that others who share our passion for exceptional engagement - but have not yet charted our path, will feel empowered to build their own experiences. For analysts: to reach beyond their comfort zone and find their inner performer. For artists: to continue inspiring but toward the result of purposeful action. Drawing upon the best elements of extraordinary live experiences lights a path along the journey to ”Feel, Know, Do.”

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

65777 - A New Metric for Information Dominance

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Richard M. Buchter		
Abstract: Many discussions have been had on Data-to-Decision (D2D) and its importance, but is there a further consideration to be had on whether one is dominant? In High Frequency Trading (HFT), D2D is an important component of executing a trade. But they also include the time it takes to make a trade (T2T- Time to Trade) in their models for dominance of other trading firms. This same data acquisition to execution completion process can be applied to the field of Information Dominance. This discussion introduces Data-to-Effect (D2E), the time it takes from collecting data to the time an effect has been applied on a target. This new construct includes the multi-source data acquisition, networking, and decision components of D2D, but also the reaction time of issuing orders to coalition partners, there response to engage times, and the time to effect of their weapons systems, following the engage decision. Doing so expands the conversation from moving and deciding on data, to whether the weapons system reaction time (including fly out) and its supporting information system(s) are fast enough to engage increasingly faster threats. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

66642 - Maximizing Financial Benefit of Lean Six Sigma Projects through Optimized Selection Criteria

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Colin Wasiloff		
Abstract: Every dollar saved by the US Army through Continuous Performance Improvement (CPI) efforts has the ability to impact our Warfighters’ mission capability, probability of success, and survival. Lean Six Sigma (LSS) and Value Engineering (VE) projects are executed by the US Army to improve quality, reduce waste and process lead time, ultimately providing the ability to re-program budgeted dollars to better serve both the Warfighter and taxpayer. Current literature review and		

organizational benchmarking of how LSS projects are selected suggests an opportunity to optimize selection criteria with the intent to maximize financial benefit output of executed projects.

FY16 Lean Six Sigma project selection data and financial benefit output from the US Army is examined in this research. The effect of seventeen project selection criteria on 119 completed Lean Six Sigma projects' likelihood of achieving a financial benefit of $1M or greater are analyzed. Additionally, project selection criteria are analyzed to determine their effect on achieving the highest levels of readiness; an Army-specific metric. Organization-specific results are presented as well as a practical process, which are proposed for use by any organization – military or civilian.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

65776 - What's The Big Idea?

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Richard M. Buchter		
Abstract: We've all heard it in our careers, a senior leader asking, "What is your "Big Idea?"" to frame future operations as part of their "visioning" process. All too often, the response provided is hailed by some as a "great leap ahead", while others upon seeing the same idea, may view it as "that looks like a small hop, or a skip, but it certainly isn't a great leap". How can this happen? The problem lies with the optics of how Big Ideas are framed by those working the problem, and a lack of common definitions, to create a shared understanding of what is needed. This presentation will briefly explore how big idea are defined, how they are used in requirements for future operational needs, how definitions vary, and how big ideas are defined in the 4GIM (Four Generations of Innovation Model) presented at MORS 2022. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

65358 - Hybrid SWOT Analysis: Practical Process and Lessons Learned

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Colin Wasiloff		
Abstract: A novel process and lessons learned are presented resulting from a hybrid approach to conducting a common SWOT analysis in a resource-constrained US Army laboratory operating in a distributed working environment. Over the course of a single week, rank-ordered SWOT data was collected, analyzed, and briefed at a team-building offsite. Following the results brief out, the leadership team was guided to further down-select singular targets for improvement in each SWOT category, leaving the group of leaders with a clear path forward to addressing organizational strengths, weakness, opportunities, and threats.		

Raw data virtually collected from an independent sample of 19 senior laboratory leaders was decomposed by a small CPI team before affinitizing and analyzing the verbatim results based on the frequency of submission and overall magnitude in each SWOT category. Over 30 naturally occurring themes were captured including Organizational Strategy, Human Capital, Bench Strength, and Partnering. The standard "Top 5" SWOT theme selection process is contrasted to an 80% Parteo-style approach.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

66534 - Navy Military Operations Analyst Community: Health and Initiatives

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: CDR Aaron Sanchez; Mr. David A. Williams

Abstract: OPNAV N81 serves as the community manager for the Navy's Operations Analyst (OA) Community. Comprising of over a thousand officers and over three hundred billets across the Navy, this community is vital in applying Operations Research (OR) techniques to the Navy's problems. Over the past year, tremendous progress has been made in improving the health and application of the community. As part of our efforts we have completed extensive surveys of both individual OA's and of Navy commands, completed a Curriculum Review of the OR curriculums with Naval Postgraduate School, and completed extensive analysis on OA Officer utilization and return on investment. We present selected results of these OA community studies and describe current lines of effort in our strategic vision for the future of the Navy OA community.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

66150 - Recurrent Neural Networks to Streamline Data Interoperability

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes a 12-month study that explored the use of artificial intelligence (AI) recurrent neural networks (RNNs) to streamline data interoperability between operations research models. The research question is: "How could RNNs improve statistical analysis, recognize data compatibility changes, and/or modify data sets to improve data compatibility between models?" This research is relevant to operations research methodology in three ways. First, it addresses how RNNs are especially suited for optimizing linear and non-linear statistical models. Second, it explores how RNNs may recognize data incompatibility between models and inform the researcher of the effects of this incompatibility. Third, it examines how an RNN may correct data incompatibility between models by converting data types and maintaining accuracy during the data transformation process. A neural network algorithm assigns weight to inputs and produces output based on the comparative weights of its inputs. Researchers may use the technology to recognize and correct situations in which data is lost or misrepresented as different models use a single data set. An RNN is uniquely suited for this research because it is agile enough to accommodate a wide range of modern optimization tools. It understands the context of its calculations, making it particularly useful for streamlining data interoperability between operations research models. This study used an RNN to model the structural

components of three quantitative research models. Findings showed that an RNN was insufficient to capture all the differences between operations research models, but an algorithm exists that may allow analysts to modify data sets to improve data compatibility between models.
This study is relevant to operations research because it potentially increases the confidence researchers place in operations research models. If tools exist to help analysts recognize the limitations and differences between research models, then analysts may use this knowledge to account for all the contributions to joint warfighting functions, which conserves resources, and ultimately serves as force multipliers for planning and contingencies. This research is relevant to this year's symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it applies artificial intelligence research to an emerging operations research challenge. The presentation will include a detailed review of the study's hypotheses and findings.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

65892 - The missing 3rd digit. The incompatibility of the Element of Resource and the Commitment Item in Army financial Systems

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: JAE H KIM

Abstract: Title: The missing 3rd digit. The incompatibility of the Element of Resource and the Commitment Item in Army financial Systems

Author: MAJ Jae Kim

Submission Group: FG 01 – Process & Performance Improvement

Classification: Unclassified

Distribution Statement: Approved for public release; distribution is unlimited.

Annually, the Office of the Secretary of Defense must meet a requirement to report a summary of price and program changes to Congress. This report, titled "Exhibit OP-3 Appropriation Summary of Price/Program Growth," is used to inform lawmakers of changes in military expenditures and summarize in which program funding is executed. This study's purpose is to look at how the Army's different and varied financial systems are used to report expenditures to Congress and the disconnects between the various systems. This study examines the history of how each system was implemented, develops a process map of the entire system highlighting incompatible or unclear components, and provides courses of action to improve the system to allow accurate creation of Exhibit OP-32.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

65603 - Best Practices to Develop Comprehensive, Accurate, Well-Documented, and Credible Cost Estimates

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr William Laing		
Abstract: The Government Accountability Office is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. To this end, the Science, Technology Assessment, and Analytics team at GAO has developed best practice guides for effective project controls for federal acquisition programs. This presentation will provide an overview of the recently revised GAO Cost Estimating and Assessment Guide (GAO-20-195G), including an overview of the best practices to develop a comprehensive, accurate, credible, and well-documented cost estimate. The presentation will also review case studies on the use of the guide and briefly discuss related topics covered in the guide such as performing an effective Analysis of Alternatives, and monitoring a project's execution using Earned Value Management. The foundational tenets for cost estimating serve to underpin effective cost analysis. When used in conjunction with the other GAO Best Practice Guides for Schedule Assessment (GAO-16-89G), Technology Readiness Assessment (GAO-20-48G), and Agile Software (Exposure Draft available), agencies can effectively address both novel and emerging technologies and associated program management challenges. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

66380 - An Epic Accomplishment - Lessons Learned from Model Modernization

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Danford Smith		
Abstract: To meet emerging technology requirements, analytic model developers should consider cloud compatibility and changes to model requirements, to include analysts' programming capabilities. The Center for Army Analysis is currently modernizing legacy models and revising approaches to model management. In 2022, the Center for Army Analysis conducted model modernization on the Early Deployer Time-Phased Force and Deployment Data Analysis (EDTA) Model. CAA uses the EDTA Model to assist senior leaders with determining an acceptable mix of Regular Army and Reserve Component units to meet war plan demands. This presentation will describe the techniques and tools CAA used to conduct model modernization and provide lessons learned. CAA's model modernization process also embraced principles of process improvement, reducing the time required for model runs and reducing the chance of errors in our process. The intent of this presentation is to inform and solicit feedback from those interested in model modernization. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement		

68696 - The Negative Effects of Defense Financial Obligation and Expenditure Benchmarks

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: COL Jesse R Marsalis
Abstract: A little-known set of metrics within the Defense Acquisition System (DAS) is detrimental to our nation's national security. Uncodified in any Department of Defense (DoD) Instruction (DoDI), Directive, Manual, or Regulation, not even the Defense Acquisition University (DAU) has historic records on these metrics. While there is no published record of these benchmarks completing a DoD staffing and approval process, leaders in Congress, the DoD, and the services each use them to judge every acquisition effort within the Defense Acquisition Enterprise (DAE). The mysterious metric is the "Office of the Under Secretary of Defense Comptroller (OUSD(C)) Rule-of-Thumb Acquisition Obligation and Expenditure Rates," also referred to as 'benchmarks', and they are slowly suffocating the DoD's ability to innovate and deliver quality capabilities by incentivizing behaviors that prioritize fast spending over capability delivery. To be clear, the author does not question the value of performance metrics to assist with congressional oversight, to help align acquisition efforts with national defense priorities, or serve as an early warning for programmatic delay. Instead, the author asserts that the current benchmarks—as they are currently structured—are overly simplistic, unrealistic, and not in line with the realities of the budget execution process or modern-day capability development. While Brown et al. (2015), Gallagher and Lee (1996), and Lee et al. (1993) each present data that reinforce how an S-curve model is more realistic than a straight-line model, such as the current benchmarks follow, this author will instead seek to describe the undesirable behaviors that the unrealistic benchmarks create. In presenting the case, the author will begin by providing a theory of why the benchmarks were developed, describe how they are unrealistic, and give a few examples of how they drive behaviors within the DAE. To illustrate the skewed nature of the benchmarks, the author will present the central findings obtained from 70 anonymous interviews with professionals in the grades of GS13/O-4 to GS15/O6 from across the DoD. The author selected a broad range of functional areas (program managers, contracting officers, financial managers, and professors) from across the DAE to ensure a fuller perspective of the benchmarks. In addition, the author integrates information gleaned from congressional staff, senior DoD leaders, and professionals from the defense industry. Finally, the author will provide a set of more realistic benchmarks that the DoD can apply, which will help alleviate the less than efficient behaviors. Location: TH323 Classification: UNCLASSIFIED Working Group: FG01 Process and Performance Improvement

68705 - Performance Measurement Case Study: From Strategy, to Metrics, to Dashboards for a Defense Research & Development Center

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Steven Lagan		
Abstract: This case study will demonstrate a strategy-based approach for developing performance metrics and the corresponding creation of dashboards for internal performance reviews and decision-making. Logic models will be introduced as the framework for clarifying organizational strategy and identifying leading and lagging performance indicators, which can be presented in custom dashboards using low-code solutions within the Office365 environment. These skills will be presented as a case study for a reimbursable defense research and development center that needed to identify		

performance metrics for its business development activities. Practical tips for performance management staff and associated data science professionals will be provided.

Location: TH323
Classification: UNCLASSIFIED
Working Group: FG01 Process and Performance Improvement

Special Session

68062 - First Timers Orientation

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 2:00 PM
Authors: Mr. John Cobb, IV		
Abstract: Join members of the 91st Leadership Team to learn how to get the most out of the MORS Symposium. Review the Schedule of events, and strategies for planning which Working Groups and presentations to attend, learn more about the Special Sessions, and how to use the MORS App to create your own personal schedule of events. The team will be available to answer all your questions and assist you to make your MORS Symposium experience worthwhile and fun! Location: TH347 Classification: UNCLASSIFIED Working Group: Special Session		

68074 - Rist Prize Competition

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 4:00 PM
Authors: Ms. Tina Yan		
Abstract: The David Rist Prize Competition is a classified session open to participants who sent in their clearances. We ask that participants please remain quiet during the judging. Rist Prize Finalists: Ukraine Crisis Airbase Defense Analysis: HQ USAFE-AFAFRICA Modeling, Simulation, & Analysis (MSA) Team By: Mr. Thomson W. McFarland, Michael Farrey, Andrew Pinto, Richard Stinson (CTR), and Capt Pat Kelly, USAF SSDP Resiliency Team Rist Submission By: Dr. Christopher Wishon, Dr. Jason Reiter, Ms. Rebecca Widrick, and Lt Col Ryan McGuire Preserving Freedom – Joint Planning Group 48-2 Partner Nation Analysis By: Lt Col David Bredesen, Mr. Cory Culver, CDR Clint Emrich, Mr. Patrick McLaughlin, LTC Micheal Meyers, and Mr. Mitch Reed Simulation-Optimisation-Data Analytics based solution to Australian Navy and Army workforce planning By: Mr. Cameron Pike and Ms. Katie Mortimer Location: Jefferson Hall, Room 002		

Classification: SECRET//REL TO FVEY Working Group: Special Session

68140 - 91st MORS Plenary

Start Date: 6/13/2023	Start Time: 8:30 AM	End Time: 11:30 AM
Authors: Ms. Jennifer Ferat		
Abstract: Join us for the 91st Symposium opening session starting at 0830 with President's remarks along with the announcement of this year's Prize and Award Winners. Following the keynote address will be the MORS sponsor panel. Location: Thayer Hall, Robinson Auditorium Classification: UNCLASSIFIED Working Group: Special Session		

68063 - First Timers Orientation

Start Date: 6/13/2023	Start Time: 11:30 AM	End Time: 12:30 PM
Authors: Mr. John Cobb, IV		
Abstract: Join members of the 91st Leadership Team to learn how to get the most out of the MORS Symposium. Review the Schedule of events, and strategies for planning which Working Groups and presentations to attend, learn more about the Special Sessions, and how to use the MORS App to create your own personal schedule of events. The team will be available to answer all your questions and assist you to make your MORS Symposium experience worthwhile and fun! Location: TH344 Classification: UNCLASSIFIED Working Group: Special Session		

68608 - Academia/ Consulting Jr/Sr Session

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Nick Ulmer; Dr. Gregory S. Parnell, FS		
Abstract: This session offers an opportunity for early career analysts interested in academia an opportunity to ask questions and interact with senior faculty members in academia. At the beginning of the session, senior faculty members will give overviews of their experiences and topics of importance in the practice of OR within academia. For the main portion of the meeting, the junior and senior analysts will engage in a wide-ranging discussion of what it is like to be a student and researcher in academia from public and military school perspectives. Location: TH343 Classification: UNCLASSIFIED Working Group: Special Session		

68598 - Air Force Junior/Senior Analyst Session

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Chan Swallow		

Abstract: Mr. Chance Swallow, SES, is the Principal Deputy Director for Studies and Analysis, Office of the Secretary of the Air Force.
This session provides junior analysts with the opportunity to meet with Mr. Swallow to learn about the Air Force military OR career field and to obtain advice relevant to their career. The session will begin with a short presentation by Mr. Swallow followed by an extensive Q&A period. The career advice can help the junior analyst establish their career goals and define the steps needed to achieve them.

Lead from where you are. Read to look around the corner, see possible futures.
Stay curious my friends. You must own the decision you point toward.
The future is Ops Analysis - are you ready to own AI, ChatGPT, and large language models?

Location: TH339
Classification: UNCLASSIFIED
Working Group: Special Session

66780 - Army Special Session with Dr. Bryan Shone, Director of the Army Analytic Directorate

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Patricia Anne Murphy; Dr. Josh Jones

Abstract: In January of 2023, Army senior leaders directed the establishment of the Army Analytic Directorate (AAD). The mission of the AAD is to integrate and prioritize Army analysis to support Army senior leaders' priorities and to inform critical policy and resourcing decisions. The newly established AAD is leading the Army Analytic Community through a transformation of data centricity and analytic proficiency with the support of civilian, military, and contractor personnel to fulfill the Army's analytic priorities. Join us for this special session to discuss the evolution of the AAD, its support to Army and DOD senior leaders, its role within the Army Analytic Community, and the way forward for the directorate.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Special Session

67995 - DHS Jr/Sr Analyst Panel

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Damian Garcia

Abstract: This session provides junior analysts the opportunity to meet with senior analysts in a small group setting to discuss notable cross-cutting analytic activities in the Department of Homeland Security (DHS). Example discussion topics may include how DHS components are leveraging the Science and Technology Directorate's System of Systems Operational Analytics (SoSOA) collaborative environment, U.S. Coast Guard efforts to grow a modern data and artificial intelligence workforce, and the latest activities of the DHS Modeling and Simulation Verification, Validation, and Accreditation Working Group, among others. Beyond the panel topic, the session is also a unique opportunity for DHS analysts to gather and professionally network within and across components and offices.

Location: TH304/306

Classification: UNCLASSIFIED Working Group: Special Session

68606 - FFRDC Jr/ Sr Analyst Session

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Joseph F Adams; Ms. Trena Covington Lilly, FS		
Abstract: This session provides analysts with the opportunity to meet with senior analysts in two Federally Funded Research and Development Organizations (FFRDCs) to obtain perspectives on what it is like to work in a think tank. The senior analysts will also provide insights on the differences between the numerous FFRDCs . Each session will start with a short presentation by the senior analyst followed by an extensive Q&A period when the junior analyst can obtain career advice. Location: TH330 Classification: UNCLASSIFIED Working Group: Special Session		

68607 - Industry Junior/Senior Analyst Panel

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Andrew Turner; Norm Reitter		
Abstract: This session provides analysts with the opportunity to meet with senior analysts in industry to obtain advice and ask career related questions. Each session will start with a short presentation by the senior analyst followed by an extensive Q&A period. Location: TH340 Classification: UNCLASSIFIED Working Group: Special Session		

65605 - USMC Junior / Senior Analyst Session

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. John Young		
Abstract: An open forum for analysts across the Marine Corps to learn from and discuss issues with senior analysts of the Marine Corps Location: TH342 Classification: UNCLASSIFIED Working Group: Special Session		

68534 - 91st MORS Keynote

Start Date: 6/14/2023	Start Time: 8:00 AM	End Time: 9:00 AM
Authors: Ms. Jennifer Ferat		
Abstract: Join us Tuesday, 13 June at 0800 for our Keynote Address. Our keynote this year is the Honorable Susanna V. Blume, Director, Cost Assessment and Program Evaluation (CAPE) in the Office of the Secretary of Defense (OSD).		

Location: Thayer Hall, Robinson Auditorium Classification: UNCLASSIFIED Working Group: Special Session

65931 - Wargaming Expo

Start Date: 6/14/2023	Start Time: 8:30 AM	End Time: 5:00 PM
Authors: MAJ (Ret) Harvey (Trey) Clark Smith, III; Mr. Michael W. Garrambone, FS; Mr. Michael A. Ottenberg		
Abstract: The Wargaming Working Group, WG30, and the Wargaming Community of Practice will host a Wargaming Expo on one day of the 91st Military Operations Research Symposium. The Wargaming Expo will consist of three special sessions over the course of the day and will include demonstrations of wargames of various methodologies and gameplay, participants engagement with wargame designers and practitioners, and even the opportunity to play some of the available wargames. The capstone of the expo will be the execution of the Jutlands 1916: Steel Castles Clash Wargame by renowned wargamers Mr. Paul Vebber (USN Ret.), Mr. Terry McKearney (USN Ret.), and Mr. Mike Garrambone (USA Ret.). Location: TH342 Classification: UNCLASSIFIED Working Group: Special Session		

65902 - "Marine Corps Long-Range Capital Planning/Force Design Affordability Analysis (FDAA) in support of Program Objective Memorandum for 2025-29 (POM-25) and beyond."

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. JJ Bancroft; Major John Bailey; Ms. Brittlea Brown; Mr. Davis Greenwood; Elena Heit		
Abstract: This years' submission serves as an update to the first version of the FDAA which was presented during the 90th MORSS in June 2022. The Marine Corps' concept for Force Design 2030 calls for major changes across the service, both structurally and programmatically. These changes created significant shifts in programmed resources and re-prioritized future funding in an already fiscally-constrained environment. The Marine Corps' Deputy Commandant for Programs and Resources (DC P&R), Program Analysis and Evaluation Division (PA&E) has developed a repeatable process to assess affordability of USMC programs with respect to the USMC topline, Force Design, and relevant portfolios within the current and potential future budgetary environments. Through this process, PA&E created a framework for assessing current and future programs that drive or constrain Force Design implementation. This year's version of the assessment includes a 15-year look at the three pillars of the Marine Corps Force Design effort: Equipment Modernization, Talent Management, and Training and Education. Additionally, this analysis will consider the Installations Plan for the Marine Corps in response to updates in the Marine Corps' Pacific Posture. To enable repeatability, PA&E has developed a Tableau-based affordability tool to facilitate the visualization of long-range capital planning. This assessment also includes potential levers, such as reductions to the Marine Corps Programs, to better assess sensitivity to relieving budgetary pressure. It is envisioned that DC P&R's FD affordability study will continue to serve as a centerpiece for trade space analysis for the Commandant of the Marine Corp's Force Design transformation initiatives. Location: TH353 Classified		

Classification: SECRET NOFORN Working Group: Special Session

66384 - ACD Panel: Typical undergraduate/graduate curriculums for DoD ORSAs - how do they fare?

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Chad Kimmel; David Scott Cohick; Dr. Nathaniel Bastian; Dr. Fred Woodaman; Dr. Brian Lunday		
Abstract: At this analytical capability development (ACD) panel, we will discuss how well the typical undergraduate/graduate based curriculum prepares their graduates for an analytical career in the DoD. Questions to be considered: How can the curriculums be improved? What type of curriculums best prepare their students for a DOD ORSA career? Is there too much focus on hard skills at the expense of soft skills in the traditional ORSA curriculum? This panel will be staffed by educators at various universities - both civilian and military - and we look forward to having good invigorating discussion with all in attendance. Location: TH347 Classification: UNCLASSIFIED Working Group: Special Session		

66409 - Army Junior-Senior Analyst Special Session

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Steven A. Stoddard		
Abstract: One of the most important responsibilities of an Army senior leader is to foster the development of the Army's future leaders. The senior leaders of the Army Analytic Community (AAC) traditionally utilize the MORS Symposium as an opportunity to observe and engage with the future leaders of the AAC. During the Symposium, the AAC's senior leaders conduct a Special Session dedicated to communicating with military and civilian junior analysts. During the 91st Symposium, senior leaders from key Army analytic agencies including The Research and Analysis Center, the DEVCOM Analysis Center, the Army Test and Evaluation Center, the Center for Army Analysis, and the Rand Arroyo Center will hold a panel discussion. Military and civilian analyst attending the session will have the opportunity to ask the senior leaders questions on a range of topics. While not required, attendees are welcome to submit questions in advance to the Army Sponsor Representative, Martin Dubbs, martin.l.dubbs.civ@army.mil. Location: TH348 Classification: UNCLASSIFIED Working Group: Special Session		

68731 - Barchi Paper: Impact of Reliability in Conceptual Design—An Illustrative Trade-Off Analysis

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Gregory S. Parnell, FS; Tevari James Barker; Dr. Eric Specking; Dr. Edward A. Pohl; Dr. Simon Goerger; Dr. Randy Buchanan		
Abstract: System reliability is treated as a parameter and not modeled in the early concept design stages. We illustrate a reliability model for system reliability in early concept design using knowledge		

from similar systems, technology readiness levels (TRL), and functional analysis methods using an unmanned ground vehicle. We integrate the reliability model with performance and cost models to demonstrate the impact of reliability in early concept design. The resultant tradespace comparison with and without early reliability assessment illustrates that reliability modeling can identify infeasible solutions in early system design. This will allow system designers to focus development on the most promising concept designs.

Location: TH312
Classification: UNCLASSIFIED
Working Group: Special Session

68563 - ChatGPT Panel

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. John Cobb, IV		
Abstract: Natural Language Processing (NLP) and ChatGPT are two innovative technologies that have the potential to revolutionize communication, decision-making, and intelligence gathering in the military. NLP is a field of computer science and artificial intelligence that focuses on enabling machines to understand and analyze human language. ChatGPT, on the other hand, in an advanced natural language processing tool that can generate human-like responses to complex questions and commands. Together, NLP and ChatGPT can be used to analyze vast datasets such as social media feeds, news articles, and intelligence reports, to identify potential threats and gain insights into the intentions of adversaries. They can also be used to automate administrative tasks, such as reporting writing and data entry, freeing up personnel for more strategic and tactical work. However, the use of NLP and ChatGPT in military settings also raises important ethical and security concerns. The potential for biases in the models, as well as the risk of data breaches or manipulation, must be carefully considered and addressed. Additionally, the use of these tools must be subject to appropriate oversight and regulation to ensure that they are used in ways that are consistent with military ethics and values. Both NLP and ChatGPT offer exciting opportunities for enhancing military operations, but must be used with caution and appropriate safeguards in place. We'll hear from several NLP experts about the potential uses, challenges, and impacts. Location: TH144 Classification: UNCLASSIFIED Working Group: Special Session		

66231 - Jutland 1916, Steel Castles Clash Special Session

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Michael W. Garrambone, FS; Mr. Terrance James McKearney, FS; Paul W Vebber, CDR USN (ret)		
Abstract: Avast ye MORSians for a unique opportunity presents itself at 91st MORS Symposium at the United States Military Academy, West Point, New York. This year during this special session, the Old		

Sea Dog with his cadre of mates will present a short player tutorial, and an opportunity to experience naval wargaming by participating in a "floor exercise" based on the tactical engagements of the Battle of Jutland, the largest naval battle in modern history. The battle represents the pinnacle of WWI naval thought where participants will learn game mechanics and venture into Jutland 1916: Steel Castles Clash a special skillful adaptation of the Dunnigan larger game tailored to this group and venue, to try their hand at decisive fleet action. This Special Session is sponsored by the MORS Wargaming Community of Practice (CoP) and Working Group 30: Wargaming. A cadre--less cutlasses, will be orchestrating the event and serving as wargame facilitators.

Location: TH340
Classification: UNCLASSIFIED
Working Group: Special Session

68684 - Navy Junior/Senior Analyst Panel

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Stew Sharp		
Abstract: This session provides junior analysts with the opportunity to meet with a senior Navy analyst in their career area to learn about the Navy military OR career field and to obtain advice relevant to their career. Each session will start with a short presentation by the senior analyst followed by an extensive Q&A period. The career advice can help the junior analyst establish their career goals and define the steps needed to achieve them. Location: TH304/306 Classification: UNCLASSIFIED Working Group: Special Session		

65778 - Using Humor in Presentations - How to Use Humor Effectively in a Presentation

Start Date: 6/14/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Melissa Wickers; Ms. Brittlea Brown; Ms. Renee G. Carlucci, FS; Maggie Dozier; Dr. Jessica Lyons; Ms. Sarah Stewart		
Abstract: Humor is a powerful tool. It allows you to calm your nerves, lighten up a difficult topic or situation, and grabs an audience's attention. Many believe humor entails telling a joke. However, there are many ways to use humor in a presentation besides telling a joke. Telling jokes require a skillset that many individuals do not have. The Women in MORS Community of Practices invites you to a Special Session for their June COP meeting featuring a presentation on why humor is useful, effective ways and where to use humor, and what are the dangers that may come along with using humor in presentations. Join us to learn and network with the Women in MORS Community of Practice members. Location: TH341 Classification: UNCLASSIFIED Working Group: Special Session		

66398 - U.S.C.G. - Developing a Data & AI Literate Workforce

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 12:00 PM

Authors: Carlos Martinez; Brian Crimmel; Kevin Laubenheimer; Clare Loftus; Luke Spurrier; Blair Sweigart; Craig Stephen Swirbliss, CAPT, USCG (ret)
Abstract: This panel will consist of senior data & AI practitioners across the Coast Guard to discuss ongoing efforts to develop our workforce to leverage data as a strategic asset with the goal of unlocking insight and automation opportunities. Agenda topics include: -Office of Data and Analytics overview -Enabling advanced analytics at scale via data teams -Creation of USCG data & AI work roles (data analyst, data scientist, data engineer) -Career pathing opportunities for military, civilians, and reservists -Analytics capabilities now and in the future Panel Attendees: CDR Kevin Laubenheimer, CG-ODA, Deputy (Moderator) CDR Brian Crimmel, CG-ODA, Data Analytics Division Chief CDR Luke Spurrier, CG-ODA, Data Team ONE Lead CDR Blair Sweigart, CG RDC, Modeling & Simulation Branch Chief Mr. Craig Swirbliss, CG-1B2, Chief USCG OR Analyst Location: TH342 Classification: UNCLASSIFIED Working Group: Special Session

66811 - Analyst Professional Development Guide

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Ms. Sarah Stewart; Mr. Christopher Lynn Hopkins; Matthew C Wesmiller		
Abstract: Within CAA's analytic workforce, analysts have different job requirements, career interests and goals, and varying backgrounds and skill levels; therefore, they require different professional development to progress their careers. CAA has developed a guide for analyst professional development no matter their background, skills, or career goals. The CAA Analyst Professional Development Guide provides a model for CAA analysts to use as a reference document as they develop their annual appraisal objectives and plan their career progression. The authors will present the CAA Analyst Professional Development Guide for other analytic organizations and outside analysts to adapt for their own use and will seek feedback on the guide for future CAA improvements. Location: TH344 Classification: UNCLASSIFIED Working Group: Special Session		

66813 - Is Affordability it's own process?

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Bruce Riggins		
Abstract: For 11 years the Affordability Analysis Community of Practice has been exploring the definition, process, and position of Affordability. We have watched affordability become important when budgets drop, and the usage of the word decrease as budgets grew. As the economy		

experiences new challenges, we wonder if affordability will again rise in verbal usage and instructional use. But affordability never went away, it just changed its vocabulary. In this Symposium, we would like to ask the members not what affordability means, but what it is. Is affordability its own study? Or might affordability be an element of many processes, from cost estimating, to investment, to project selection. Is affordability all about money? Or do we apply the concept when we choose how many people to assign to a task, the number of planes we can send on a mission, or what percent of our petroleum stores we can use release in an emergency? Is affordability its own defined process? Or is it an element of any process that has to decide how to use a limited resource supply? Join us for a Special Session as we discuss this important subject. Location: TH341 Classification: UNCLASSIFIED Working Group: Special Session

65286 - MORS Data Science & Artificial Intelligence Community of Practice Meeting

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. Nathaniel Bastian; Mr. David Saranchak; Mr. Thomas Goode		
Abstract: Annual meeting for the MORS Data Science and Artificial Intelligence Community of Practice. Location: TH304/306 Classification: UNCLASSIFIED Working Group: Special Session		

66234 - MORS Logistics Community of Practice Symposium Session

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Norm Reitter		
Abstract: The MORS Logistics Community of Practice includes an eclectic group of participants from across organizations that make up and support the U.S. National Security Community. We are logisticians, operational experts, and research practitioners who enjoy learning about current problems and solutions related to all aspects of supply chain and logistics - from manufacturing through expeditionary logistics operations. Join us during this session to share, learn, network and to hear the "state of our community" for 2022 - 2023. Location: TH327 Classification: UNCLASSIFIED Working Group: Special Session		

Tutorial

65413 - Antifragility and Future Conflict: A Tutorial

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 10:30 AM
Authors: William Buppert		
Abstract: Operations research needs to acquaint itself with the limits of modeling and the pitfalls of insufficient and misguided asymmetrical evidentiary bars. Antifragility offers not only an explanatory		

framework of black swan events but creates opportunities for organizations to build themselves from the ground up to be adaptable and resilient in the face of crisis and conflict.

This tutorial will introduce the novice to the concepts of antifragility and how the model may create new ways of looking at future conflict, achieve adaptive frameworks, improve conflict forecasting and better explain ways to build military organizations that respond to violence and capability degradation in a way that parallels the stressor strength improvement in complex systems.

This brief will discuss how the adoption of antifragility models to template conflict dynamics and build resilient learning organizations that improve with stress optimizes the western ability to survive peer and near-peer conflicts in the future. Problem structuring methods (PSM), morphological analysis and other operations research methodologies will be used to tackle the wicked problem sets in antifragility.

Location: TH328
Classification: UNCLASSIFIED
Working Group: Tutorial

65683 - Emerging Complexity Techniques for Operations Research

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 5:00 PM

Authors: Dr. John Thomas Hanley, Jr, PhD

Abstract: Part I:
- a history of applied mathematics that provided the origins for operations research in World War II
- advances in OR techniques during the war
- the establishment of OR as a discipline following WWII
- the institution of systems analysis and growth in computer simulation in DoD

Part II:
- concepts of play and games
- the evolution of games with the evolution of mathematics
- the origins of war games and issues in gaming over the past two centuries
- the role of war games in U.S. Navy and Wehrmacht campaigns of learning up to World War II

Part III:
- new applications of mathematics following World War II
- computers and the origins of artificial intelligence
- games, game theory, and artificial intelligence

Part IV:
Introduction to complexity science techniques
- Deterministic chaos
- non-linear dynamical systems
- agent-based models

Location: TH324
Classification: UNCLASSIFIED
Working Group: Tutorial

66258 - Large Language Models and their Applications for Defense

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 12:00 PM
Authors: Dr. Onur Savas		

Abstract: In recent years, large language models (LLMs) such as GPT-3, BERT, and Transformer-XL have shown remarkable success in a variety of natural language processing (NLP) tasks, including language generation, translation, and question answering. However, LLMs are not limited to just NLP applications and have great potential for use in defense-related tasks as well.

This tutorial will provide an overview of LLMs and their architecture, followed by a discussion of their applications for defense. Specifically, we will examine how LLMs can be used for natural language understanding, knowledge graph construction, and threat detection in defense scenarios. For instance, LLMs can be used for automatic translation and interpretation of foreign language documents, enabling analysts to quickly identify and respond to potential threats. Additionally, LLMs can be used to analyze social media feeds and other online sources to identify sentiment, assess the public perception of an issue or event, and identify potential unrest or threats to national security.

Furthermore, LLMs can be used for automatic summarization and text classification, making it easier for analysts to process large volumes of data and quickly identify key information. For example, LLMs can be used to summarize news articles, social media posts, or other online content, enabling analysts to quickly gain insights into a developing situation. LLMs can also be used to classify documents and identify patterns in the data, enabling analysts to quickly identify potential threats and respond proactively.

Despite their potential benefits, using LLMs in defense-related tasks also presents challenges and limitations. One major concern is privacy, as the use of LLMs can potentially infringe on individual rights and freedoms. Adversarial attacks, where an attacker tries to manipulate the input to fool the LLM, are also a concern. Additionally, LLMs may be biased based on the data they are trained on, which can lead to inaccurate or discriminatory results.

Overall, this tutorial aims to provide a comprehensive understanding of how LLMs can be used in defense-related tasks and the potential benefits and drawbacks associated with their use. Whether you are a researcher, practitioner, or just curious about the field of natural language processing, this tutorial will provide you with the knowledge and insights necessary to explore LLMs' applications in defense.

Location: TH347
Classification: UNCLASSIFIED
Working Group: Tutorial

66660 - Modeling with Streamed Sensor Data – "What to do when your data is a curve."

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 9:30 AM
Authors: Dr. Thomas A. Donnelly		

Abstract: Sensors that record sequences of measurements are now embedded in many systems. There is information in the shapes of the sensor stream that is highly predictive of the likelihood of a system failure or performance. These data are often being used inefficiently due to lack of knowledge

and tools for how to leverage it properly. In this presentation we will show how to fit various basis functions – but especially wavelets - to data streams and extract features called functional principal component scores. Then, we use these features as inputs into machine learning models like neural networks. Answering a wide variety of questions becomes a two-step process of functional feature extraction followed by modeling using those features as inputs. Additionally, it will be shown how when combined with Design of Experiments, one can then model the principal component scores to predict the shapes of data streams as functions of the factors in the design. The DOE analysis can be reversed to determine what factor settings would yield a target curve.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Tutorial

66035 - Operations Assessments Tutorial

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 12:00 PM
Authors: LtCol Tim Holzmann		

Abstract: Operations research analysts are commonly called on to guide operations assessments, but formal training for assessments is limited in number of courses and scope of material. This tutorial will provide "how to" guidance for the conduct of operations assessments. The tutorial structure will follow a guided discussion format. Experienced practitioners in operations assessments are welcome to attend and share their insights. Planned topics include: the purposes of operations assessments, theory and practice of designing measures, the linear additive function and weight selection, embedding assessments in campaign planning and phases, and data collection and management practices.

Location: TH344
Classification: UNCLASSIFIED
Working Group: Tutorial

65615 - Probabilistic modeling and statistical inference: algorithms for OR practitioners

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 5:00 PM
Authors: Dr David Rushing Dewhurst		

Abstract: The OR community uses probability and statistics every day. Well-known tests and models such as t-tests, ANOVA, linear regression, and decision trees are simple yet powerful tools that drive value for diverse OR communities, from logistics and sustainment, e.g., did the part waiting time significantly deviate from historical trends?, to strategic wargaming , e.g., did Red team exhibit significantly higher probability of successful mission than Blue team when confronted with unexpected novelty? However, in messy, real-world environments, the assumptions of such tests and models are often badly violated; more powerful and flexible algorithms are needed to help OR practitioners address the issues raised in today's operational environments.

In this tutorial, we will cover some subset of the following listed topics. The focus will be primarily algorithmic; while theory will be introduced, we will concentrate on implementation of probabilistic models and inference algorithms to solve difficult practical problems. Crucially, each topic will be accompanied by code snippets to demonstrate implementation of the concepts discussed in

commonly used programming languages. We will make accessible a code repository containing the complete source code so that attendees may revisit the examples.

Probability basics: discrete vs. continuous probability distributions; Summary statistics and functions applied to distributions, e.g., moments and quantiles. Sampling from distributions in theory and in practice.

Probabilistic modeling basics: definition and examples of data generating processes or DGP; choosing probability distributions for your DGP; sampling from the DGP; time and memory complexity considerations; Bayes' theorem and its implications; equivalence of some DGPs and graphical models; stochastic control flow and open-world models

Statistical inference basics: definition and discussion of what inference means; families of inference algorithms; exact inference via conjugacy and variable elimination; message passing; sampling-based algorithms, including Markov Chain Monte Carlo and relationship with stochastic optimization.

Probabilistic programming: separation of modeling and inference concerns; querying models; interfacing with external codebases; language choice and implementation considerations.

Location: TH327
Classification: UNCLASSIFIED
Working Group: Tutorial

65734 - Wargaming Counternarcotics in Central and South America via First Stop

Start Date: 6/12/2023	Start Time: 8:30 AM	End Time: 12:00 PM

Authors: Mr. Jeffrey Dan Havlicek; Franklin Kenter

Abstract: It is estimated that over 2,000 metric tons of cocaine is transported toward North America. The main obstacle for narcotic traffickers is law enforcement interdiction during the first transit from the source zone in northern South America into Central America. This transit is the focus of interdiction law enforcement agencies as once shipments reach Central America, the shipments are divided into smaller movements for northward distribution.

One of the major considerations in this scenario is the cooperation required to interdict narcotic traffickers. No one country can tackle the issue of narcotic trafficking on their own as the sheer size of the geographical domain; the minimal number of detection, monitoring, and interdiction assets; and the number of sovereign nations traversed make interdiction a challenge. The Joint Interagency Task Force - South aims to catalyze this cooperation between U.S. Government Agencies and Partner Nations for successful interdiction and detention pending prosecution as well.

We have developed First Stop a narcotics transport wargame to emulate this scenario emphasizing the with emphasis on the diplomatic and tactical operational aspects of the mission. This game differs from traditional wargaming as cooperative predator dynamics are pitted against a well-resourced and well-concealed prey.
This game features three truly asymmetric sides: BLUE, GREEN and RED representing the US, Partner Nations, and narcotics cartels, respectively. The design goal of this game is to emphasize the operational and cooperative aspects of Western Hemisphere operations in the Eastern Pacific Ocean

especially for new partners to the JIATF-S mission. Indeed, a version of this game is planned for use during employee orientation at JIATF-S.

This game is designed for play with 5-6 players. A tutorial demo will be offered for 3 hours with included time for rules explanation at the start and participant feedback at the end.

Location: TH304/306
Classification: UNCLASSIFIED
Working Group: Tutorial

66202 - Design of Experiments for Stochastic Simulation Modeling

Start Date: 6/12/2023	Start Time: 9:30 AM	End Time: 12:00 PM
Authors: Dr. Averill Martin Law		

Abstract: Simulation models often have many input factors, and determining which ones have a significant impact on performance measures (responses) of interest can be a difficult task. The common approach of changing one factor at a time is very often incorrect, because for many models factors interact to impact on the responses. In this tutorial we present an introduction to design of experiments specifically for stochastic simulation modeling, whose major goals are determining important factors and predicting model responses for factor-level combinations that were not actually simulated due to execution-time or setup-time constraints, or because predictions are needed in real time. Traditional experimental designs such as two-level factorial, two-level fractional factorial, and central composite often do not work well because responses are typically nonmonotonic functions of the factor levels and because three-factor (or even higher) interactions may be present. We then discuss Latin hypercube designs that are often more appropriate for the complex response surfaces seen in simulation models. This is followed by a presentation of metamodels (surrogate models) based on regression and neural networks.

Location: TH342
Classification: UNCLASSIFIED
Working Group: Tutorial

66661 - Exploratory Data Analysis and Root Cause Analysis – "What Can You Do When You Don't Have a Designed Experiment?"

Start Date: 6/12/2023	Start Time: 9:30 AM	End Time: 10:30 AM
Authors: Dr. Thomas A. Donnelly		

Abstract: This tutorial demonstrates how to explore data and do root cause analysis for any data set. Analysis is often straightforward when data come from a designed experiment. But when they don't, and the data are messy, and potential predictors are highly correlated, there are still robust approaches to finding what are the dominant factors. This tutorial explores both graphical and statistical tools for getting to the root cause of a process. Methods demonstrated include: Dynamically linking graphs and filtering responses to find correlations. Using easy to understand data mining methods like decision trees. Finding the best design of experiment subset of data within an historical haphazardly collected data set. Using Penalized Regression methods (e.g. LASSO) to do variable selection among correlated factors and reduce the dimensionality of the process space.

Location: TH348

Classification: UNCLASSIFIED Working Group: Tutorial

68340 - Ethics for Analysists and Data Scientists: From the Theoretical to Daily Application in the Workplace

Start Date: 6/12/2023	Start Time: 10:30 AM	End Time: 12:00 PM
Authors: Mr. Terrance James McKearney, FS		
Abstract: We'd all agree that ethical behavior is particularly critical in the practice of OR and data science; as practitioners we need to be seen as honest, forthright, and dedicated to the highest principles of honesty. But how do we adapt these principles and then apply them as we go about our business? In this tutorial, hosted by the MORS Ethics Committee, we will assemble some of the leaders of our profession who have not only had to wrestle with issues of professional ethical behavior in their careers, but guide others in the conduct of ethical analysis. We will review the current thinking on ethics in analysis, including the MORS Code of Ethics. Because attaining these ideals is a matter of constant practice and self-awareness, the tutorial will feature not only a presentation on current ethics regulations and concepts, but a workshop/seminar, where participants will be challenged to respond to a series of situations where ethical issues in the conduct of their daily work will be challenged. This will enhance the tutorial with a lively dialogue on the ethical challenges analysts and data scientists face as junior and senior analysts from both industry and government. Participants will be challenged to explore ethical issues and discuss the role of ethics in their efforts to provide forthright and honest assessment. Location: TH321 Classification: UNCLASSIFIED Working Group: Tutorial		

66233 - Jutland 1916, Steel Castles Clash Tutorial

Start Date: 6/12/2023	Start Time: 10:30 AM	End Time: 12:00 PM
Authors: Mr. Michael W. Garrambone, FS		
Abstract: The Battle of Jutland (German) or Skagerrak (Danish) was significant for being the largest naval battle of the First World War and the most severe in numbers of lives lost. The battle engaged a total of 100,000 men aboard some 250 warships over the course of 72 hours. It questioned the ability of the British navy to maintain a strategic blockade and severely diminished the German naval fleet's capabilities. This presentation provides background on the battle and teaches new wargamers the mechanics of participating in the adapted wargame special session. Location: TH341 Classification: UNCLASSIFIED Working Group: Tutorial		

66662 - Quickly Comparing Machine Learning Methods

Start Date: 6/12/2023	Start Time: 10:30 AM	End Time: 12:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: Through example analyses, you'll see how to build better predicting and more robust models with a range of machine learning techniques. The approaches shown will help answer questions like:

1. With so many machine learning methods, how can I find the best candidate approaches quickly?
2. How can I prevent overfitting and better trust my models - for both large and small data sets?
3. How can I find the dominant factors quickly, especially when there are hundreds of factors?
4. How can I find the best predicting model?
5. How can I find a potentially more interpretable model with confidence intervals?
6. How can I add confidence intervals to any model?
7. How can I visually compare multiple machine learning methods?
8. How can I do multiple model trade-space analysis or optimization?
9. How can I guard against extrapolation in high dimensional factor space?
10. How can I use a sensor stream of highly correlated data to make better predictions?

Featured methods will include different types of regression, neural networks, decision trees, ensemble modeling, and functional data analysis. You will also see how to use graphical and statistical comparison techniques to help choose the “best” predictive model. This presentation is for engineers and researchers interested in learning how machine learning techniques can help them use the data they have today to better predict tomorrow.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Tutorial

65668 - Battlefield AI and Autonomy for Non-Technical Beginners

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 5:00 PM

Authors: Mr. Jerry L. Schlabach

Abstract: The U.S. Government, its military competitors, and the global defense industry are racing to militarize Artificial Intelligence (AI) and Machine Learning (ML) for future autonomous systems. This tutorial will:

- Define and characterize the various levels of military autonomous systems with respect to AI/ML capabilities, human direction, and human trust.
- Dispel and re-characterize common misperceptions about AI/ML and battlefield autonomy, to include the likely technical, moral, and operational limits to weaponization.
- Introduce at a conceptual level the AI and ML fields, with example applications.
- Explain the extraordinary dependency of modern Deep-Learning ML upon the acquisition and conditioning of large amounts of training data (or synthetic models).
- Frame the likely military utility of integrating AI/ML into military systems at the various levels of the cognitive domain (Bloom’s Taxonomy). Identify which cognitive tasks are likely to remain with humans, and which are candidates for machine reasoning.
- Highlight and discuss select OR analytic implications from battlefield AI/ML integration with respect to traditional paradigms such as Commander’s Intent and decision-making.
- Outline select AI/ML issues related to the future of warfare.

Jerry Schlabach is an Engineering Fellow at Raytheon Missiles and Defense in Tucson, who also co-chairs MORS Working Group (#35), "AI and Autonomous Systems." He has a Master's degree in Computer Science (AI) from the University of Illinois at Urbana-Champaign, as well as a Bachelor's degree in Physics from the United States Military Academy at West Point. In addition to a 22-year Army career in Military Intelligence, he has over 25 years' experience at integrating AI into C4ISR prototypes. The 2023 Symposium will be the fifth year Jerry has presented this tutorial in some form, with the assistance of other WG-35 co-chairs.

Location: TH304/306
Classification: UNCLASSIFIED
Working Group: Tutorial

66663 - Custom DOE – Making Your Experimental Design Fit the Problem

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 2:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: This tutorial will present solutions to real-world Design of Experiment (DOE) problems. Nearly all solutions listed below cannot be achieved using classic textbook DOE. If textbook designs are your only resource experimenters will often change their problem to fit the available designs. It is highly recommended that experimenters instead make their design fit their real-world problem. This tutorial will show how to treat separately and in-combination, factors of the following types: continuous/quantitative, categorical/qualitative, discrete numeric, mixture, covariate, blocking, and hard-to-change. It will demonstrate how to constrain design regions and disallow certain factor level combinations. It will show how to augment or add onto existing experiments. By using both augmentation and constraints it will show how to repair a broken design. It will show how to design for special knowledge of the model. Algorithmic custom DOE is the most efficient way to develop accurate and useful models of real-world processes.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Tutorial

66215 - Front Line Operational Analyst Training (FLOAT): a taste from the UK

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 3:00 PM
Authors: Mr Richard Peter Hoyes		

Abstract: This tutorial provides a highly interactive sample of the larger training the UK provides to our deployable analysts and invite our partner nations to attend. The session centers on being effective in an unknown or new environment – ensuring you have the key skills to add value and become that force multiplier a deployed analyst can be. This session focusses less on the specific analytical techniques needed and more on the problem structuring, analytical design and communication.
In the UK we deploy Civilian Operational Research analysts into military Operations (and UK crises) to provide analytic and scientific support to senior decision making. These analysts may deploy anywhere the UK military go and work any type of task. We hold these civilian analysts at Readiness and send them out to the "front line" in support of senior decision makers with minimal notice (24 hrs to 30 days notice). We must ensure they are effective as possible when they arrive. To do this we have a rigorous selection and training program leading to their certification as suitable to deploy.

Whilst the training needs analysis completed to design our program's syllabus is focused on our deployed staff, the tutorial should be useful insights (and be fun) for any one working as an analyst or with analysts in a high paced environment.

Location: TH328
Classification: UNCLASSIFIED
Working Group: Tutorial

66709 - Managing Change for Analytical Professionals

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 5:00 PM

Authors: Ms. Jennifer Ferat; Mr. Walt DeGrange

Abstract: Change can often be wrought with uncertainty, but analytics professionals are well-equipped to drive successful outcomes. The analytics professional has the tools and the insight required to anticipate and navigate change when designing, developing, and implementing analytical solutions. With our course on Managing Change for Analytical Solutions, analytics pros have access to valuable resources that will guide them through any changes as they develop their analytics projects. We provide step-by-step guidance backed by years of research and experience in analytics management so analytics experts can effectively manage change from start to finish. This course is a must-have for analytics professionals looking to confidently handle change when developing analytics solutions. Join us now for the knowledge you need to make sure your analytics projects succeed!

Location: TH341
Classification: UNCLASSIFIED
Working Group: Tutorial

66115 - Rapid Development of Good Enough Machine Learning Models

Start Date: 6/12/2023	Start Time: 1:00 PM	End Time: 5:00 PM

Authors: MAJ Iain Cruickshank

Abstract: Abstract: Are you interested in trying out machine learning solutions for your problems but don't want to spend too much time and resources on them? Do you want to learn how to use the latest zero-shot and low-shot machine learning techniques in your analysis and workflows? This tutorial will show you how to quickly implement machine learning solutions for real-world problems using no-train and limited labeled data approaches. Specifically, we will cover how to use zero-shot text, image, and text-and-image models and how to fine-tune them for specific use cases. By the end of the tutorial, you will be able to quickly implement these machine learning solutions to evaluate the feasibility of using machine learning before investing in expensive data collection, labeling, and model building work.

Length of Tutorial: 3 Hours

Level of the Tutorial: Intermediate. Students must know python programming, to include object-oriented programming, and should have some familiarity with the data science workflow, deep learning, and familiarity with data programming tools in Python like Numpy, Pandas. Being familiar with Pytorch and HuggingFace will allow students the best use of content of this tutorial.

Description and Outline: The tutorial will be conducted in 3 blocks of instruction, roughly corresponding to the core data modalities.
- Block 1: Text
  - Zero-shot labeling for a text corpus
  - Fine-tuning pre-trained models.
- Block 2: Image
  - Using language-image multi-modal models
  - Creating a custom image-text multi-modal model
- Block 3: Advanced topics
  - Using Large Language Models
  - Zero-shot object detection

Location: TH344
Classification: UNCLASSIFIED
Working Group: Tutorial

66664 - Modern Screening Design of Experiments to Get More Information from Fewer Trials

Start Date: 6/12/2023	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: This tutorial is meant to expose testers to the most effective Design of Experiments (DOE) screening methods introduced in the last decade. Attendees will learn about recently published methods for not only efficiently screening factors but for using the data to more rapidly develop second-order predictive models. Definitive Screening Designs (DSDs) will be shown to not only detect main effects and curvature in each factor, but in many cases also two-factor interactions.
DSDs when first published in 2011 could support only continuous factors. Over the last decade methods have been developed to support 2-level categorical factors and blocking. Furthermore, a new way to take advantage of the inherent fold-over structure of row pairs allows for robust modeling of first-order and second-order effects when less than half the factors are active. When the number of significant factors is small, a Definitive Screening design can collapse into a 'one-shot' design capable of supporting a response-surface model with which accurate predictions can be made about the characterized process.
A case study will be shown in which a 10-factor process is optimized in just 24 trials. Checkpoint trials at predicted optimal conditions show the process yield increased by more than 20%. In cases where more than a few factors are significant and the design can't collapse into a one-shot design, the existing trials can economically be augmented to support a response-surface model in the important factors. Graphical comparisons between these alternative methods and traditional designs will show the new ones to yield more information in often fewer trials.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Tutorial

66665 - Efficient Modeling & Simulation Using Design of Experiments

Start Date: 6/12/2023	Start Time: 3:00 PM	End Time: 4:00 PM
Authors: Dr. Thomas A. Donnelly		

Abstract: This presentation will show how Design of Experiments (DOE) methods can be used to extract the most useful information from the smallest number of computer simulation runs. By sequentially running blocks of simulations, computer experimenters can conduct the overall fewest trials necessary to do sensitivity analysis of the factors being studied without over-utilizing high performance computing resources. The greatest benefit occurs when fast-running (seconds) surrogate model can be developed for long-running (hours, days or weeks) simulations.
The fast surrogate model enables testers and analysts to interactively query the modeled process to find optimal operating conditions or the frontiers of the acceptable operating window. These conditions of high interest can then be run using the full simulation to both validate the surrogate model as well as increase the accuracy of prediction. Design solutions demonstrated will include the application of traditional DOE methods to discrete event and agent-based simulations, and modern space-filling designs to more complex physics-based simulations such as Computational Fluid Dynamics (CFD).
When to use, and how to choose among traditional linear regression approximation methods and spatial regression interpolation methods will be discussed. The effective practice of using checkpoint simulations for determining the accuracy of surrogate model predictions will be demonstrated.

Location: TH348
Classification: UNCLASSIFIED
Working Group: Tutorial

65754 - Introduction to Probability Management

Start Date: 6/12/2023	Start Time: 3:00 PM	End Time: 5:00 PM
Authors: Dr. Sam Savage; Mr. Philip Alan Fahringer; Connor S McLemore		
Abstract: The discipline of probability management communicates uncertainty as data that obey both the laws of arithmetic and the laws of probability. The latest open standards can express millions of stochastic simulation trials as small JSON objects stored in the cloud. Formerly siloed stochastic simulations may be assembled into collaborative networks. This tutorial will show how the results of simulations, data science, AI, and statistical applications may be used in chance-informed dashboards by non-technical decision makers in such environments as websites, native Excel models, or other downstream simulations. Attendees are encouraged to bring their laptops with Excel as DISA approved Excel add-ins will be provided. The tutorial will explain how to create examples such as the Top Gun Maverick and Eagle Claw models available at the MORS Probability Management Community of Practice. Location: TH347 Classification: UNCLASSIFIED Working Group: Tutorial		

66089 - How to Validate Your Models and Simulations

Start Date: 6/13/2023	Start Time: 3:00 PM	End Time: 5:00 PM
Authors: Dr. Averill Martin Law		
Abstract: All models and simulations are surrogates for physical experimentation with the system of interest, which is usually impossible, disruptive, or not cost-effective. Thus, if a model is not reasonably “valid,” then any conclusions drawn from the model results might, very well, be erroneous. In this tutorial we present a comprehensive set of techniques for building valid and		

credible simulation models. Ideas to be discussed include the importance of a definitive problem formulation, discussions with subject-matter experts, interacting with the decision-maker on a regular basis, development of a written "assumptions document" (not the same as a requirements document or conceptual model), structured walk-through of the assumptions document, use of sensitivity analysis to determine important model factors, comparison of model and system output data for an existing system (if any) using numerical statistics and graphical plots, and comparison of model output data with the comparable output data from another model that is thought to be "valid." Each idea will be illustrated by one or more real-world examples. We will also discuss the considerable difficulty in using formal statistical techniques (i.e., confidence intervals and hypothesis tests) to validate simulation models, due to the unavailability of model and system output data with the correct characteristics.

Location: TH308
Classification: UNCLASSIFIED
Working Group: Tutorial

65647 - Analysis of War Games

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Dr. John Thomas Hanley, Jr, PhD		
Abstract: "Gaming is a powerful method for simultaneously mastering complexity, enhancing communication, stimulating creativity, and contributing to consensus and a commitment to action." (Duke & Guertz, 2004, p. 23) However, games cannot provide proof of cause-effect relationships. The reasoning in games is abductive, triggering insights that require further investigation. Along with the invention of the game of Kriegsspiel in the early nineteenth century, the Prussians instituted a campaign of learning that became a model for U.S. Navy and led to success in the Pacific in World War II. The German Wehrmacht's even more rigorous campaign of learning between the World Wars provides additional lessons for gaming up and down the chain of command and interactions between concept generation and exploration, gaming, prototype development, and fleet/field exercises. The presentation will address how DoD has come to rely too heavily upon computer-based campaign analysis to execute its systems analysis paradigm. Also, the ability of artificial intelligence to compete with humans in games is a principal metric for advances in AI. Games as parts of campaigns of learning will become even more important with the deployment of artificial intelligence. One hour is required for the presentation and Q&A. Location: TH329 Classification: UNCLASSIFIED Working Group: Tutorial		

65456 - Art of Successful Analysis

Start Date: 6/13/2023	Start Time: 3:30 PM	End Time: 5:00 PM
Authors: Mr. Arthur H. Barber, III, FS		
Abstract: This tutorial presentation, which was very well-attended at the 90th Symposium, will summarize the key steps in the end-to-end process of developing and delivering quality, successful analysis and then explain how to succeed at each step. These steps include defining the problem in terms suitable for analysis; attacking it with appropriate analytic techniques; assuring quality of the results; preparing the briefing of results; and delivering the briefing. It particularly emphasizes and		

provides guidelines for success in the last two of these. The presentation incorporates lessons from the author's 25 years of leading analysis projects and organizations in the Pentagon and 9 subsequent years as the Chief Analyst of a major private sector analytic provider.

Location: TH341
Classification: UNCLASSIFIED
Working Group: Tutorial

65649 - Confrontation Analysis

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Dr. John Thomas Hanley, Jr, PhD

Abstract: Confrontation Analysis is a gaming technique based upon game theory developed to account for contending sides dynamically introducing new strategic options as the situation evolves. Confrontation Analysis can be used both for anticipating the behavior of various actors involved in a contingency, or bringing actual stakeholders together, as British gamers have in conflicts in the Balkans, the Levant, and Libya. Employed by British General Rupert Smith when he served as Commander Bosnia and Herzegovina Command in 1995-1996, the technique was refined for peace operations campaigns and is broadly applicable to “gray zone” and coalition-building campaigns, and for bringing together stakeholders having different positions where there is no threat of actual violence. The technique, supported by computer software, identifies dilemmas created by the positions of the various players and provides the players opportunities to revise their positions as the other players do, leading to resolving the conflict or a better understanding of what conditions need to change to if the conflict is to be resolved. The presentation will use material from a class that explored follow on to the Joint Comprehensive Plan of Action for Iran’s nuclear material following President Trump’s decision to withdraw from the agreement.

Location: TH342
Classification: UNCLASSIFIED
Working Group: Tutorial

66204 - Depicting and Assessing Risk Correctly: The Pandemic Case

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Dr. Douglas A. Samuelson

Abstract: We discuss how to assess various methods of depicting and responding to threats: risk is best expressed as neither a sum nor a product, but rather as a sum of products -- or, in more general form, a multiple Stieltjes integral. This seemingly somewhat daunting depiction greatly clarifies the problem and simplifies readily, as SIPMath ™ provides a quick and easy way to compute probabilities and expected values of consequences. Chancification ™ software, the newest breakthrough from probabilitymanagement.org, then makes it easy to display histograms of risk and locate tipping point values. Deterrent and mitigation effects are then best depicted as the difference between computed risk with and without the proposed measure. We then show how usual metrics of statistical variation can be wildly misleading when assessing risks involving rare, high-consequence events, often leading to grossly inaccurate estimates of risk. Again, proper depiction of risk avoids the pitfalls. Illustrative examples are drawn from modeling scenarios of spread and mitigation of epidemics, including how to estimate whether facilities are likely to be overwhelmed. We note that the same methods and

software can be easily adapted to cybersecurity scenarios. We present and discuss how to apply SIPMath and Chancification to develop these kinds of metrics.

Location: TH347
Classification: UNCLASSIFIED
Working Group: Tutorial

68718 - MORS Mentorship Program - MentorCity

Start Date: 6/15/2023	Start Time: 3:30 PM	End Time: 5:00 PM

Authors: Dr. Simon Goerger; Ms Katherine Miller; Dr. David Myers

Abstract: The MORS Mentorship Program is designed to match MORS members with a mentor that can help the member plan their career, become more involved in MORS, and/or improve a presentation or paper. The program helps MORSians achieve their professional goals by improving their understanding of and skills as related to the National Security Analytical Community and/or Society through engagements with MORSians. The programs objectives include, a) professional development of MORSians as members of the National Security Analytical Community, and b) development of MORSians as leaders of the Society. This tutorial is designed to familiarize MORSians with the MORS Mentorship Program, the MORS mentorship website, and the 2023 MORS MentorCity web-based tool that facilitates the linkage and collaboration of MORS mentors and mentees.

Location:
Classification: UNCLASSIFIED
Working Group: Tutorial

WG01 Homeland Security Analysis

65944 - Migrant Models Integration (MMI)

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Michael Resig

Abstract: The DHS S&T Migrant Models Integration Tool (MMI) is a modeling and simulation solution developed by the United States Department of Homeland Security Science and Technology (DHS S&T) to address the challenges of integrating data from multiple sources to support decision-making processes. MMI is a discrete time-step simulation which depicts end-to-end migrant processing throughout multi-agency pathways. MMI enables agencies and operators to integrate multiple models from various sources, including those related to migration patterns, to obtain a comprehensive understanding of migration trends. This information can be used to develop proactive and evidence-based policies and programs. MMI has a user-friendly interface that streamlines the integration process, allowing organizations to quickly and efficiently access the information they need. The tool resides within SoSOA – a DHS virtual environment that enables users to work collaboratively on their operational analysis projects – which has robust security features to ensure the privacy and protection of sensitive information. Additionally, MMI provides a centralized platform for managing and monitoring data integration processes, ensuring that the information is up-to-date and accurate. DHS S&T is committed to developing innovative solutions that address the complex challenges faced by organizations in the migration domain. This presentation will demonstrate the status of the Migrant Models Integration Tool, its development, and how it provides agencies the support they need to make informed decisions based on current insights.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

65644 - Forecasting Migrant Encounters at the Southwest Border: A Force Multiplier for DHS and the Wider Federal Government

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Justin Schon; Dr. Douglas Baals; Dr. Nadwa Mossaad

Abstract: How many migrants will attempt to cross the United States Southwest land border with Mexico in the next six months? The Office of Immigration Statistics (OIS) in the Department of Homeland Security (DHS) seeks to answer this question with a mixed methods approach that provides new forecasts each month. First, OIS estimates separate Bayesian Structural Time Series (BSTS) models for 33 country-family type groups (top 10 countries plus all other, each broken down into Single Adults, Family Units, and Unaccompanied Children). Then, predictions from the BSTS models are averaged with predictions from a qualitative model produced by subject matter experts within the Customs and Border Patrol Statistical (CBP Stat) office. The final predictions are disseminated across DHS components, other federal government agencies, Congressional budget appropriators, and the White House for operational planning, policy development, and budgeting. In addition, the projections are used as a major input in many downstream modeling efforts and operational planning uses. These uses include budget review and justification, modeling the effects of Title 42 termination, holding capacity, and anticipated demand on partner agencies. OIS predictions therefore serve as a force multiplier that contributes to building forward-looking understandings of migration patterns and facilitates modelling for a wide variety of immigration enforcement outcomes and processing stages. In addition, prior predictions are rigorously validated against actual migrant encounter numbers to evaluate forecasting accuracy. Overall, OIS migrant encounter predictions have averaged an absolute percent error under 10% one month ahead – with the greatest accuracy for Single Adults and Mexican nationals – with growing error further into the future, an unprecedented accuracy given the high uncertainty around these migration flows.

Location: TH324
Classification: UNCLASSIFIED // FOUO
Working Group: WG01 Homeland Security Analysis

66132 - US-Mexico Border: Strategic Security Measure Allocation for Better Surveillance and Safety

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Eva K. Lee

Abstract: The large influx of immigrants across the US-Mexico border has seriously strained the US Government's capacity to handle border safety and protection. Although there have been numerous debates regarding strategies and policies for securing border safety and mitigating the risks and danger migrants go through to arrive in the United States seeking a better future, an effective unifying theme of border security and operational infrastructure has not emerged.

Working with the U.S. Customs and Border Patrol (CBP), we design a quantitative construct for optimizing security measure investments to achieve the most cost-effective deterrence and detection capabilities. We model the CBP Enterprise Rise Management using 3-tier security measures that include satellites monitoring the geographic area of the border, high altitude drones with high fuel

capacity for extended surveillance, and a ground layer of mixed autonomous security surveillance systems and manned outposts.

A large-scale multiple-objective portfolio optimization problem is formulated to return an optimal allocation of security devices and measures by optimizing three objectives: 1) maximize the utility of the applied portfolio, 2) maximize the probability of detection, and 3) minimize total operational cost. The physical/cyber / resource/logistics constraints include resource capacities, device installation, sector installation budget, resource availability, and sector resource.

The utility objective improves by adding strategically stronger security measures to a sector that sees larger rates of apprehensions on average and has a larger region of coverage with less manpower. Each security measure has a probability of detecting a threat, with the system as a whole having an overall threat detection probability. Since the system is layered, this is a conditional probability that at least one of the measures/devices in place will detect a threat given there is a threat. From here, a system reliability analysis can be performed with the intent of maximizing risk reduction or threat detection.

To the best of our knowledge, our work presents the first mathematical model that optimizes security strategies for the CBP and is the first to introduce a utility factor to emphasize deterrence and detection impact. Com[itational strategies will be discussed in solving these intractable instances.

This work is partially supported by a grant from the Department of Homeland Security. The content and result of this work have been briefed to the Homeland Security Advisor to the President, and part of the recommendations have been adopted for implementation.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

65795 - Measuring Joint Performance - A Case of a DHS Operations Coordination Plan Modernization Effort

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr. Yukari K Hughes

Abstract: Effectively measuring operational performance is integral to achieving an organization's goals. The traditional way of measuring performance is through quantitative data measures; however, qualitative measures via observations, interviews, and narrative input from questionnaires also allow analysts to probe the extent of the effectiveness of plans and programs. In addition, readily available textual analysis tools would make qualitative (thematic) analysis effortless and save time.

In this presentation, the author focuses on qualitative measures used to assess the effectiveness of the DHS Maritime Operations Contingency Plan (MOC-P, 2011). The MOC-P established DHS' cross-component plan for maritime operational coordination, planning, information-sharing, intelligence integration, and response activities for an efficient, effective, and coordinated departmental response to threats (i.e., unlawful exploitation of the maritime domain). The plan was implemented by the operational execution arms (Regional Coordinating Mechanisms - ReCoMs) in the Coast Guard Sector geographic areas of responsibility (AORs).

The author presents how a questionnaire was used to determine the strengths and shortfalls of the joint plan and the maturity of ReCoMs to modernize the decade-old plan for greater success where joint performance data are scarce.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

65890 - Determining the Coast Guard Enforcement Cutter Fleet Sufficient to Meet Current and Emerging Missions

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Joshua Kitenko; Daniel Winter

Abstract: The United States Coast Guard maritime enforcement cutter fleet projects surface presence domestically and abroad. The fleet is undergoing its largest recapitalization effort since World War II with three, simultaneous acquisition programs. Given recent growth in emerging mission demands, and the mission overlap with these recapitalized assets, Congress requested analysis to determine the fleet sufficient to meet current and emerging mission needs with which to base follow on acquisition and homeporting decisions. Coast Guard analysts in the Office of Requirements and Analysis elicited presence requirements and capability constraints from tactical commanders and evaluated trends in historical data. Analysts then crafted a mixed integer optimization model to optimize the enforcement cutter fleet force structure by minimizing the estimated total fleet lifecycle cost while meeting the capability requirements for each mission area. This presentation will provide an overview of Coast Guard enforcement cutter missions, platforms, and general force planning business rules and how analysts completed a research study to optimize the future recapitalized fleet to meet future needs.

The views expressed herein are those of the author and are not to be construed as official or reflecting the views of the Commandant or of the U. S. Coast Guard.

Location: TH324
Classification: UNCLASSIFIED // FOUO
Working Group: WG01 Homeland Security Analysis

66135 - "New Problems", Forgotten Solutions

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Aaron Horwood

Abstract: In the 42 days following hurricane Maria, the Federal Government deployed 366 generators with a combined 122-Megawatt electric (MWe) capacity to Puerto Rico. This powered 1/3 of the island's critical infrastructure, resulting ~4,600 excess deaths and a FEMA's cost estimate of ~80 billion dollars. This DSCA effort also highlights the DoD's current inability to meet its historic wartime needs for mobile electricity seen throughout the 20th century, let alone feed its energy hungry transition to synthetic fuel/electric vehicles over the next two decades. The whole of government response in Puerto Rico provided only half the 250 MWe necessary for an all-electric Army division, far less than the DoD will need as a whole.
Failure to address this energy capability gap now will drastically increase the DoD's logistical vulnerabilities and will directly result in the needless suffering of US citizens in times of peace.

Thankfully the USG and DoD have a proven solution to this problem. One which if effectively employed, could flip this vulnerability into unparalleled opportunity to; build US productive resilience, expand US hard and soft power, dominate global energy markets, and fundamentally shift global supply chains.
That solution is a robust combination off first leverage local grids when able, powering major nodes with large floating power plants, and pushing small ground mobile generators forward to more isolated critical energy needs. During WW2 ~220 MWe of mobile floating generating capability, and ~100 MWe of ground-based generators were built. They represented 1.5% of the US power grid total capacity in 1940 and are equivalent today to ~7 GWe. These floating assets provided essential power to Cherbourg, Ghent, Antwerp and Manila during WW2, Pusan and Inchon in the Korean War, supported the US buildup in the Vietnam War, and were used for domestic disaster relief mission and to support arctic and pacific DoD installations from the 1940's to the 1970's.
The floating capability aged out in the 1970's, and the small ground-based generators have since significantly atrophied. Today they need to be rebuilt, and in many cases built to use nuclear power. The Navy has proved the value of nuclear power to the DOD in freeing it from the chains of liquid fuel logistics; further nuclear is the only energy source that can enable military forward synthetic fuel production. In combination this would allow the DoD to meet any mix of electricity or liquid fuel demand almost anywhere in the world.
This approach is also cost effective as these assets would generate value in times of peace and could be developed in a public private partnerships model to underwrite initial development. Successful long term commercialization of this technology would allow the DoD to use a COTS based approach for future procurements. This would open up substantial benefits in dealing with global warming, sustaining the US economy, and projecting soft power globally.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

66118 - Current US Army Developments of Micro-Mobile Nuclear Power Plants for Ground Operations

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr. Kenneth S. Allen

Abstract: The original US Army Corps of Engineers Army Reactor Operators Course ended in the 1970s when the Corps of Engineers concluded the Army Reactor Program which included several fixed-base and mobile nuclear reactors. In 2018 in response to high costs and casualties associated with POL use to produce electricity, the Strategic Capabilities Office (SCO) designated the US Army as the lead to investigate the use of Micro Mobile Nuclear Power (MMNP) reactors for ground operations. In 2019, the SCO created Project PELE to develop a prototype MMNP reactor designed to create 10 MW electricity, be air-deployable, and use high-assay low enriched TRISO fuel. As of October 2022, the SCO project PELE down selected to one corporate developer (BWXT) for the MMNP prototype with a criticality target of 2024. In 2021, the Office of the Chief of the Corps of Engineers (OCE) established the Nuclear Power Branch with responsibilities that include developing the training and curriculum for both enlisted reactor operators (RO) and officers who will serve as reactor leads (RL) and senior reactor operators (SRO). Currently, the Nuclear Power Branch is working with the Department of Physics and Nuclear Engineering at West Point to help develop the program of instruction and move forward to meet strategic milestones and requirements set by Army Reactor Office for licensed operators as the MMNP prototype is developed. In spring of 2022, Dr. Allen conducted a virtual

course for six weeks to over 65 members of the Army and DoD titled “Nuclear 101”. This course was sponsored by OCE to help educate and train various members across the Army to include Army Testing Command members about the basics of radiation, nuclear reactors, radiobiology, and safety. This was the first step in the education and training of the Army’s personnel to introduce nuclear power capability safely and effectively to the service. For the future Reactor Operators, the current ideation for training has initial concepts such as the basics of math, physics, heat transfer, and electrical systems provided by the OCE. Following the basics, the students would receive training from members of the West Point Nuclear Engineering program on nuclear theory, reactor operations, radiological control, health physics and safety. This partnership leverages the intellectual capital of the trained Army officers and civilian faculty at the Academy in support of the future of ground nuclear power plants. Following the academic phase, the students would move to the hands-on simulator and then eventually move to the actual reactor prototype for final licensing and eventually providing safe, reliable power to DoD installations worldwide.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

66066 - Sciti Labs: Accelerating Innovation for First Responders by Leveraging Commercial Best Practices and Predictive Analytics

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Daniel Thomas Maxwell; Mr. David Ihrie		
Abstract: Much of the technology innovation in the commercial marketplace originates in small start-up businesses. This is especially true for innovations available at a price point accessible to first responders and local planners. The DHS Sciti Labs Program, initiated in 2017, was created to capitalize on this characteristic of the economy. As potential effectiveness multipliers the program leveraged the expertise of the Virginia Center for Innovative Technology assist in the selection and mentoring of start-up companies. Additionally, the selection process used a Bayesian Network based predictive analytic model, called EXOGENiUS, to score applicant companies. One challenge of assessing the efficacy of analytic approaches to choosing companies is it often takes five to ten years to obtain reliable data on their outcomes. This presentation shares extremely positive return on investment results of the program at the five-year mark and reviews the correlation of the results to the analytic methods used to select the companies. Location: TH324 Classification: UNCLASSIFIED Working Group: WG01 Homeland Security Analysis		

66183 - Identifying Potential Impacts of Geopolitical Tensions on Domestic National Critical Functions

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: James Marks; Donald Kim Erskine; Duane Verner; Darren Chen; Dr. Elizabeth Bolton; Dr. John R. Hummel, FS		
Abstract: Argonne National Laboratory, in support of the U.S. Department of Homeland Security (DHS), Cybersecurity and Infrastructure Security Agency (CISA), National Risk Management Center		

(NRMC), is analyzing the potential impacts of current geopolitical tensions on domestic National Critical Functions (NCFs).

The international system is increasingly more competitive – and more unstable – shaped in part by challenges from Russia's invasion of Ukraine and a rising China – and at greater risk of conflict as states and non-state actors exploit new sources of power and erode longstanding norms and institutions that have provided stability in past decades. Argonne subject matter experts are engaging with their partners in NATO, the EU, and others to better understand the current geopolitical landscape and potential new risks to NCFs.

Argonne is helping the NRMC answer the following research questions:
• Do circumstances suggest the need to consider criticalities to determine the relative importance of critical infrastructure differently? If so, how?
• Would representations of criticality also need to change (e.g., NCFs, or other schema)?
• What, if any, guiding principles have emerged regarding best practices for resilient NCF performance?
• Are there risk categories or specific types of risk that are not yet well addressed by our current assessment approaches?
• Are there indicators that can serve as early signals of significant changes in the strategic operating environment that should be incorporated into our anticipatory scanning?
• What has been the West's response to events unfolding in Ukraine and across the globe?
• How vulnerable is the U.S. across the political, military, economic, social, informational and infrastructure (PMESII) domains to hybrid threats targeting the West and its democratic institutions?
• What if China invaded Taiwan? Could the United States "decouple" from China by reducing U.S. dependence on Chinese products and supply chains - for both economic and national security reasons? How would decoupling from China impact the NCFs?

To date, Argonne has examined emerging geopolitical threats through the lens of Russia as a hybrid warfare actor employing hybrid threat tools as conventional and unconventional instruments of power and subversion to exploit its adversaries' vulnerabilities. Argonne conducted an initial screening of all 55 NCFs to determine which ones are potentially vulnerable to disruption based on current threat analyses and available functions-based decompositions of NCFs.

Going forward, Argonne will explore the broader geopolitical landscape, and will assess the implications of emerging or potential future geopolitical tensions on NCFs. The team will assess changes to the level of risk to NCFs, and will review and update of possible outcome scenarios, seeking to identify any characteristics or indicators of systemic change.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

66219 - A Network-of-Networks Framework for Analyzing Functions-Based Critical Infrastructure Risk and Resilience

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Samrat Chatterjee; Dr. Auroop Ganguly; Dr. Dennis Thomas; Jack Watson; Matthew Oster; Ilya Amburg		

Abstract: The U.S. Department of Homeland Security Cybersecurity and Infrastructure Security Agency (CISA) is developing new analytic capabilities and a Risk Architecture (RA) to understand, manage, and reduce multi-hazard risks to our cyber and physical infrastructure. This includes defining National Critical Functions (NCFs) that are vital for ensuring safety, security, and economic prosperity of our homeland. National Critical Functions (NCFs) and their decomposed subfunctions, critical infrastructure systems, and assets represent interdependent networks with diverse dependencies. Characterizing interdependent NCF network behavior under uncertainty is essential for securing, maintaining, and restoring functionality against compound natural and targeted failures. This talk will discuss how network analysis and data science methods are being used to support risk, resilience, and decision analysis with NCF networks. Our approach blends network science, graph theory, and network optimization methods within a network-of-networks framework (including multigraph, multiplex, interdependent, and dynamic network constructs) to enable NCF risk, resilience, and decision analysis. This framework incorporates interdependent infrastructure system topology and dynamics, risk and resilience feedbacks, stochastic cascading impacts, and diverse dependencies spanning across nested levels of networks. NCF network analysis results include identification of critical nodes, paths, impact propagation, cascading effects, and multi-level visualizations. We will discuss notional examples with NCF-level and transportation infrastructure asset-level data, as well as briefly describe the mathematical methods and early analytic results. Our network-of-networks framework will provide secure and defensible methods to analyze functions-based NCF networks. Analytic outcomes and insights based on our framework will assist CISA and their partners to implement the NCFs and RA.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

65948 - Data & Info Sharing: Taxonomies & Ontologies in Critical Infrastructure Protection

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:30 PM

Authors: Ms. Carmen Zapata; Jesse D Osborne

Abstract: The Cybersecurity and Infrastructure Security Agency (CISA) created a critical infrastructure data taxonomy (IDT) to serve as a common nomenclature used by the infrastructure protection community and industry partners to categorize infrastructure assets. The IDT establishes a detailed and structured terminology that facilitates common data management practices to enable data sharing amongst mission partners. Applying an ontological approach and using techniques to store the IDT as a spatially enabled Knowledge Graph (KG), CISA is advancing the IDT's capabilities to model, visualize, and analyze risk to critical infrastructure using graph theory. In this presentation, CISA will review progress since MORS 90th presentation of IDT work. The talk will include a walk through the history of the IDT and how CISA is strengthening decision-making by building geospatial visualizations of infrastructure networks' interdependencies that demonstrate how disruptions to cyber operations impact critical assets of the physical world. Working group discussion will welcome feedback and ideas on the methodology, the viability of leveraging ontologies, and how to best engage industry to gather requirements for refreshing and adopting an enhanced IDT.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

65386 - A Historical Lesson in Homeland Security: Protecting the "Zone of the Interior" in World War II

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Cyrus J. Staniec, FS		
Abstract: When World War II started in Europe in September 1939, the United States was faced with the immediate task of rebuilding its depleted armed forces, with the initial concern of defending our nation's borders from invasion and subversion. In 1940, 13 National Guard divisions were Federalized and trained through a series of exercises culminating in the Great Louisiana Maneuvers of 1941, leaving states with limited internal capabilities. The attack on Pearl Harbor in December 1941 brought the dilemma to a head – the United States was now drawn into a war with two theaters of operation, but still had to secure its internal areas and assets. The solution was the creation of the Corps of Military Police, particularly the battalions designed and equipped to protect and defend the "Zone of the Interior (ZI)." But how did it come to be? Military Policing was, at the time, a function within other military organizations, largely dedicated to law enforcement activities, with only two actual battalions in existence. This talk, using source material from the National Archives and the National Military Personnel Center, will recount the remarkable process by which the US Army "bootstrapped" over 100 "ZI" battalions in 1942 to defend the "Arsenal of Democracy." It will address where they were stationed and why, how they were trained and equipped, and what some of their operational issues were. In addition, we will discuss the group fates of these units, and why. In its conclusion, the talk will consider whether such a mobilization might ever be necessary in our future, and how such a need might be met. We expect that listeners will add some historical perspective to their critical thinking about the strategic defense needs of the United States. Location: TH324 Classification: UNCLASSIFIED Working Group: WG01 Homeland Security Analysis		

65936 - The Aviation Security Screening Optimizer for Risk and Throughput (ASSORT)

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Nick Betzsold		
Abstract: In the wake of September 11th, 2001 the United States has allocated a tremendous amount of resources into improving aviation security policies and practices. The increased attention on aviation security practice necessitates the ability to monitor the risk an airport faces at any point in its operation. With a focus on airport security checkpoints, the Aviation Security Screening Optimizer for Risk and Throughput (ASSORT) is exploring different conceptual traveler types (e.g., general, trusted, and trusted-plus) and different checkpoint screening Concept of Operations (CONOPS). For instance, having a higher starting trust level than a general traveler, a trusted traveler may be required to encounter fewer or quicker-but-less-thorough screening technologies, resulting in significantly greater passenger throughput. As a web-accessible platform, ASSORT can be used to determine the optimal balance of checkpoint screening CONOPS subject to passenger throughput and risk preferences. This presentation will review the ASSORT algorithms that quantify risk as a function of numerous factors (e.g., threat scenarios) and parameter settings (e.g., security posture). Risk is quantified at the checkpoint, at the aircraft, and for the airport, consistent with the DHS risk assessment methodology using the core risk components: threat, vulnerability, and consequence.		

ASSORT also combines this risk calculation with a dynamic discrete event simulation to more realistically mimic airport operations as stochastic passenger arrivals to the airport/checkpoint ebb and flow throughout the day. This implies checkpoint queues also ebb and flow, and in turn checkpoint configurations may change to increase passenger throughput during high wait time periods to decrease risk and vice versa. ASSORT allows exploration of opportunities for optimization and trade-off analysis of checkpoint CONOPS and configuration settings. This will help to determine the right size and mix of resources (to include TSA personnel staffing levels) and also offer reduced staffing and life cycle costs when appropriate. In addition, ASSORT can help to improve the passenger experience at checkpoints in the future. Lastly, ASSORT can help to uncover the benefits and prioritization of future technologies/CONOPS as they come to fruition.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

66079 - Simulation of Individual Human Behavior and Group Dynamics in Crowds

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Susan K. Aros

Abstract: Simulation modeling of human behavior in crowds is a difficult task that has been undertaken by researchers across multiple disciplines, and for various purposes. We model human behavior within crowds using an agent-based simulation we developed called WRENCH. WRENCH models human perception, movement, and collision avoidance, incorporates emotions and cognitive processes, explicitly models groups and changing identifications, and models security forces deployed in the area. We discuss our approach to modeling human behavior and demonstrate the use of WRENCH to explore emergent crowd behavior in a developing protest situation in response to a security force that can deploy non-lethal, as well as lethal, weapons. We discuss how we model the individual people, their behavior, and group dynamics, and discuss insights for simulation modeling of crowds in a security context.

Location: TH324
Classification: UNCLASSIFIED
Working Group: WG01 Homeland Security Analysis

66039 - Using Bayesian inferencing for pattern-of-life anomaly detection

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Miles Kelly; LtCol Tim Holzmann

Abstract: Despite decades of research, maritime traffic models' limited predictive power continues to constrain their operational utility. We build on previous pattern of life modeling algorithms and contribute a Bayesian inferencing model for anomaly detection. Our probabilistic approach provides decision makers the capability to tailor the belief threshold for identifying anomalies and to enact a measured response based on the degree of abnormality. We perform a case study to evaluate the results, verifying that our Bayesian inferencing method accurately refines its probability when given the location and time of a ship of interest, and serving as a proof of concept for providing actionable information to inspect abnormal behavior.

Location: TH324 Classification: UNCLASSIFIED Working Group: WG01 Homeland Security Analysis

66369 - Shifting With the Adversary: Developing Indicators for A Changing Cyber Landscape

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Ruby Booth		
Abstract: Cyberattacks occur when a threat actor is motivated to commit a harmful act and has access to a target or targets in the absence of any capable guardian that could prevent an attack. However, the specific mechanism an actor uses is dependent many factors. Anticipating changes to the nature and frequency of cyberattacks poses a thorny problem. Fortunately, cybercriminals generally function as rational actors employing a risk/reward calculus that can be understood. Unlike cyber, many common risks are well represented by historical trends and have well-established precursor events. Trajectories of hurricanes - for example - can be estimated weeks in advance. As time to landfall decreases, projections and damage estimates can be refined and incident response coordinated in a timely manner. By contrast, cyber intrusions are dynamic, evolving quicky. Cyber actors can bypass defender actions in a way natural catastrophes cannot. The speed and flexibility of cyberattacks make characterizing the cyber risk space challenging. Furthermore, there is relative lack of historical cyber incidents to draw upon compared to vast amount of data available on natural catastrophes. Additionally, what historical data does exist can quickly become outdated as attackers adapt. In order to reduce the harms from cyberattacks in the long term, nations will need models that can anticipate trends in cyberattacks rather than simply reacting to trends once they occur. In this session, we will describe an approach for identifying candidate indicators that have the potential to enable anticipation of shifts in cyberattack trends. Audience participation is encouraged. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525; SAND2023-11553A Location: TH324 Classification: UNCLASSIFIED Working Group: WG01 Homeland Security Analysis		

WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

66468 - Functional Formulation DOE for Process Optimization

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr John Powell Davies, Jr		
Abstract: Functional Formulation DOE for Process Optimization The Decontamination Sciences Branch at the U.S. Army Combat Capabilities Development Command Chemical Biological Center (DEVCOM CBC) studies the physical and chemical mechanisms that are relevant to chemical warfare agents (CWAs) for the purposes of developing decontamination technologies. Recently, Functional Data Analysis (FDA) has been used to handle response data that is in the form of a scaler value that varies over some longitudinal component. This type of data often occurs where sensors are streaming data over a period of time. The longitudinal component is most often “time” but the longitudinal component can be any other factor that varies while the scalar data		

is being collected such as temperature, pressure, etc.. FDA can be thought of as Principal Component Analysis (PCA) applied to curves (functional forms) in that it decomposes the curve into a small set of latent factors. The latent factors generated by FDA are known as Functional Principle Components (FPCs) and are based on Eigenfunction decompositions. The benefit of working with the FPCs as opposed to just clipping off “landmark” features from the curves and using those for analysis is that the FPCs carry along key information extracted from the full shapes of the curves that might otherwise be lost by clipping off just the “landmark” features. This talk will demonstrate FDA/DOE being used to characterize and optimize various CBRNE systems from a Bio agent sensor to an agent vapor test chamber.

Approved for public release: distribution unlimited

Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

65417 - Homeland Security Biological Detection and High-Quality Technology Readiness Assessments

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Paul Bauer		

Abstract: Working Group(s): WG 2 CBRNE Defense
Working Group Chair: John Davies Jr, Army
Abstract Title: Homeland Security Biological Detection and High-Quality Technology Readiness Assessments
Abstract Text: Countering Weapons of Mass Destruction (CWMD) was established within the Department of Homeland Security (DHS) to protect against the dangers posed by hostile state and non-state actors who seek to acquire and use nuclear, chemical, radiological or biological materials in the form of weapons of mass destruction to harm Americans or U.S. interests. CWMD is pursuing efforts to update the BioWatch program that was established in response to the 2001 anthrax attacks and designed to provide early indication of an aerosolized biological weapon attack. Biological Detection for the 21st century (BD-21) is the latest acquisition in a series of efforts to upgrade BioWatch. However, critical technologies needed to provide early detection have inherent limitations. DHS has proposed the use of a new and novel capability through artificial intelligence / machine learning technology that, if successfully developed, could be an improvement over the existing system. The Government Accountability Office (GAO) was asked to evaluate BD-21 technology readiness and made several recommendations aimed at improving technology readiness assessments across the agency and the BD-21 program.
GAO is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. GAO has developed a Technology Readiness Assessment Guide (GAO-20-48G) to provide a better understanding of technology maturity and a framework for conducting high-quality TRAs. GAO’s TRA guide establishes a methodology for evaluating critical technologies, such as those being pursued by CWMD, based on best practices that can be used across the federal government to determine a project’s readiness to move past key decision points that typically coincide with major commitments of resources.
Presentation Classification: Unclassified for Public Distribution
Presentation Distribution Statement: For Public Distribution

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Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

66671 - Biodefense Opportunities and Challenges

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. John M Ortiz, Jr

Abstract: Biological threats have the potential to cause catastrophic loss of life and sustained damage to the economy, societal stability, and global security. Biodefense consists of actions to counter biological threats, reduce biological risks, and prepare for, respond to, and recover from biological incidents, whether naturally occurring, accidental, or intentional. Due to the complexity of these efforts that depend on capabilities from multiple federal agencies, as well as private sector partners, a whole-of-government approach is required. For over a decade, GAO has evaluated federal biodefense efforts and identified challenges and opportunities for improvement.

GAO is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. GAO's work identified several challenges associated with the national biodefense strategy, a need to strengthen biodefense preparedness, and necessity to replace the current BioWatch system to provide a capable early warning of a biological threat. GAO made recommendations aimed at addressing these challenges, including the direction of the interagency biodefense body to document guidance and methods for analyzing data, direction of federal agency efforts to take steps to address gaps to identify patterns of challenges and root causes, and conduct technology readiness assessments that follow GAO's best practices before making acquisition decisions.

Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

66638 - Operations Research Tools in an Epidemic

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: (Ret.) LtCol Anthony O'Connor

Abstract: Operations Research tools have been integral to the development of strategies to counter disease. Epidemics have had profound effects on armies, countries and even entire civilizations. The ability of leaders to address the problems presented by disease have often been the difference between their success and failure. These tools and techniques have evolved over the centuries and are continuing to evolve. This presentation will discuss the current applications of models and data analytics in conjunction with the applications of medical strategies to defend agents an epidemic.

Location: TH325

Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

65780 - Re-Evaluation of Percutaneous Liquid Toxicity Estimates for G-Agents and VX

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Douglas R. Sommerville

Abstract: Current G-agents & VX percutaneous (PC) liquid mild effect estimates were reviewed in support of establishing decontamination standards for personel hand-held equipment. Such estimates are also used in other applications: casualty & contact hazard assessment and various system evaluations (personal protective equipment & detection). Two important findings came out of this review. First, mild effect estimates have never been developed for the G-agents and only recently proposed for VX. Second, existing severe effects & lethality estimates have differing implied assumptions between the G-agents & VX: dermal conditions--room temperature/dry (G-agents) and not stated (VX); and dermal location-- forearm (G-agents) & cheek (VX). The current estimates understate the PC liquid potency of the G-agents relative to VX due to the differing standards.
New PC liquid mild effects estimates were developed for the G-agents as a function of the two main factors—dermal conditions (normal-dry versus hot-sweaty) & location (cheek—most sensitive versus forearm—near median). Human G-agent PC liquid data exists for normal/dry/forearm exposures only. However, human sub-lethal VX PC liquid data exists for a variety of dermal conditions & locations. Previous ordinal regression analysis (with probit link function) of the VX dataset has established probit slopes & the ratios of effective median doses (ED50) between the various factor levels, and it was assumed that the slopes & ratios for the G-agents would be approximately the same as VX. The % inhibition of blood acetylcholinesterase (AChE) levels was used as a proxy mild effect—with ED50 & probit slope estimates being provided for both 20 & 50% AChE inhibition (as was previously done with VX). Other reseachers have demonstrated (based on human nerve agent data) that humans having AChE inhibition below 50% have a low probability (<1%) of developing severe clinical effects.
New proposed toxicity values were also calculated for G-agent PC liquid severe effects & lethality to reflect the known impact of dermal conditions & location on toxicity—expanding on the current values which implicitly assume normal/dry dermal conditions & forearm exposures. Severe effects & lethality estimates for VX were also calculated for conditions beyond the currently implied assumptions of hot/sweaty dermal conditions & cheek exposures. The new estimates (mild to lethal) make more sense overall, with common comparison basis established for differing dermal conditions & location.
An unexpected finding from this exercise is that G-agents have a greater PC liquid toxicity than previously appreciated—relative to VX and when previously neglected adjustments for dermal conditions & location are considered. Past hazard risk assessments for G-agent PC liquid exposure scenarios should be re-examined—particularly for GD & GF.

Location: TH325
Classification: UNCLASSIFIED // FOUO
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

65279 - Developing a Country-Level CBRN Readiness Metric

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr Joseph L Stallings, Jr		
Abstract: The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to support plans and operations that counter development and exploitation of Weapons of Mass Destruction (WMD) and emerging threats. As Combatant Commands assess their Areas of Responsibility (AOR), it is important to understand where vulnerabilities exist. A Country-level CBRN Readiness Metric will enable Commands to visualize regions of the Command that may be less prepared for WMD, or WMD-like, events and to prioritize resources to improve readiness and reduce vulnerability. The CBRN Readiness Metric develops information from about 100 indicators into several categories and then into 3 capability sectors; Recognize, React, and Recover, which ultimately contribute to the overall Readiness metric. The indicators that form the foundation of the metric are captured from open source data sets which enables collaboration with security partners to address country vulnerabilities. The discussion will introduce the data hierarchy and compilation methodology. Location: TH325 Classification: UNCLASSIFIED Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense		

66205 - Measuring WMD Effects in a Campaign Level Combat Scenario

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Charles D Burdick, CAP		
Abstract: DTRA has many fine models for the propagation and effects of WMD, particularly – Chemical Warfare, but no single large-scale multi-domain model in which the ability to measure the effects of these deadly systems on both military operations and civilian noncombatants in a Campaign-level environment. Yet that capability existed only a decade ago. This presentation addresses the use of DTRA provided algorithms and data in the Joint Analysis System (JAS), an OSD built model with the ability to simulate an entire campaign in just a single model including the WMD aspects. DTRA contributed software and data to and used the model up until 2011 when OSD/CAPE called in all copies of JAS and archived the model. Capabilities in the model to be discussed will include: Computing operational effects on combat and support troops in a WMD scenario: Casualties if in no protection, various levels of MOPP, and from overheating in MOPP Effects of reduced combat capabilities for extended times. Measuring the opportunities for improving the operations and lessening of casualties due to of improved protection from both the chemical and the heat overload on the MOPP wearer. Improving local detection of chemicals in various environments and decreasing Downwind Warning times. Reducing secondary effects, medical demand under various conditions, examining options for personal decontamination means and the resources necessary, priorities for decontamination, etc. Effects on Weapons, Transportation, and Logistics Equipment. Loading and Unloading at air and seaports, decontamination of aircraft, ships, and auxiliary equipment. Effects on civilian noncombatants		

Addressing means for warning civilian populations to the likely presence of lethal or toxic chemical coming into their area and reducing casualties during decisions on evacuation vs shelter in place in both combat and natural disaster scenarios.
DTRA supported WMD in JAS because it provided an external source of approved scenarios and an ability to link chemical effects to likely impacts of their use in three different strategic scenarios.
As the threat of chemical and biological warfare increases with the rise of regimes with the will to employ them, we need to return the JAS simulation capability to operational use especially for organizations who seldom get to see the effects of their capabilities in a combat context, examine them in detail in a likely scenario, and be able to modify their effectiveness.

Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

66203 - Population Protection and Monitoring in Response to Radiological Incidents

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Eva K. Lee

Abstract: Emergency response and medical preparedness for radiological incidents are critical cornerstones for U.S. Homeland Security, along with biological and chemical incidents. The Three Mile Island and the Chornobyl nuclear accidents, and the 2011 Fukushima Daiichi nuclear plants in Japan underscore the paramount importance of such emergency and medical preparedness and response capability. Such needs are widespread as many nations employ nuclear plants for energy generation. With the conflict in Ukraine, and the nuclear instability in Iran and North Korea, the threat of nuclear war is back 'front and center'.

In this tutorial, we will discuss the development and deployment of a real-time information–decision support system, RealOpt-CRC© along with the knowledge data bank that can be used by regional and local radiation and public health administrators to prepare for and deal with radiological emergency situations. The system allows emergency planners to:

i) rapidly setup shelters to house the displaced and at-risk populations;
ii) determine efficient resource allocation and operations for rapid screening and emergency response, accommodating on-the-fly changes as the situation evolves;
iii) establish community centers for population screening and decontamination.
iv) monitor within-center cross-contamination propagation and provide guidance on dynamic triage responses to minimize it;
v) recommend and facilitate practical steps to minimize exposure risk.
vi) perform effective population registry for long-term health monitoring.
vii) train regional radiation and public health agents for emergency preparedness and familiarize them with procedural steps for screening and decontamination, and emergency services;
viii) analyze and assess the adequacy of existing resources (locally and/or regionally), and identify budget and labor needs to accommodate emergency responses, and/or maximize throughput under resource constraints during real situations;
ix) perform large-scale virtual exercises.

Such a system is critical not only for population health monitoring, it is also important for rapid screening of workers during the emergency management of nuclear plant failure.

We will share our on-the-ground experience regarding the Japan Fukushima nuclear incidents. Especially, we will discuss the impact to the Japanese families who lived within twenty kilometers of the failed nuclear plants. The discussion will be based on data collected regarding timelines for evacuation, screening, health status, radiological awareness and sociological information of the local population and workers, and subsequent psychological and medical impacts.

The development of the system was partially supported by funds from DTRA and CDC.

Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

65361 - Markov Model of Country-Level Nuclear Latency and Nuclear Weapons Capability

Start Date: 6/15/2023	Start Time: 10:00 AM	End Time: 10:30 AM

Authors: Gabrielle LaRosa

Abstract: Nuclear latency – the ability to quickly proliferate without currently holding any nuclear weapons – is an important consideration for combatant commands as they plan to mitigate nuclear proliferation in their AOR. This is also an important consideration for the Defense Threat Reduction Agency (DTRA), as our mission is to deter strategic attacks against the United States and its allies, prevent, reduce, and counter WMD and emerging threats, and prevail against WMD-armed adversaries in crisis and conflict.

We consider a Markov chain to model country transitions between 3 states: (1) non-nuclear, (2) nuclear latent, and (3) nuclear capable. The transition probabilities are estimated as a function of both time and country-level covariates, such as access to fissile material, number of uranium enrichment/reprocessing facilities, number of enemy states, and economic/political stability.

From this Markov model, we can answer questions such as: What is the probability that a given country moves from non-nuclear to nuclear latency? On average, how long do we expect a given country to remain in the nuclear latent state before transitioning to nuclear weapon capability? What covariates are the strongest indicators of a country moving to nuclear latency and/or nuclear capability?

The model results will provide insight to combatant commands on where, and how, to prioritize resources when seeking to deter nuclear weapon proliferation in their AOR.

Location: TH325
Classification: UNCLASSIFIED
Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

66703 - Integrated Nuclear Detonation Detection

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Tracy E.L. Light		
Abstract: The United States employs systems both in ground and in space for remote sensing in service of nuclear treaty monitoring. Traditionally, both the space- and ground-based systems assess data individually across sensing domains (e.g., radio frequency, optical, seismic, etc.), and rely heavily on subject matter expert interrogation of the data. Additionally, all domains generally use domain-specific waveform analysis to reject background events (for example, to discriminate an earthquake from an explosion). This talk will first describe a novel statistical method for rejecting lightning, a prevalent background signature in the space-based detection program. The talk will then outline a data fusion technique that can bring together all the space- and ground-based detection domains for joint analysis, despite a disparity in signal timescales that spans over six orders of magnitude. The intent is to design a processing pipeline that maximizes whole system (space + ground) sensitivity while lowering throughput of false alarms, and without requiring costly improvements to individual sensor technologies. Location: TH325 Classification: UNCLASSIFIED Working Group: WG02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense		

WG03 Infrastructure Analyses, Protection and Recovery

65624 - Generating Sorties Under Attack (GSUA) Cluster Study - Volume 2&3

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Andrew Langland; Mr. anthony alvarez dronkers		
Abstract: GSUA is a series of studies to address “the fight to get airborne” using SAF/SA’s Airbase Damage-Assessment and Resiliency Model (AD-ARM). The Cluster study explores the potential benefits of non-traditional hub-and-spoke operations focused on generating combat sorties from several small operating locations, the spokes, supported by a more traditional base of operations, the hub. Since the cluster concept deviates from traditional operations, this study also explores the feasibility and challenges of operating as a cluster, with a focus on the support elements required to generate combat sorties. While the study focuses on generating sorties under new operating concepts, other mitigating factors, such as air defenses and resiliency measures, are tested as well to provide insights for interacting effects. Due to the broad scope of the study, the results have been split into three volumes: Volume 1 provides the research insights gained while leaning how the cluster concept could be supported from the perspective of munitions production, fuel operations, aircraft maintenance, and recovery after attack. Volumes 2 and 3 cover the analytic insights for traditional basing and cluster basing, respectively. Location: TH353 Classified Classification: SECRET//REL TO FVEY Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

65709 - Where does the Army use energy and water? Leveraging data to identify requirements for resilience and pathways for sustainability.

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Noah Garfinkle		

Abstract: Every mission on DoD installations is dependent upon secure and resilient infrastructure utility (e.g. energy, water, natural gas) supply chains. The Department is facing simultaneous requirements to secure these supply chains while meeting ambitious new sustainability requirements. Meeting these dual obligations will require a comprehensive understanding of how DoD installations use energy and water, but current data is insufficient to meet this standard. This presentation will guide participants through how Army researchers are using available installation data and data science/machine learning techniques to leverage data available, identify targets for new data, and generate actionable insights into installation energy and water security. The desired outcomes of this presentation will be to 1) illustrate what is currently known, and not known, about installation energy and water usage, 2) outline the methodology used in the study, 3) present findings about how Army installations use energy and water, and 4) engage the audience in discussion about how findings and future work can influence decision-making about installation infrastructure and facility operations.

Location: TH326
Classification: UNCLASSIFIED // FOUO
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

65093 - Outbrief MORS Scoping the Analytical Implications of Climate Change and Extreme Events for National Security Special Meeting; 6-8 December 2022

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Donald H. Timian; Dr David J Alexander; Dr. Daniel Thomas Maxwell		
Abstract: The Military Operations Research Society (MORS) hosted its first Climate Change Special Meeting at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, December 6-8, 2022. Purpose of this presentation is to briefly summarize the meeting. During the meeting five Sessions with 25+ presentations were given, along with Keynotes from the Honorable James Appathurai, North Atlantic Treaty Organization (NATO) Deputy Assistant Secretary General for Emerging Security Challenges; Mr. Daniel Cotter, Executive Director, Department of Homeland Security (DHS), Office of Science and Engineering (Acting); Mr. Brad Archer, CEO Australian Climate Change Authority; Mr. R. David Harden, CEO Q2 Impact; and Dr. Miles Palmer founder 8 Rivers. Points emphasized by our Keynotes will be reported, along with summarizing session presentations and Synthesis observations. Lastly, recommendations – as to path ahead for MORS – will be presented. Minus Questions: Approx. 25 Minutes Need for Presentation Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

66192 - POWER SYSTEM BENCHMARKS FOR INFRASTRUCTURE IN NAVALINSTALLATIONS

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Olive Oliveros; Prof. David L. Alderson; Daniel A Eisenberg		
Abstract: When a military installation cannot function optimally or operates at a less than desirable state due to unpredictable events, the installation and ultimately the servicemembers at that		

installation will fail at meeting the mission. Benchmarks for similar facilities exist but do not take into account the missions that a military installation supports. This research aims to develop benchmarks for a pre-1950's power system, a more recent power system from the 1980's and a power system based on today's military installation. Optimization will be conducted through python/pyomo. Models produced will be consistent with experiences that facility managers and public works officers alike experience and a useful training tool for personnel in and around facility management and critical infrastructure defense.

Location: TH326
Classification: UNCLASSIFIED // FOUO
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66708 - Emergency Fuel Distribution for Disaster Relief for Marine Corps Base Hawaii

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Felicia Goodell		

Abstract: Marine Corps Base Hawaii (MCBH) is isolated on the island of Oahu in the Pacific Ocean and is vulnerable to shocks that impact its supply chain. Specifically, if a large-scale disaster or long-term blackout impacts installation energy access, significant effort will be required to keep backup power systems functioning. Despite this risk, there is no plan for refueling generators at mission assurance facilities and emergency services. This work develops a novel data set and model to route trucks and schedule the refueling of backup generators to keep the power on at MCBH. Using our model, we compare installation capabilities for refueling to contracted trucks that are limited in supply across the island. We also study several procurement the installation can make to increase fuel truck and diesel storage capacity on installation.

Location: TH326
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

65546 - Determining Biogas Potential for U.S. Army Installations

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Phillip D Schmedeman		

Abstract: Sustainability challenges are particularly complex on military installations, where security and environmental objectives are often in tension. Currently, wastewater treatment facilities on Department of Defense (DoD) installations are a source of greenhouse gas emissions (GHG) and contribute waste to landfills at the installations' expense. The beneficial use of biogas through anaerobic digestion offers a means to reduce emissions and landfill contributions, decrease energy costs and reliance on fossil fuels, and improve energy security. Nevertheless, the economic feasibility of biogas applications on DoD installations remains unknown. This study models the economic and environmental implications of utilizing anaerobic co-digestion to produce electricity from wastewater and food waste across U.S. Army installations. Given infrastructure and population characteristics for each installation, we calculate biogas production, energy and GHG savings, waste excluded from landfills, and the additional infrastructure costs. Following model validation, we incorporate decision variables that control which installations upgrade their facilities for biogas production over a 10-year period. We optimize this integer program to maximize energy savings. We conclude with sensitivity analysis that quantifies the financial and environmental benefits over a range of uncertain

parameters, thereby illuminating installation-specific characteristics that are the most appropriate for the beneficial use of biogas.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66064 - • Modeling Impacts to Defense Critical Electric Infrastructure from Natural Hazard Events and Adversarial Attacks

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Steve Folga; Robert Hanson; Edgar Portante; Ashton Raffety; Eric Rollison; Chel Samuels; Dr. David Karl Sehloff; Leah Talaber

Abstract: The electric power system is vital to the Nation's energy security, supporting national defense missions, emergency services, critical infrastructure, and the economy. A Critical Defense Facility (CDF) is a site critical to U.S. defense and vulnerable to a disruption of the supply of electric energy provided by an external provider. Defense Critical Electric Infrastructure (DCEI) is electric infrastructure that serves a CDF but is not owned or operated by the CDF owner or operator. Risk-based assessments on DCEI supporting CDFs can inform risk mitigation decisions and lead to the continued function of assets and defense capabilities necessary to support national security missions.

Led by the U.S. Department of Energy's (DOE) Office of Cybersecurity, Energy Security, and Emergency Response (CESER), Argonne National Laboratory (Argonne) and Lawrence Livermore National Laboratory (LLNL) are partnering with electric utilities serving CDFs to model their electric system and simulate the impact of plausible natural hazard incidents and adversarial attacks (cyber and physical). The natural hazards studied depend on the geographic location of the selected DCEI operator and include tsunamis, earthquakes and extreme weather. A common set of cyber and physical attack vectors are simulated assuming an intelligent adversary.

Modeling, scenario development, simulation, and validation measures are used to determine the potential impacts of the hazards and threats on the DCEI. Detailed scenarios are developed which are used to analyze risk and estimate possible cascading impacts throughout the DCEI operator's system. Consequence metrics highlight the severity of each hazard and threat, and are inclusive of load loss, outage duration, unserved energy, and other valuable measures that reflect various impacts predicted to affect the DCEI.

This presentation will describe the methodology and assumptions employed to derive a simulation-based DCEI outage event, provide context in which the modelling and simulation characterize the DCEI, enumerate directly and indirectly affected assets, quantify the overall outage footprint, identify electric components presumed to be damaged, and provide electric restoration time estimates.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66224 - A Network Science and System Dynamics Simulation Framework for Installation Resilience under Compound Extremes

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Samrat Chatterjee; Dr. Auroop Ganguly; Dr. Dennis Thomas; Dr. Satish Chikkagoudar		
Abstract: Military installations comprise of interconnected assets whose operations further depend on the external ecosystem of lifeline networked infrastructures and communities that surround or support them. Climate change as well as socioeconomic and geopolitical tensions are increasing the chances of correlated weather and water extremes, coordinated opportunistic failures, and policy or resource shocks, thus leading to the possibility of compound extremes across local to regional scales, including military installations. This talk will discuss a novel computational framework for installation resilience where operations within an installation are modeled with system dynamics simulation principles and the surrounding infrastructures are modeled with network science methods. Feedbacks between the system dynamics and network science modules highlight operational complexities in such an environment under compound extremes. Mathematical and computational methods, and early analytic results with notional simulation examples will also be discussed. Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

65408 - A MORDM ANALYSIS OF SEAWALL UPGRADES AT THE UNITED STATES NAVAL ACADEMY

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Robert K Pekarek		
Abstract: This thesis explores an innovative planning approach suitable for conditions of deep uncertainty to protect the United States Naval Academy (USNA) in Annapolis, Maryland from flooding due to sea level rise (SLR). The increase of the relative sea level by 1.06 feet in Annapolis since 1929 has accelerated flooding frequency and damage to USNA infrastructure. The probabilities correlating to the magnitude of future sea level rise are unknown; hence, the future condition is described as deeply uncertain. Due to this deep uncertainty, it is challenging to determine the appropriate level of seawall height, which can lead to potential under or over-preparedness. The Department of Defense (DOD) has embraced a robust decision-making approach to evaluate decisions across multiple future scenarios. This research incorporates Many Objective Robust Decision Making (MORDM), a method which utilizes a multi-objective evolutionary algorithm (MOEA) to generate and evaluate thousands of seawall upgrade policies for USNA. A Pareto-approximate frontier of MOEA-generated upgrade strategies is then re-simulated across multiple future discount rates and SLR scenarios, comparing each policy's performance across a wide range of plausible future uncertainty. By conducting a satisficing analysis on the set of MOEA-generated policies, this research found several robust upgrade policies. These robust policies can guide the USNA's seawall upgrade strategy to be more resilient against future climate uncertainties. This research displays a practical application of a MOEA to conduct a MORDM analysis of a DOD facility and serves as a blueprint for incorporating deep uncertainty into infrastructure upgrade decision-making for the DOD. Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

65702 - Understanding Risk in Complex Engineered Systems: Flood Risk Management

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Willie Brown; Dr. John Richards; George Edward Gallarno; Dr. Christopher Morey; Mr. Titus Rice		
Abstract: Many complex socio-technical systems enable the conduct of daily activities across the United States. These systems incorporate engineered systems, their human operators, processes, and the people, property, and environments the systems affect. Understanding these socio-technical systems and the interactions within them is difficult. The U.S. Army Corps of Engineers must allocate resources to operate and maintain complex socio-technical systems across multiple business lines, such as Flood Risk Management, in order to mitigate risk. This researched developed a methodology to provide decision makers with an improved understanding of their complex socio-technical systems through the development of a risk-informed prioritization framework. Likelihood of facility and system degradation based on the condition of components is developed from subject matter expert-initialized Bayesian networks. Designed simulation experiments with hydrological models provide estimates of flood consequences at the watershed level. By combining likelihood and consequence values, this methodology develops relative risk scores that are used as inputs to a mixed integer program that provides decision makers a recommended set of investments given constrained resources. A case study application is provided. Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

66129 - ASSET Management Value Models

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl		
Abstract: The United States Army Corps of Engineers (USACE) Civil Works (CW) program includes $250 billion worth of assets. USACE seeks to use asset management techniques to acquire, operate, maintain, and retire physical assets (e.g., locks, dams, port infrastructure). Our Engineer Research and Development Center (ERDC) led project team has reviewed existing Navigation Business Line performance metrics for asset management and are creating a line-of-sight model using Multiple Objective Decision Analysis. Our current focus is on locks and dams that support cargo transport and recreation navigation through U.S. inland waterways. Our next focus will be on the recreation business line with the eventual addition of other USACE business line value models. The project goal is to enable USACE to make budget work package trade-offs using the recommended set of performance metrics. Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

66144 - Data Analysis of Climate and Interconnected Lines of Communication for Military Mobilization Planning

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Kyler Rice		

Abstract: Understanding environmental conditions and potential disasters unique to geographic location is important when planning for the movement of equipment and resources through interconnected lines of communication. Having crucial country-level environmental and transportation infrastructure data readily available for military planners to make informed decisions will increase on the ground readiness during mobilization efforts. Our team is collecting and analyzing country specific climate and transportation infrastructure data from the combination of various open-source datasets, reliable geospatial data, climate models, factual news media, and available USACE research. This data is strategically communicated in a readily available format to efficiently inform military planners of potential bottlenecks in an interconnected transportation system. Lines of communication, consisting of roads, railroads, bridges, ports, and inland waterways, are all negatively impacted by extreme heat events, drought, floods, and other weather events in unique ways. Having readily available data will help planners see the potential cascading effects that a crucial line of communication being deemed inoperable will have. An example is the Mississippi River, an inland waterway that is historically impacted by drought and flooding. When the river reaches an impassable travel depth, transportation of exports and movement on the river is not possible. When a route is impassable, planners need to know which alternates are available in the short term and long term. When barges cannot use the Mississippi River, for example, railroads and roadways may see increased use and physical strain. Additionally, when the river floods, surrounding roads, railroads, and communities may become inundated. Other examples include heatwaves that weaken and damage road, rail, and runway infrastructure, and droughts that make docking at a specific port unachievable because of low water levels. In the example of the Mississippi River being impassable, the data that we are collecting would aid planners by having readily available nearby port information, including cargo handling capabilities, railroad-freight handling networks, and road infrastructure with specific bridge and tunnel data, to name a few. The over-arching goal is to provide this data in a readily available format for military planners to utilize, resulting in increased readiness and reduced risk when mobilizing heavy machinery, resources, and troops.

Location: TH326
Classification: UNCLASSIFIED // FOUO
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

65079 - Weather Effects on the Lifecycle of DoD Equipment Replacement (WELDER)

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Peter Larsen		

Abstract: The U.S. Department of Defense (DoD) has identified climate change as a critical national security threat and has taken initial and ongoing steps to address vulnerabilities at installations. We developed a module called WELDER that plugs into BUILDER—the U.S. DoD Sustainment management System used to comprehensively assess and forecast conditions for ~212,000 buildings and ~9.3 million component sections. WELDER estimates the likelihood of extreme weather metrics and projects extreme weather-related impacts on the condition and lifespan of DoD site facilities/systems/components. WELDER estimates the risk premium (additional lifecycle costs) down to the component-level, but allows users to aggregate these extreme weather-related costs to the facility-, site-, and organization-level. WELDER communicates these impacts to BUILDER, which generates alternative “Work Action” reports for facility planners. Results from this project can help (1) inform actual work planning activities at a specific organization/site/facility and (2) justify future climate change-related budget needs.

Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66173 - Climate Impacts on Water Infrastructure in the DoD (CIWI-D)

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Marlene Marie Perez; Daniel A Eisenberg		
Abstract: Ongoing climate changes (e.g., rising temperatures) and water scarcity introduce vulnerabilities to numerous installations across the Department of Defense (DoD). Climate vulnerabilities for installations, as defined by the DoD, are the combination of exposure, sensitivity, and adaptive capacity. Two standalone tools the DoD currently has at its disposal are the DoD Climate Assessment Tool (DCAT) and the Defense Installations Spatial Data Infrastructure (DISDI). However, there is no integrated system on DoD installations that can quantify changes in vulnerabilities caused by climate and weather events on installation missions (e.g., training, weapons testing, fire suppression, and sanitation) and long-term infrastructure planning. Utility systems, like potable water distribution pipelines, are essential for mission assurance on installations; their assets and operations may be impacted by future climate and weather events. Still, current models and tools do not provide analysis that informs exposure, sensitivity, and adaptive capacity of water infrastructure. The purpose of this work is to leverage climate models and tools (e.g., DCAT) to develop a method that assesses climate impacts on water infrastructure for DoD installations and missions. This work is the first step towards an integrated tool to support climate vulnerability analysis across the DoD called the climate impacts on water infrastructure in the DoD (CIWI-D, pronounced seaweed) tool. Working in tandem with Naval Facilities Engineering Systems Command (NAVFAC), USACE, and climate modeling teams within the DoD, we will develop exposure, sensitivity, and adaptive capacity libraires that enable separate and integrated vulnerability assessment. These libraries will include benchmarks to support analysis and methods to link the libraries in the integrated CIWI-D tool. First, we will combine forecasts from several, vetted sources (e.g., DCAT, DISDI) that focus on military installations to determine water infrastructure exposure. This library will then combine the water infrastructures into networks to communicate climate forcing effects into the system sensitivity and adaptive capacity libraries. The sensitivity library will utilize the network created from the exposure library with data from vetted sources (e.g., UFC, BLDR, WLDR) to model the changes in failure rate on an infrastructure due to climate forcing. Finally, these two libraries will be merged using a Python-based package, WNTR, in the adaptive capacity library. The adaptive capacity library provides insight into how well a water infrastructure will provide it's services given the subjectivity to exposure. CIWI-D will be utilized to inform mission impacts and provide recommendations to mitigate future stress on DoD installations. Location: TH326 Classification: UNCLASSIFIED Working Group: WG03 Infrastructure Analyses, Protection and Recovery		

65954 - PCAP Analysis on a Military Campus

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Jeffrey Dean; Dr. Thomas S. Anderson		

Abstract: This presentation focuses on the challenges faced in maintaining the security of Department of Defense (DoD) networks due to the volume, velocity, and variety of network traffic data. The study collected packet data from a medium-sized campus network at the Naval Postgraduate School (NPS) and analyzed it using the NPS High-Performance Computing (HPC) environment. The results of the data analysis were used to identify traffic anomalies and potential gaps in firewall rules, and inform network command and control. The presentation highlights the significance of the study and its initial findings as indicators for further security analysis.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

65816 - Preserving The Conceptual Integrity of Critical Infrastructure With a Community Cyber Force

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Alexander Brickner

Abstract: Cyber security has become a critical priority for critical infrastructure, which is increasingly dependent on information technology and telecommunication infrastructure to ensure the reliability, safety, and security of the electric grid. Increasing threats from criminal and nation-state actors reinforce the growing need for collaboration, communication, and a whole-of-community approach to defending and responding to cyber incidents impacting critical electric infrastructure (CEI) through formalized information sharing partnerships and standards.

Military installations are dependent on linked physical and cyber electric infrastructures . These interconnected infrastructures, while improving capabilities and mission effectiveness, also increase vulnerability to potential failures due to human error, natural disasters, or intentional attack. Threats to installations are becoming more complex, covert, and unpredictable due to advancements in technology. Risks are compounded because the DOD does not have an organized, outward-facing focus on CEI and lacks the dedicated staff, capabilities, or processes to effectively coordinate cyber incident responses with utility systems. This capability gap delays response time and forces critical incident communication into cognitively strained channels such as email, phone, radio, and text.

Implementing software is challenging because there is no central program office that has the vision, authorities, and expertise to drive and execute on the CEI cybersecurity mission. Coordination and collaboration between utilities and the military is a challenge. The stakeholder convening processes to have constructive dialogue around defense energy resilience planning are complex. Prominent DOD control system cybersecurity programs have identified technical targets of reducing CEI cyber responses times from months to hours through more effective threat information sharing and CIE.

Maintaining an effective cyber posture requires a coordinated virtual cyber terrain map and actionable specifications that are continuously maintained, updated, and rapidly available throughout the enterprise. In the realm of power distribution and utility control system cybersecurity, actionable information has become large, multi-dimensional, specialized, and massively distributed. UMLARC proposes that Community Cyber Forces, in partnership with critical infrastructure providers, are responsible for deploying cyber infrastructure to identify vulnerabilities, protect critical energy infrastructure and networks, enable automated assessment, provide situational awareness, and respond to the threats within the electric sector across disparate and siloed cybersecurity platforms at multiple levels of classification.

The University of Massachusetts Lowell will discuss research related to a establishing a CCF near Hanscom AFB to support the Northeast region during critical infrastructure cyber incidents.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66374 - Occupancy and Space Allocation (OSA) - Efficient Use of Space

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr. Kokou Tchrifo

Abstract: The Center for Army Analysis conducts occupancy and space allocation assessments of key Department of Defense (DoD) facilities. Many organizations find they need to periodically reevaluate overall occupancy and space allocation when organizational changes, new mission requirements, or changes to the workplace made possible by new or emerging technology occur. With numerous competing demands at play, finding the ideal mix of collocated functions and tiers of leadership is a complex problem to solve for large organization.
This briefing describes one process used to efficiently allocate workspaces within a DoD facility. Key discussion topics include collecting and manipulating data and developing the integer linear program mathematical formulation used in the General Algebraic Modeling System (GAMS).

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66325 - Comparison of Socio-Technical Threat Models for Electrical Vehicle Charging Stations

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Gabriel A. Weaver; Daniel A Eisenberg

Abstract: Given the adoption of emerging technologies and the increasing complexity of managing such systems with a lifecycle much shorter than that of critical infrastructure systems, there is a practical need to be able to analyze sociotechnical dependencies and their associated evolving risks. Threat models based on social influence techniques can be used to implement adversarial tactics analogous to the cyber kill chain and attested to within the MITRE ATT&CK for ICS framework including Initial Access, Persistence, Collection, and Impact. Furthermore, as with cyber disruptions, the impact of social influence threat models can have an asymmetric impact that is not spatially-localized. Finally, unlike cyber attacks with a reasonably short duration (ransomware takes days to months), social influence based attacks have the potential to persist for much longer as they are based on long-term strategic infrastructure investments within the private sector.

Given the increased importance of electric vehicle charging stations as a long-term, strategic infrastructure investment within the Energy and Transportation Sectors, we provide initial results that compare the impact of a Loss of Availability (T0826) realized through cyber and social influence based threat models. The analysis employs techniques from automated reasoning and measures of network complexity to understand evolving dominance of EV payment and charging networks

within geographic region of interest. Within this context, we compare the impact of a loss of availability due to ransomware versus that of loss of support due to a merger and acquisition. Results across several different metro areas will be provided.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

65611 - Sick and Tired: Leveraging Local National Manpower Analysis to Enable Organizational Change

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: MAJ Jaison Desai, PhD; Matthew Eidt

Abstract: The U.S. Army operates thousands of training ranges worldwide to support the readiness requirements of both U.S. and partner forces. The most realistic versions of these ranges utilize dynamic targets to assess firing reflexes and the ability to hit moving objects. Behind the computers and sensors is a precious commodity, critical to ensuring the success of the mission – range operators trained in the safe and effective operation and maintenance of these target systems. This presentation discusses a collaborative assessment of the unique constraints of German local national manpower in support of the largest U.S. range complex in Europe, the Grafenwoehr Training Area. We describe how Training Support Activity Europe (TSAE) effectively leveraged the operations research team at 7th Army Training Command (7ATC) to help frame the problem, gather relevant data, and present compelling analytics to illuminate potential solutions. This produced an objective analysis that enabled data-driven decision making by senior leaders within the organization. The study highlighted how current Army-level manning models underestimate necessary manpower in a European setting. By highlighting gaps in coverage plans we enabled the director to make timely and relevant policy changes in the near-term and consider longer-term changes to the organizational structure.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

66187 - Identifying Potential Impacts of Geopolitical Tensions on Domestic National Critical Functions

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: James Marks; Donald Kim Erskine; Duane Verner; Darren Chen; Dr. Elizabeth Bolton; Dr. John R. Hummel, FS

Abstract: Argonne National Laboratory, in support of the U.S. Department of Homeland Security (DHS), Cybersecurity and Infrastructure Security Agency (CISA), National Risk Management Center (NRMC), is analyzing the potential impacts of current geopolitical tensions on domestic National Critical Functions (NCFs).

The international system is increasingly more competitive – and more unstable – shaped in part by challenges from Russia's invasion of Ukraine and a rising China – and at greater risk of conflict as states and non-state actors exploit new sources of power and erode longstanding norms and institutions that have provided stability in past decades. Argonne subject matter experts are engaging

with their partners in NATO, the EU, and others to better understand the current geopolitical landscape and potential new risks to NCFs.

Argonne is helping the NRMC answer the following research questions:
• Do circumstances suggest the need to consider criticalities to determine the relative importance of critical infrastructure differently? If so, how?
• Would representations of criticality also need to change (e.g., NCFs, or other schema)?
• What, if any, guiding principles have emerged regarding best practices for resilient NCF performance?
• Are there risk categories or specific types of risk that are not yet well addressed by our current assessment approaches?
• Are there indicators that can serve as early signals of significant changes in the strategic operating environment that should be incorporated into our anticipatory scanning?
• What has been the West's response to events unfolding in Ukraine and across the globe?
• How vulnerable is the U.S. across the political, military, economic, social, informational and infrastructure (PMESII) domains to hybrid threats targeting the West and its democratic institutions?
• What if China invaded Taiwan? Could the United States "decouple" from China by reducing U.S. dependence on Chinese products and supply chains - for both economic and national security reasons? How would decoupling from China impact the NCFs?

To date, Argonne has examined emerging geopolitical threats through the lens of Russia as a hybrid warfare actor employing hybrid threat tools as conventional and unconventional instruments of power and subversion to exploit its adversaries' vulnerabilities. Argonne conducted an initial screening of all 55 NCFs to determine which ones are potentially vulnerable to disruption based on current threat analyses and available functions-based decompositions of NCFs.

Going forward, Argonne will explore the broader geopolitical landscape, and will assess the implications of emerging or potential future geopolitical tensions on NCFs. The team will assess changes to the level of risk to NCFs, and will review and update of possible outcome scenarios, seeking to identify any characteristics or indicators of systemic change.

Location: TH326
Classification: UNCLASSIFIED
Working Group: WG03 Infrastructure Analyses, Protection and Recovery

WG04 Analytic Capability Development

66337 - Analytic Capability Development Focus Session Overview and Introduction

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Chad Kimmel; Christopher Santos; Melissa Sayers; John H Woodcock, Jr; Chad Wynkoop; Mr. Nick Ulmer; David Scott Cohick		
Abstract: The existing MORS Communities of Practice (CoPs), Working Groups (WGs), and Distributed Working Groups (DWGs) are generally focused either on specific analytic techniques, or on the functional applications of those techniques. No MORS entity is currently dedicated to the professional development of the analyst, or to the infrastructure and support an organization must provide to the analyst. The Analytic Capability Development (ACD) working group represents a major milestone in addressing this gap - now in our first year as a full working group.		

The ACD working group session features presentations from current practitioners and professional development leaders from across the MORS community along the following collaboration pillars:

> “Man” refers to the professional development of analysts from a career path, experiential, and mentorship perspective.
> “Train” refers to the training and education opportunities available to the analyst.
> “Equip” refers to the provision of hardware and cutting-edge software necessary to conduct analysis, as well as advocacy for safe, analyst-friendly IT policies.

To support this effort at MORS, various panels and presentations have been included as part of the ACD line-up at MORS. Furthermore, an ACD milSuite group page (https://www.milsuite.mil/book/groups/analytical-capability-development) has been created for the purpose of sharing ACD related resources from across the DoD. For example, there is a document already on this group page to share CONs and AOAs (for software approval) from across the various branches.

The goal is to create invigorating/engaging discussion and make attendees better analysts after the symposium. Help us to formalize this “home” for capability development topics, whether by presenting, attending, or participating in the ACD sessions this week.

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66364 - Empowering Operational Leaders to Resource Analysts

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Melissa Sayers; Mr. Matthew Lee Peck		
Abstract: Operational government leaders often do not understand what it takes to make their data dreams a reality. They may have dreams for a predictive artificial intelligence algorithm or a dashboard that lets them see and understand their organization to make better "data-driven" decisions. They often do not understand what is needed to get to this dream. Let's discuss a framework for empowering these operational leaders with the language to understand what is needed. Let's discuss how to show them where they can influence and resource this framework to get to their dreams. We'll use the data science pyramid and give real world examples. Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development		

65886 - Island ORSA in a Technical Wasteland

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Chad Wynkoop		
Abstract: As operations research analysts we all want to solve real and interesting problems and feel like we are having an impact. We go to school to learn the analytical techniques, methodologies, and for those of us under the age of 60 we learned various software packages and languages like Matlab, JMP, Tableau, CPLEX, Simio, Python, etc. Then we go to work for the DoD and land somewhere that		

does not have any of this. They could have funding issues, technical challenges or policy that have prevented the acquisition of these resources or they are just plain unaware that they exist because they have never had a true analyst in the organization before. Whatever the reason, you have been shipwrecked on this island and have to produce with nothing but the standard desktop image software. What do you do?

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66218 - Training Analysts to Deploy as Force Multipliers on Ops and Crises

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr Richard Peter Hoyes

Abstract: In the UK, Dstl embed Civilian Operational Research analysts into military Headquarters (and some government departments) to provide analytic and scientific support to their decision making. These analysts may deploy anywhere the UK military go: onboard aircraft carriers in the Indian Ocean, in tents in a desert, with special forces operations in the snow, in a NATO Corps HQ in Europe, an aid camp in Africa or to hotels in London. Wherever they go Dstl look to provide people who are training and prepared to provide the very best support possible in any situation: warfighting, disaster relief or national emergency.
Dstl hold these civilian analysts at Readiness and send them out to deploy in support of senior decision makers with minimal notice (24 hrs to 30 days notice). To ensure that they are effective as possible, we have a rigorous selection and training program leading to their certification as suitable to deploy. This program has been developed over the years but is continually refined and developed to allow the analysts to be prepared and experienced in a range of environments before they face these difficult tasks and add massive value to the military in a real life Operational situation.

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

65779 - Air Force VAULT Platform: Accelerating AI/ML Readiness

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Christopher Gillie; Gerson Escobar; Sepideh Maharati; Mr. Isaac Jerome Roberts, IV

Abstract: Before the VAULT Platform, building data analytic pipelines and creating data visualizations was a great effort. An individual use case faced a variety of time intensive challenges including discovering and accessing the correct data, finding the right analytical tools, and hiring technical experts, to name a few. In order to bridge this capability gap, the Air Force Chief Data and AI Office developed the VAULT Platform, a secure cloud-based environment hosted in AWS GovCloud up to the secret level. VAULT provides users access to over 75 authoritative AF data sources with a full data capabilities stack from data exploration and visualization through model development and machine learning resources. The VAULT Platform equips Airmen, Guardians, and Civilians to execute a use case through its lifecycle with industry leading tools and resources. Join us for an overview and demonstration of VAULT's capabilities. We will present a Pilot Readiness use case demonstrating the ML and visualization capabilities within VAULT using industry leading tools such as Databricks and Plotly Dash.

Location: TH321
Classification: UNCLASSIFIED // FOUO
Working Group: WG04 Analytic Capability Development

66282 - Talent Data and Data Talent: Building Analytic Teams for Army Talent Management

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: COL Kristin C Saling

Abstract: Army Talent Management's primary objective is collecting and leveraging personnel and talent data to acquire, develop, employ, and retain the Army of 2030. However, that data can't be transformed into action without the work of creative and capable analytics teams. This presentation will cover the development and composition of such analytic teams for HQDA G-1, Army People Analytics, Army Talent Management, and Army Human Resources Command as well as lessons learned from talent inventories and team research conducted for the Army Data Workforce Talent Management planning effort in support of the Army Data Plan. The speaker draws from expertise building these multidisciplinary teams and leading data analysts, HR professionals, and IT experts to develop solutions for HR operations and decision making. Key takeaways and lessons learned will include: the team ecosystem, or ensuring that the team has the right people, platforms, processes, pipelines, and culture to perform; collaborative culture and knowledge sharing; identifying and prioritizing key challenges that can be addressed through analytics and developing roadmaps for tackling them; developing and implementing data sharing and governance processes and including the right back-end data expertise; using data visualization tools and techniques to translate analytics into action; measuring and evaluating the impact of analytics initiatives; and enabling better communication of data throughout the organization with data literacy training. Attendees will leave the presentation with a better understanding of how to build analytics teams and shape the ecosystem around them to make the biggest impact on organizational performance.

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

65614 - Army of One: Building an Organizational Analytics Capability using the SIG-ACT Model

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: MAJ Jaison Desai, PhD

Abstract: While the demand for high-quality data analysis grows at every echelon of the military, subject-matter experts in data science and operations research are in finite supply. This presentation describes how the 7th Army Training Command (7ATC) leveraged a single Operations Research & Systems Analysis (ORSA) officer to lay the foundations of a data analytics capability throughout the headquarters and directorates. We illuminate six key components for success – three essential elements of prioritization (Strategic-Focused, Insightful, and Generalizable) and three engagement approaches (Analyze, Consult, Teach). This SIG-ACT Model provides a useful framework for organizations to build a data analytics capacity, even with limited expert resources.

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66502 - Balancing Peril and Promise – Generative AI in Graduate Education and Operations Research

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 12:00 PM
Authors: David Scott Cohick; Dr. Ruby Booth; Chad Kimmel; CPT John T McCormick; Mr. Terrance James McKearney, FS; Daniel O Rice		
Abstract: Like the Wright Brothers at Kitty Hawk, North Carolina in 1903, we are at a pivotal moment in history where generative Artificial Intelligence (AI) technologies have reached a major milestone that could have a significant impact on society, education, and Operations Research. This panel aims to discuss the promises and perils of generative AI technologies, such as ChatGPT, in graduate education and Operations Research. The panel will examine how generative AI can facilitate student learning and enhance education. It will also discuss the potential dangers of generative AI, such as the risk of technology dependence and the possibility of compromising the quality of education. Panel members will discuss the ethical implications of using AI in education and how it can affect the role of educators and the autonomy of students. The panelists will share their experiences and best practices in using generative AI in teaching. The session aims to provide valuable insight for educators, analysts, and policymakers. Join us in this important discussion to enhance the Operations Research community's understanding of generative AI and how to best balance its benefits and risks in education and Operations Research. At this Kitty Hawk moment of generative AI, we must embrace our pioneering spirit and push the boundaries of disruptive technologies to make great strides in education and military operations research. Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development		

66423 - Modernizing Big Data Analysis of Army Experiments Using Cloud Technologies and Interactive Data Visualizations: A Network Use Case

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Marc A Gula		
Abstract: Army experiments tend to accumulate vast amounts of data coming from a variety of sources in a variety of formats. Being able to individually process, sort, and analyze each of the millions of elements stored within the collected data is critical to performing effective analysis that provides tangible and actionable results. Data sources often need to then be aggregated and explored as an integrated product to derive context and build confidence in the resulting analysis. To address the growing needs of big data analysis of Army experiments, network analysts at DEVCOM Analysis Center (DAC) have built tools to process, analyze, and explore large-scale network traffic data. DAC analysts achieve this by utilizing scalable, cloud-based resources and open-source data visualization applications. A data processing and analysis pipeline within Army's Microsoft Azure-powered platform, cARMY, has been established to enable quick turn-around from data harvest to analysis products. Additionally, a Grafana-powered data exploration and visualization tool was developed to be able to interactively examine the network traffic and merge other data sources for added context. These tools provide a network-focused example on a path towards modernization of analysis capabilities for experiment data and other big data challenges faced by the Army and wider DoD communities.		

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66366 - Tool Showdown: Advana, Vantage, DDSD, etc

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 3:00 PM
Authors: Melissa Sayers; John Brosius; MAJ Nathan Parker		
Abstract: Panel discussion to learn what analytic and app development tools are out there using several examples. Advana is a Department of Defense data analytics platform using Databricks and Qlik. Vantage is an Army data analytics platform using Foundry. The Army Futures Command Data and Decision Sciences (DDS) Directorate is using on site data engineers and servers to create and provide app development for Futures Command. How are they the same and how are they different? Where are the gaps in capability? If we do not understand the pros and cons and what is out there, how do we advise our operational leaders on the direction our organizations need to take? Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development		

66365 - What is Cloud Computing and Distributed Computing and Why Should I Care?

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Melissa Sayers; Anita Mehuys; Brian Negus		
Abstract: Cloud computing and distributed computing are enabling military analysts to do more. They have become catchy terms that you hear. Do we really understand what they are and what they enable us to do? How do we harness the power they provide? Which analytic tools around me have one and not the other? Which tools have both? Which have neither? Why should I care? I'll give you a hint, you should. Let me help you understand why. Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development		

66131 - Operations Analysis Factory

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Renee Borrero; Daniel Duhan; Matthew D Ovios		
Abstract: Title: Operations Analysis Factory Authors: Renee Borrero, Dan Duhan, Matt Ovios Lockheed Martin Corporate Operations Analysis team is leading digital transformation across the company's distributed team of more than 300 analysts. The Operations Analysis Factory, combines the People, Processes and Methodology, with an evolving Synthetic Environment, to bring advanced, flexible, scalable and faster analysis to decision makers and warfighters. Lockheed Martin's JADO Synthetic Environment provides a community modeling and simulation environment to support the execution and delivery of strategic Operations Analysis. Major capabilities include: advanced scenario		

generation, integrated analytics, interoperable multi-domain simulations, digital twins, all deployed using a DevOps pipeline and on top of multiple classified infrastructures. Creation of the environment is enabled by adopting software factory processes, including Agile and DevOps. Similarly, agile processes are incorporated into the execution of Operations Analysis, parsing analytic work into features and stories, and releasing updates and results in two week sprints. Analytic efforts are cross-matrixed into subject matter "dojos", harnessing expertise across the four distinct business areas of Lockheed Martin. Combining Agile processes, with the full breadth of subject matter expertise, to conduct analysis in a virtual, distributed, live capability, enables customer intimacy, collaboration, and immersive

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66053 - The Digital Age: Upskilling & Analytics as a Force Multiplier

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Gabrielle Cappadona		

Abstract: Analytics, when leveraged effectively, can serve as a force multiplier in decision-making and planning for the future. The fact of the matter is - the lack of data literacy and culture remains a major challenge for government agencies seeking to extract value from data at scale.

In this talk, we will explore the value of data literacy in government agencies, how it can foster sustainable data cultures, and the transferrable skills that make up the data literacy spectrum. We will also discuss best practices for beginning an upskilling journey in data science, with a focus on how DataCamp can serve as a catalyst for change in the Dept of Defense.

Tune in for the following takeaways:

- The foundational role analytics play in accelerating decisions within government agencies
- How data upskilling can accelerate analytics outcomes within government agencies
- How DataCamp can support individuals of any skill level and ambition to accelerate their data upskilling journey

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

65591 - NAVSUP's Journey to Collaborative Self-Service Analytics

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Christopher David Ferrarini		

Abstract: The fleet relies on working parts to fulfill its mission and stay ready across the world. The Naval Supply Systems Command (NAVSUP) manages billions of dollars' worth of wholesale parts for the fleet. During these uncertain times, never before has it been more important to make accurate decisions based on a plethora of data to ensure that the fleet quickly gets their orders fulfilled. As such, the pure magnitude of NAVSUP's supply chain necessitates a collaborative self-service technology stack for data and analytics.

Much of NAVSUP, let alone the Department of Defense, is full of analysts learning cutting-edge analytic tools and techniques in academia, only to enter the workforce and have access to a severely limited toolkit. Complex requirements for maintaining Navy Marine Corps Intranet (NMCI)-supplied Science and Technology (S&T) Developer computers are unsustainable, heavy reliance on IT support to engineer data & canned web-based analytic products reduces agility, limited North Star collaborative analytics creates stovepipes & increases the chance of duplicative/contradicting work, and limited publishing capability exists to share & consume analytic products. In addition, there are key capabilities that are required for an advanced Operations Research Analyst or Data Scientist in any organization to be successful: data engineering, data visualization, optimization, simulation, machine learning, and statistics.

For the past two years, NAVSUP's Lead Operations Research Analyst in its Business Process Analytics and Integration Division has conducted a gap analysis and shaped the requirements for an analytic architecture that will enable it to more agilely support the Navy. Heavy coordination and communication with NAVSUP's Information Technology (IT) arm have made significant strides possible, moving NAVSUP away from passing spreadsheets around and toward web-based self-service analytics. Having this architecture in place will enable the command to respond to initiatives faster and increase data-driven decision making. One use case is on what to buy & repair into the Navy's wholesale system to increase readiness while preserving fiscal solvency of the Navy's Working Capital Fund (NWCF).

This presentation will illustrate an example of an analytic architecture, the initiatives underway to improve analytics, and the vision for the future. At the end of the presentation, a demo will be shown on how to engineer data inside of the Navy Data Platform (NDP) data warehouse, create a quick Tableau dashboard connected to it, publish this dashboard on Tableau Server, and consume the results of the dashboard...all within 10 minutes!

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

68148 - Army Analytic Priorities

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Michael J McCarthy; Douglas Serota		

Abstract: Army Senior Leaders (ASLs) are looking for analysis to underpin the key decisions they make. There's a tremendous body of knowledge being developed by the Army analysis community that doesn't always bubble up to ASLs. To create a stronger connection, the Army has identified 12 Army Analytic Priorities and established the Army Analytic Directorate (AAD) to provide oversight. The Priorities include priorities related to people (recruiting, facilities, programs), readiness (capabilities for key theaters, reserve component mobilization), and modernization (investments in Army of 2030 and 2040, transforming the digital enterprise). AAD is working with key stakeholders to use ongoing analysis efforts to respond to these priorities. This paper will review the Army Analytic Priorities and discuss the approach the Army is taking to respond to senior leaders.

Location: TH321

Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

66223 - DoD Lakehouse Tour - Developing Analytic Innovation and Outcomes

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Lisa Marcus

Abstract: DoD Lakehouse Tour - Developing Analytic Innovation and Outcomes

Enhance your skills, knowledge, and capabilities for solving analytic challenges from basics through advanced Machine Learning and AI using Databricks Lakehouse capabilities available on DoD environments. Conquer your latest mission challenges regarding working with all types of data (structured, unstructured, streaming,etc) data sharing or working with data mesh or fabrics, and providing actionable information for decision advantage.

In this session, attendees will be provided with an overview of Databricks' industry leading Lakehouse capabilities like MLFlow, Delta, AutoML, as well as some newer capabilities. Learn where and how to gain access, some common use cases, complementary tools, and resources available for continual learning and certifications. This session is geared for a variety of business and analytic persona's. Examples including quick start guides and tips will be provided.

Location: TH321
Classification: UNCLASSIFIED
Working Group: WG04 Analytic Capability Development

65701 - System of Systems Approach to Operational Analytics

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Levent Ozdemir; Mr. Jesse Coleman

Abstract: Operational Analysis, supporting the investment and operational decisions, can no longer only focus on individual systems, without addressing their role in the larger complex mission architecture including disparate systems, data, organizations, and activities. A "system of systems" approach, combining cross-functional, operational data and analytic tools, is needed to provide analysts and decision makers insights to make smarter operational and investment decisions across the diverse Homeland Security Enterprise.

DHS S&T's System of Systems Operational Analytics (SoSOA) program offers a virtual environment for collaborative operational analyses that enables complex, timely, mission-focused decisions across DHS. SoSOA supports analysts and decision makers by combining the right data, tools, and training to enhance analytic capabilities DHS-wide. This cloud-based platform provides a project-based, web accessible, integrated analytics toolset in a secure and compliant environment for quick turn analysis in a government setting.

This case study explores how SoSOA has evolved, using a system of systems approach, to address complex mission problems using agile principles. This study will also cover SoSOA's practice of defining and refining requirements for operational analytics capabilities through pilot analysis projects.

Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development

65586 - Sustainment Data Education in Support of a More Data Centric Army

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Brian Thomas Johnson; Dr. William Smith		
Abstract: The Multi-Domain environment demands and requires Sustainers to quickly organize and present data from multiple sources to describe the current sustainment situation and make data-informed decisions. Sustainers must rapidly describe what happened, diagnose why it happened, and apply the analytical competencies and skills enabling them to prescribe optimal actions. These actions account for interrelated effects across the industrial base, the global distribution system, and the complex, multi-domain battlefield. Army Sustainment leaders must adopt a culture of rigorous data-driven decision-making, and it starts by providing the workforce the analytic competences required to develop sound recommendations through effectively using increasingly available data. Army Logistics University (ALU) is implementing a program comprised of sequential and progressive levels of data education embedded in professional military education for officers, non-commissioned officers, and civilians throughout their careers. This approach will include expanding existing professional military education and functional courses, developing exportable interactive multimedia instruction and programs of instruction, assessing civilian academic programs for equivalency, and increasing access to advanced academic degrees. Talent management will identify exceptional sustainers and connect them with the right educational and broadening assignment opportunities to create sustainment data specialists. Additionally, senior decision makers attend a Senior Leader Data Course to better utilize the skills being developed in Sustainers. This will blend both math and computer skills with Army Sustainment Warfighting Function (SWfF) requirements. To change the culture and develop data analytic skills and proficiency across the Army, ALU proposes a multi-tier approach to establishing, delivering, and sustaining data education. ALU will embed sequential and progressive data education into current ALU courses. This will be practical rather than theoretical in nature, blending both math and computer skills with SWfF requirements. For exceptional sustainers, talent management identifies those personnel to enhance their data education external to ALU. These personnel complete data analysis related graduate degree programs or training with industry. The Army's technical capabilities in collecting, storing, and disseminating data has increased dramatically over the last two decades. The capabilities of Sustainment Soldiers and civilians to effectively use that data has not developed at the same rate, giving rise to a gap between analytic competencies and technical capabilities which will only widen if not addressed. Sustainers must be capable of exploiting and understanding relationships of data from the tactical to strategic level. The Army's investment in materiel modernization must be matched by an investment in its people. Location: TH321 Classification: UNCLASSIFIED Working Group: WG04 Analytic Capability Development		

66566 - Navy Force Structure Review

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Stephen Steacy		

Abstract: The Navy Force Structure Review (NFSR) assesses combat effectiveness, affordability, and feasibility of the Navy in the 2040-timeframe. NFSR incorporated analytic lessons learned from the Future Naval Force Structure study and the Deputy Secretary of Defense's analytic priorities to develop a comprehensive design of experiment. We compare the planned Navy force structure with several alternative future fleets using campaign analysis, mission-level assessment, war gaming, and other analytic tools. The results support Navy force design and POM procurement decisions. Brief will discuss the analytic design, process for developing alternative future fleet designs, and the major takeaways from the study.

Location: TH353 Classified
Classification: SECRET NOFORN
Working Group: WG04 Analytic Capability Development

WG05 Cyber Operations

66436 - Analytics, the Cyber Cognates of Anything, Everywhere, All at Once

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Thomas Tenorio; Dr. Laura Freeman; Ricardo Valerdi

Abstract: This presentation now considers the cognitive dynamics discussed in “The Logistics of Data in the Future G Fitness Landscape”. Multidomain operations sets the stage for extreme competition involving cohorts of MASS (Men-Agents-Smart Systems). Analytics is the orchestration mechanism for collective intelligence and collaborative action. This framework considers knowledge curation and enrichment; learning and adaptation: mission and system space; system life cycles; future operating environments; and discovery in the real-world of collaborative and competitive action.

Analytics are integral to the sustainment of planetary scale systems advancing generationally every 18 months with a heavy focus on profit driven viability. The analytics of Silicon Valley exploit cognition enabling exponentially expanding monetization. Learning and adaptation as exemplified by Blackbox systems on Commercial Airplanes enabling an evolutionary model for knowledge by continuously refining measures of cognition, information and physical. Artificial Intelligence and Autonomy address the dynamic and integrity limits of the human collectives. The Analytics of Doctrine, Operations, Training, Materiel, Leadership, Personnel, Facilities and Policy (DOTMLPF-Po) must identify where DOTL-Po is over constraining MPF dooming acquisition to 10-year Industrial Era fielding cycles.

The Joint Operational Environment defines the Cyber Domain as Cognitive, Informational, and Physical, where Information is a Warfighting function. Yet, the development of universal analytics with utility for man, agents, and machines is marginally expanding. Despite growing enthusiasm for analytics, there remains a critical lack of resourcing for enterprise knowledge systems and tools.

World Models inherent to autonomous systems and mission space can be based on ontology, symbolic AI, deep learning AI and Autonomy yet each remains unique to each problem space. This effort builds on research in Unmanned and Autonomous Systems Test, Autonomous Systems Test and Evaluation, Pattern Frameworks, and Cognitive Networks for Expeditionary Cyber for Survivability and Lethality.

The cognitive framework for this effort comes from a multi-disciplinary perspective emphasizing Win in a Complex World. Analytics of defense must expand into evolutionary frameworks of cognates composable across Warfighter Functions for 10x, 100x, 1000x improvements. Each cognate of limited extent can be enhanced in a variety of ways (temporally and semiotically) to enrich collective intelligence and reduce ambiguity continually. The cognate framework must continually ensure modification enhances inclusivity across applications. Analytics adaptation and curation are critical given expected emergence in Revolutions in Military Affairs (RMAs) involving new military tactics,

strategies, doctrines, along with innovations in technologies and discoveries in basic research or science.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65953 - PCAP Analysis on a Military Campus

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Jeffrey Dean; Dr. Thomas S. Anderson		
Abstract: This presentation focuses on the challenges faced in maintaining the security of Department of Defense (DoD) networks due to the volume, velocity, and variety of network traffic data. The study collected packet data from a medium-sized campus network at the Naval Postgraduate School (NPS) and analyzed it using the NPS High-Performance Computing (HPC) environment. The results of the data analysis were used to identify traffic anomalies and potential gaps in firewall rules, and inform network command and control. The presentation highlights the significance of the study and its initial findings as indicators for further security analysis. Location: TH327 Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

66201 - Responding to the Linked Threats of Pandemic and Misinformation

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Eva K. Lee; Dr. Douglas A. Samuelson		
Abstract: In modern, interconnected society, epidemics spread more through group interactions than via the individual major carrier on whom traditional models focus. Also, countering the epidemic entails spreading information in a fashion similar to physical spread of infection: we are in a race between two dissemination processes. Clearly, then, an adversary seeking to harm a large, modern nation could disrupt and confound information dissemination to amplify the effects of an organic infection, regardless of that infection's origin. If this is not already happening, surely the COVID-19 pandemic has provided potential adversaries with a wealth of information about how to make it happen in the future. Major reassessments and restructuring of national processes and resources are indicated. Location: TH327 Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

65284 - Graph Representation Learning for Context-Aware Network Intrusion Detection

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Augustine Premkumar; Madeleine Schneider; CDT Carlton Spivey; John Pavlik; Dr. Nathaniel Bastian		
Abstract: Detecting malicious activity using a network intrusion detection system (NIDS) is an ongoing battle for the cyber defender. Increasingly, cyber-attacks are sophisticated and occur rapidly,		

necessitating the use of machine/deep learning (ML/DL) techniques for network intrusion detection. Traditional ML/DL techniques for NIDS classifiers, however, are often unable to sufficiently find context-driven similarities between the various network flows and/or packet captures. In this work, we leverage graph representation learning (GRL) techniques to successfully detect adversarial intrusions by exploiting the graph structure of NIDS data to derive context awareness, as graphs are a universal language for describing entities and their relationships. We explore several methods for NIDS data graph representation at both the network flow and packet level utilizing the CIC-IDS2017 dataset. We leverage graph neural networks and graph embedding algorithms to create a context-aware network intrusion detection system. Results indicate that adding context derived from GRL improves performance for detecting attacks. Our highest-scoring classifier incorporated both GNN embeddings and flow-level features and achieved an accuracy of 99.9%. Adding GRL methods to augment the flow/packet features improved accuracy by as much as 52.41%.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65488 - Autonomous Cyber Warfare Agents: Dynamic Reinforcement Learning for Defensive Cyber Operations

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: David Arthur Bierbrauer; John Pavlik; Robert Schabinger; Dr. Nathaniel Bastian		

Abstract: In this work, we aim to develop novel cybersecurity playbooks by exploiting dynamic reinforcement learning (RL) methods to close holes in the attack surface left open by the traditional signature-based approach to Defensive Cyber Operations (DCO). A useful first proof-of-concept is provided by the problem of training a scanning defense agent using RL; as a first line of defense, it is important to protect sensitive networks from network mapping tools. To address this challenge, we developed a hierarchical, Monte Carlo-based RL framework for the training of an autonomous agent which detects and reports the presence of Nmap scans in near real-time, efficiently and with near-perfect accuracy. Our algorithm is powered by a reduction of the state space given by a transformer, CLAPBAC, an anomaly detection tool which applies natural language processing to cybersecurity in a manner consistent with state-of-the-art. In a realistic scenario emulated in CyberVAN, our approach generates optimized playbooks for effective defense against malicious insiders inappropriately probing sensitive networks.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65285 - Data-Efficient, Federated Learning for Raw Network Traffic Detection

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: CDT Mikal Willeke; David Arthur Bierbrauer; Dr. Nathaniel Bastian		

Abstract: Traditional machine learning (ML) models used for enterprise network intrusion detection systems (NIDS) typically rely on vast amounts of centralized data with expertly engineered features. Previous work, however, has shown the feasibility of using deep learning (DL) to detect malicious activity on raw network traffic payloads rather than engineered features at the edge, which is necessary for tactical military environments. In the future Internet of Battlefield Things (IoBT), the

military will find itself in multiple environments with disconnected networks spread across the battlefield. These resource-constrained, data-limited networks require distributed and collaborative ML/DL models for inference that are continually trained both locally, using data from each separate tactical edge network, and then globally in order to learn and detect malicious activity represented across the multiple networks in a collaborative fashion. Federated Learning (FL), a collaborative paradigm which updates and distributes a global model through local model weight aggregation, provides a solution to train ML/DL models in NIDS utilizing learning from multiple edge devices from the disparate networks without the sharing of raw data. We develop and experiment with a data-efficient, FL framework for IoBT settings for intrusion detection using only raw network traffic in restricted, resource-limited environments. Our results indicate that regardless of the DL model architecture used on edge devices, the Federated Averaging FL algorithm achieved over 93% accuracy in model performance in detecting malicious payloads after only five episodes of FL training.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65414 - Offensive Cyberspace Operations: Using Markov Kill Chains to Justify Tactical Delegation Authority

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: LtCol Arun Shankar

Abstract: Offensive cyberspace operations (OCO) play a crucial role in every phase of modern warfare, from competition to conflict to stability. Generally, geographic combatant commanders (COCOM), US Cyber Command (USCYBERCOM), or service-level components hold the authority to use these weapons. Though there are methods for tactical commanders to request OCO support from these operational level commands, they can be arduous, time-consuming, and impractical during active conflict. For this reason, conventional warfare demands organic OCO capabilities at the tactical level.

Contrarians persist that this delegation is impossible, because cyberspace is so abstract and dimensionless that every OCO has the risk of undesired catastrophic effects, hence the need to maintain the capability at Fort Meade under close supervision. However, even an amateur understanding of networks will reveal that this premise is likely exaggerated. Though it is acknowledged that network structures often do not correspond with physical space, they do have a logical space defined by IP addresses. This logical space can be assigned to a MAGTF battlespace owner, much like airspace, sea lanes, and battlefields. Designated as a restricted operating zone, it could also constrain maneuver to reduce collateral damage. Tactical commanders could be permitted to execute OCOs within these constraints when missions are deemed to have an acceptable probability of success.

We develop a mathematical model to calculate this probability of success by decomposing an OCO into a sequence of individual steps, forming a Continuous Time Markov Kill Chain. The probabilities of success between simulated tactical and operational level delegation scenarios are then compared. Tactical scenarios are characterized as preplanned targets using a linear kill chain, and operational scenarios reflect dynamic targeting using two-dimensional kill webs. Optimal parameters for the Markov Chain are determined through simple optimization. Improvements to law and policy are proposed from these results.

Location: TH327

Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65485 - Systems Thinking; A Force Multiplier of Analytics

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Michael Woudenberg; Mr. Carl J. Unis

Abstract: No matter how advanced, how novel, or how tech-enabled, compartmentalized analytics cannot solve increasingly complex and emergent wicked problems. Join us as we explore the roots of systems thinking underpinning Operations Research through a combination of insatiable curiosity, humility, and an intentional reframing of the problem to ensure perspective. We'll demonstrate a simple, yet powerful framework we use to decompose problems based on the systems views of physical, logical, and persona applied to case studies on cyber, autonomy, and supply chain resilience. Systems thinking is the force multiplier of analytics and when properly aligned provides the keys to innovation, wicked problem reduction, and complex systems solutions.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65820 - Preserving The Conceptual Integrity of Critical Infrastructure With a Community Cyber Force

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Alexander Brickner

Abstract: Cyber security has become a critical priority for critical infrastructure, which is increasingly dependent on information technology and telecommunication infrastructure to ensure the reliability, safety, and security of the electric grid. Increasing threats from criminal and nation-state actors reinforce the growing need for collaboration, communication, and a whole-of-community approach to defending and responding to cyber incidents impacting critical electric infrastructure (CEI) through formalized information sharing partnerships and standards.

Military installations are dependent on linked physical and cyber electric infrastructures . These interconnected infrastructures, while improving capabilities and mission effectiveness, also increase vulnerability to potential failures due to human error, natural disasters, or intentional attack. Threats to installations are becoming more complex, covert, and unpredictable due to advancements in technology. Risks are compounded because the DOD does not have an organized, outward-facing focus on CEI and lacks the dedicated staff, capabilities, or processes to effectively coordinate cyber incident responses with utility systems. This capability gap delays response time and forces critical incident communication into cognitively strained channels such as email, phone, radio, and text.

Implementing software is challenging because there is no central program office that has the vision, authorities, and expertise to drive and execute on the CEI cybersecurity mission. Coordination and collaboration between utilities and the military is a challenge. The stakeholder convening processes to have constructive dialogue around defense energy resilience planning are complex. Prominent DOD control system cybersecurity programs have identified technical targets of reducing CEI cyber responses times from months to hours through more effective threat information sharing and CIE.

Maintaining an effective cyber posture requires a coordinated virtual cyber terrain map and actionable specifications that are continuously maintained, updated, and rapidly available throughout the enterprise. In the realm of power distribution and utility control system cybersecurity, actionable information has become large, multi-dimensional, specialized, and massively distributed. UMLARC proposes that Community Cyber Forces, in partnership with critical infrastructure providers, are responsible for deploying cyber infrastructure to identify vulnerabilities, protect critical energy infrastructure and networks, enable automated assessment, provide situational awareness, and respond to the threats within the electric sector across disparate and siloed cybersecurity platforms at multiple levels of classification.

The University of Massachusetts Lowell will discuss research related to a establishing a CCF near Hanscom AFB to support the Northeast region during critical infrastructure cyber incidents.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

66121 - Unmasking Blackbox Systems to See For Eyes: C4I Must Reveal the Core Data in 2023

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Ms. Jena Jordahl; Dr. Tamara B Schwartz; Ms. Christine Don

Abstract: Today's C2 systems present a highly complex challenge for warfighters. Traditional OR approaches often make the mistake of privileging one perspective as "objective," while marginalizing other points-of-view and creating bias within C2 systems. Warfighters commanding AI-enabled C2 systems face the risk of following a directive given by a flawed blackbox-AI system and putting themselves in danger.

Blackbox AI-enabled C2 systems must be stress-tested using a chaos engineering approach combined with a capability to repair broken software once it is identified. However, in an effort to protect intellectual property, few companies provide enough access to their code bases to allow users or vendors to fully understand them. Infinite IQ has developed tools for accessing and analyzing these protected code bases.

Testing a blackbox system from the outside, only verifies the computations in the output, but testing it from the inside, using known algorithms, allows the combination of data structures to be tested. Within a series of computations, we can discover what a blackbox system is doing under a given set of circumstances. This approach acts as an MRI of the data architecture of the system as a whole, allowing the use of a surgical approach to repair it using large language models that are capable of writing code.

Chaos engineering is essentially breaking things on purpose. It involves experimenting on a distributed system by simulating turbulent conditions. In the current IOT&E methodology, we do not test the interaction of multiple C2 systems, instead we test only a single contract functionality. Thus, we don't stress test the entire situational awareness capability such that we understand what happens when systems are functioning simultaneously and under duress.

By testing C2 systems with a model of probabilistic troop and materiel movements, and pushing it through the system at a real-time volume, this injection of real-world inputs enables a better understanding of the systems' behavior and identifies system points of failure by using Learner AI tools to see into the "blackbox." Learner AI is different from standard chaos engineering in that it goes beyond simply simulating intrusions. It includes the simulation of real world simultaneous events across systems.

Since real world events are so diverse, Learner AI uses a large language model and predictive capabilities to hone in on the essential combination of situations that are realistically likely to occur. In essence you are not just testing for a bad day with graceful degradation of capability and correct error messages. Instead, you are testing for the likely availability of multiple capabilities that are intended to save assets and lives in a given set of probable circumstances.
Once the system points of failure are identified, the introduction of large natural language processing models based on transformer neural networks allows us to inject code to repair breaks in the software.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG05 Cyber Operations

65845 - Demonetizing Cyber Crime; Tracing Funds through Blockchain Analytics

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Michael Woudenberg		
Abstract: Cryptocurrencies are exploding across the financial markets, and with that, illicit actors are using crypto to extract revenue from cyber attacks such as ransomware, crypto hacking, and other cybercrimes. State and non-state actors are also using crypto as a method to bypass sanctions and anti-proliferation laws, obfuscate money laundering and anonymize cyber criminals. Join us as we explore blockchain analytics, crypto tracing, criminal attribution, and the public and private partnerships required to demonetize cybercrime. Location: TH327 Classification: UNCLASSIFIED Working Group: WG05 Cyber Operations		

68010 - Cyber-to-Sortie Analysis

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: John Jang		
Abstract: (U) Cyber activity is investigated for potential impact on real world operations of military assets. The Air Force Studies and Analysis (SAF/SA) cyber team proposes a framework to characterize cyber vulnerability data. The framework assesses the presumed threat and provides a trade space of defensive actions. The investment of defensive action is quantified as purchasing cost and the return on investment (ROI) is estimated analytically as a dollar amount. The framework is demonstrated with a real world case study of airfield operations. The study uses a SIMIO simulation to characterize cyber effects on sortie generation. The key contribution of this framework is translating the cost of cyber threats, defensive purchases, and ROI into a common currency. Location: TH358 Classified Classification: SECRET NOFORN Working Group: WG05 Cyber Operations		

WG06 Command and Control (C2)

66116 - Developing a Domain Specific Language for Complex Military Operational Analysis using Simulation

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mark Sumile; Dr. Jose Bricio-Neto; Dr. Saikou Diallo; Michael R. Hieb, PhD; Dr. Daniel Thomas Maxwell; Dr. Ali K Raz; Christopher Santos; Cameron Schlonski

Abstract: The DARPA Secure Advanced Framework for Simulation and Modeling (SAFE-SiM) program is developing a high-resolution combat simulation and supporting knowledge management system intended to advance the state of the art in military operational analysis. Envisioned analyses include operational concept exploration as well as Command and Control (C2) and System of Systems (SoS) analysis in support of acquisition, testing, and budgetary processes. A major challenge to reaching the SAFE-SiM vision is achieving the semantic consistency necessary for effectively communicating among members of a diverse multi-disciplinary team to support design and development, as well the even more rigorous challenge of enabling effective simulation and machine reasoning in a highly complex multi-domain environment.

Attempting to communicate concepts between the simulation development and military warfighter communities is extremely difficult. The historically limited success in this endeavor led to a focus on Domain Specific Languages (DSLs). A DSL is a technical language specialized to a particular application domain. This is in contrast to a general purpose language (GPL), which is broadly applicable across domains. In our case the domain is strictly limited to the military missions being evaluated by the SAFE-SIM program.

The function of the SAFE-SiM DSL is to facilitate a standardized translation of doctrinal input to an ensemble of executable models. The SAFE-SiM DSL is designed to facilitate reasoning on automated decision-making for entities within these models. An Operator/Analyst will use an interface to input pre-simulation scenario specifications. The DSL will provide a representation and interface to an ensemble of models that are built and modified by Simulation Engineers.

The SAFE-SIM DSL addresses C2 concepts, such as Authorities & Relationships and Reporting & Coordination, as well as standard simulation inputs such as Tasks, Control Measures, and Targeting Priorities. Because of this there is a critical need for the DSL to represent existing doctrinal and experimental concepts to provide a mechanism for clearly communicating operational concepts developed by operational SMEs to simulation developers. This overcomes the difficulty often encountered communicating complex operational concepts between operational SME's and technical developers, particularly in the area of command and control.

This presentation describes the process used to develop the SAFE-SiM DSL, challenges, and lessons learned during the process that would be applicable to other simulations used for military operational analysis. More importantly, we give an overview of the resulting DSL and demonstrate how it creates a layered vocabulary and a pathway of linking commanders intent and doctrinal input to parameters of executable code in a complex simulation.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

65999 - EADSIM: Understanding the Results

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Michael L Thomason		
Abstract: This presentation provides an overview of some of the integrated tools and techniques within the Extended Air Defense Simulation (EADSIM). These tools aid in deployment of systems as well as analysis of the performance of those deployed systems. Evaluations range from operating as a standalone capability or operating as an integrated, complementary capability across multiple domains against a given threat. The EADSIM is a force on force simulation of air, missile, and space warfare. It provides capability for analysis, training, test, and operational planning in a single, integrated package. EADSIM is capable of evaluating small vignettes of a few entities up to entire theaters with thousands of entities. A simulation can be executed as fast as possible (generally faster to much faster than real time) for a stochastic, multiple Monte Carlo evaluation of a scenario. It can also be slowed down to real time to allow interaction with an operator in the loop or interactions with live and simulated systems using embedded capabilities for DIS, HLA, and multiple tactical communications protocols. No matter the mode of operation, EADSIM records a plethora of data that is available for post simulation analysis and visualization. This presentation will take a look at tools that assist with deployment of defensive and offensive systems. This will include tools such as sensor coverage diagrams, GPS jammer to signal levels, defended area and launch area denied footprints for missile threats, coordinating Time on Target, and the Defense Analysis Tool for air breathing threats. We will also cover capabilities for post simulation analysis. This will include examples of data extraction and overlays into the multiple visualization views. Expected overlays for demonstration include both truth and perception views with usage considerations, event plotting onto both geographic displays and timelines, and value overlays onto the path of an entity. Specific Monte Carlo results will also be demonstrated that provide rapid mechanisms for analyzing changes to either the defensive capability to interdict the threat or the offensive capability to penetrate the threat. These tools and techniques will benefit those that use EADSIM, as well as those that are looking for additional ways to evaluate performance of systems in a force on force context. Location: TH328 Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

66081 - Analysis and Evaluation of Kill Webs via Graph Theoretic Methods

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. Ali K Raz; Mohammed A. Bhuiyan; Michael R. Hieb, PhD; Cameron Schlonski; Christopher Santos; Dr. Daniel Thomas Maxwell; Dr. Jose Bricio-Neto		
Abstract: Mosaic warfare concept promotes dynamic composition of kill chains in a system of systems (SoS) where multiple sensors and weapons can be opportunistically linked in near real-time to address emergent threats. This presents a major shift from the status-quo where the kill-chain composition is defined via a static SoS architecture. Dynamic composition of kill chains presents a novel challenge of first identifying a super set of all potentially feasible paths to link distributed systems into a kill chain and then reducing this super set to most promising paths based on risk, performance, and engagement metrics. This network of kill paths and kill chains with ability to engage one or more targets and missions is referred to as a kill web.		

Our team is using an Adaptive Kill Web Framework (AKWF) as a foundation for conducting concept exploration, feasibility assessment, and performance evaluation of kill webs at a theater-wide level for the US Department of Defense. The AWKF provides a conceptual formulation of kill web representations via mathematical notation—derived from set-based principles—and pairs it with technical analytical methods to facilitate analysis.

This presentation focuses on Graph theory formulation within the AKWF to analyze kill chains in a given theater. Graph theory provides a mathematical approach to study networked systems where an individual system (or the task/function it performs) is represented as a node and information flow between the nodes as edges. By using graph theory to model Kill Webs, we are able to depict not only the relationships between individual sensors, weapons, targets and communications, but also to identify if they contribute to finding, fixing, tracking, targeting, and engaging (F2T2E) a target which forms the basic constructs of a kill chain. These constructs are then investigated with mathematical metrics such as eigen vector centrality, betweenness centrality, and node degree etc., to develop a better understanding of Kill web, e.g., identify critical systems or bottlenecks. Furthermore, this is extended by introducing the platforms that sensors and weapons are attached to. These graphs can be then filtered based on the nodes of interest to find the best target/weapon pairing.

We present an overview of the AKWF, show how we use graph theory to model the AKWF, give a detailed example in Air/Sea warfare, and discuss future work.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

66416 - Cyber resilience analysis of Tactical Networks using elastic and reconfigurable software defined network slices

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Mr. Anthony Castanares

Abstract: Tactical software defined radios such as the AN/PRC-162, the AN/PRC-163, and the AN/PRC-167 have opened new opportunities to secure military network architectures through sophisticated segmentation and isolation techniques in the data plane. For example, software defined network slicing is a relatively new technique being deployed in both mobile and fixed enterprise networks throughout Europe to create strongly segmented enclaves that provide guaranteed Quality of Service (QoS) resources to systems in each slice (such as bandwidth, latency, jitter, etc.). DAC's work aims to take lessons learned and best practices from these deployments and apply them to current and next generation tactical networks using software defined radios to secure these enclaves and make them more resilient against threats or attacks when the network is breached. Our presentation will show how network slicing is implemented in a robust and commercial grade network controller (Open Network Operating System or ONOS) that can be used to manage tactical radios using the OpenFlow network management protocol to achieve granular device-level software configuration management in order to 1) secure the network with mission-specific slices, and 2) quickly react and respond to threats or attacks by reshaping and reconfiguring the network to isolate breaches in real-time. We will present measurements that show the impact of software defined resilience reconfiguration by analyzing the change in delivered QoS at infected network enclaves with and without slicing, as well as measuring time to threat isolation with and without slicing and infection spread analysis among systems in the enclave with and without slicing. Preliminary follow-on work will also be presented

that focuses on broad Quality-of-Service impact analysis resulting from network slicing in a distributed tactical radio software defined network.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

66004 - EADSIM Capability in Multidomain Operations Simulation

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Michael L Thomason

Abstract: This briefing provides an overview of Multidomain Operations within the Extended Air Defense Simulation (EADSIM) environment. We will discuss specific Multidomain Operations modeling cases, the extensive Multidomain Operations modeling available in EADSIM now, and the potential to better support land combat through federation to economically provide the robust consideration of this important topic.
Multidomain Operations require integrated consideration across the military branches. Considerations include blue and red Air and Missile Defense; Command and Control; Communications, Intelligence, Surveillance, and Reconnaissance (ISR); Long Range Precision Fires / Air Strike Operations; Space; Electronic Warfare (EW) and Cyber; Position / Navigation / Timing (PNT); and Intelligence Preparation of the Battlefield (IPB). These analyses must connect the operations in each of the domains to each other and ultimately to the usefully meaningful combat outcomes (the 'so what?' question). EADSIM provides this modeling, allowing confident analysis of the Multidomain Operations battlefield.
EADSIM has a current limitation in modeling maneuver warfare aspects of land and surface combat. EADSIM has participated in multiple federations, in some cases using HLA or DIS interfaces. In other cases, "sneaker" net is employed. The integrated nature of the effects makes it difficult to capture all interdependencies when crossing the federated boundaries. The federations so far have primarily considered lethal effects exchanged between the federates, and still need to be further extended to allow the full integration of effects to be presented in a realistic manner.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

65756 - Developing a Southern Asia CBRN Decisional "Wind Sock" Tool and Methodology

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Colonel (Retired) Scott Henry

Abstract: The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to support decision-making, plans and operations that counter development and exploitation of Weapons of Mass Destruction (WMD) and emerging threats. As the INDOPACOM Combatant Command monitors and conducts regular assessments of their Southern Asia Area of Responsibility (AOR), it is important to understand where the potential operational and strategic vulnerabilities and opportunities exist. A Country-level CBRN decisional tool (aka the CBRN Wind Sock) methodology that will enhance the Command's ability to visualize this region of their AOR that may be less prepared for WMD, or WMD-like, events and to prioritize resources to improve readiness and reduce vulnerability.

The CBRN Decisional Tool (CBRN Wind Sock) is derived from information from numerous open-source data sets, indices and indicators, which ultimately orients to a vulnerability scale. The socio-economic and defense indicators that form the foundation of the "CBRN Wind Sock" are captured from diverse open-source data sets which enables collaboration with security partners to address country vulnerabilities. The discussion will include thoughts on the data hierarchy and compilation methodology along with potential emerging vulnerabilities and opportunities.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

66122 - Dreamcatcher: Integrating Distributed All-Domain Fires, Maneuver, and Logistics Planning

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Connor S McLemore; Michael Albrecht; Travis Hartman; Jeffrey Linderoth		
Abstract: We present an optimization model to help the U.S. Navy's Maritime Operations Centers (MOC) and equivalent C2 elements rapidly generate plans involving time to best allow many distributed and moving Blue missile platforms to conduct strikes against many distributed and moving Red ships, submarines, and other platforms in dynamic, high-threat environments, while also accounting for the logistical supportability of the generated plans. Given Blue and Red Orders of Battle, the approach supports rapid planning towards the assignment of many kinetic and non-kinetic effects to many Red targets, including defended targets, in a manner that balances Blue offensive coverage and defensive posture in accordance with commander's intent while preserving Blue assets and resources. Dreamcatcher allows MOC planners to maintain experienced human control of planning processes while reducing the coordination burden and planning time delays by handling the heavy computational aspects, freeing planners to focus on cognitive tasks. The model is focused on days, not hours, and optimizes the employment of a finite number of Blue missile platforms based on the Red order of battle. It takes into consideration multiple objectives (e.g., commander's priority, probability of success, speed of attrition, defensive capabilities, preserving valuable weapons, etc.) and Red undersea, surface, air, and space capabilities to allow Maritime Operations Center planners to optimally plan schemes of maneuver over location and time for many Navy and Marine Corps platforms while accounting for threat pairings for soft and hard kills and integrated all-domain defense. Dreamcatcher is accessible Fleet wide from any connected SIPR computer via URL. Local installations on individual SIPR computers are not required. Location: TH328 Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

65639 - SAFE-SiM Behavior Development Process

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Christopher Santos; Ms Donna Lea McDaniel; Dan White; Mark Sumile; Mr Jeffrey Michael Saling; Dr. Jose Bricio-Neto		
Abstract: DARPA is sponsoring the development of the Secure Advanced Framework for Simulation and Modeling (SAFE-SiM) to enable and accelerate faster-than-real-time (FTRT) modeling, simulation, and analysis (MS&A) of complex kill webs involving hundreds of thousands of entities across an entire		

theater at mission-level fidelity. One of the unique requirements for such kill web analysis is the ability for the computer to execute dynamic tasking and re-tasking of assets within simulation runtime, which requires a robust Battle Management Command and Control (BMC2) architecture and schema. Furthermore, this BMC2 requires a comprehensive behavioral foundation in order to make accurate, informed, and plausible dynamic tasking and re-tasking decisions. DARPA's vision for SAFE-SiM is that it should not only be able import and utilize models from other frameworks such as Advanced Framework for Simulation, Integration, and Modeling (AFSIM) and Next Generation Threat Simulation (NGTS), but it should be able to import the behaviors associated with those models. However, in practice this has some challenges.

The first main challenge is that behaviors developed in these existing frameworks are scripted or coded using non-standard terminology that would appear foreign to the warfighter. This complicates the ability of the warfighter to inspect behaviors for suitability and/or accuracy.

The second main challenge is that behaviors are typically customized to each model, which prevents scalability and application of the same mission behavior to different platforms that can perform the same mission. Furthermore, behavior scripts are often "hard-coded"; this makes it very difficult to swap in a new capability or concept into the scenario without creating a new set of behaviors.

Finally, existing frameworks (AFSIM for example) often require the user to have coding skills. Other frameworks (such as NGTS) use a graphical decision tree approach, but the underlying behavior modules are hidden behind source code and cannot be parsed or deciphered by SAFE-SiM. Both have implications for importation, inspection, and even creation of behaviors.

This presentation provides an overview of the lessons learned and approaches being implemented in SAFE-SiM to address or mitigate these challenges. We introduce a framework that clarifies the different layers of behavioral elements and how they interact. Then we walk through the process of decomposing warfighter missions, tactics, and concepts into a structured Domain Specific Language (DSL), applying this DSL to the SAFE-SiM architecture, and ultimately the development of a SAFE-SiM user interface that allows the warfighter user to create, inspect, and apply scalable and flexible behaviors.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

65995 - Command Post Survivability: Using Simulation to Identify Trades between Situational Understanding and Network Requirements

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Matthew Wesloh		
Abstract: A division command post (CP) manages the planning and execution of operations. Traditionally, CPs are a single entity. However, the threat of enemy interdiction poses a risk to a consolidated structure. The Army introduced a new dispersed CP concept to reduce the risk of losing any one location. However, dispersing the CP inhibits face-to-face communication, reducing situational understanding. The Research and Analysis Center (TRAC) and Mission Command Battle Lab (MCBL) undertook an effort to simulate and define the trades between situational understanding and network requirements. The study team built a representative set of intra-CP communications and		

used discrete event simulations to determine the operational impacts of potential requirement levels. The study team found that the Army requires updated CP doctrine and TTPs to enable dispersed command post operations. This presentation will summarize the approach to enumerating and simulating the communications demands and will provide an overview of lessons learned from the process.

Location: TH328
Classification: UNCLASSIFIED // NOFORN
Working Group: WG06 Command and Control (C2)

66455 - Interoperability Challenges of the Combined Joint Force: Technologies, People, Processes, Permissions, and Authorities.

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Arrio Granum

Abstract: The Army's Project Convergence is a campaign of Combined Joint Experimentation with core emphasis on interoperability. Project Convergence 2022 (PC22) was an attempt to understand how the data from various domains aggregate across a command and control architecture, available on demand to the Combined Joint Force (CJF) to make decisions at machine speed. PC22 was targeting-focused, designed to determine data-to-shooter linkages required for an interoperable CJF. Combined Joint All-Domain Situational Awareness (CJADSA) was one of the main threads for enabling the CJF during experimentation. The focus of establishing a CJF, a mission partner environment (MPE), or any combined environment is to leverage data across all domains at scale. Accomplishing this complicated capability is the very definition of interoperability and is paramount for a CJF to get correct across all domains. CJADSA for a CJF increases the cost of adversary escalation of hostilities.

Technology: PC22 highlighted several technological challenges primarily in integrating message format types from a technical (and sometimes doctrinal terminology prospective) across a system of experimentally linked network nodes. Additional technological challenges highlighted the need for enterprise-wide change towards data-centric zero trust architecture over network centric and stovepipe data flows.

People and Process: Interoperability agreements exist to help define roles and processes. American, British, Canadian, Australian, and New Zealand (ABCANZ) standards are one of the main Army agreements among the Five Eyes (FVEY) partners. PC22 demonstrated the importance of partner interoperability standards such as ABCANZ and how they can apply in a Combined Joint experimentation environment. Joint and multidomain interoperability standards enable a CJF. Enabling CJF requires interoperable network capabilities, and PC22 demonstrated the importance of having the right personnel with the relevant network expertise to adequately provide network capabilities at the scale of combined joint experimentation and for an operational CJF.

Authorities Policies Permissions: PC22 demonstrated the wide range of necessary considerations of Partner laws, doctrine, organization, weapons, equipment, capabilities, terminology, culture, politics, religion, language, and objectives to shape an interoperable CJF. Several mission threads, while technically achievable, were often hindered by policies and authorities predicated along national stovepipe protection of data flows with no easy way to operationalize sharing of data across the CJF at the speed of machine learning. Examples include sharing of communication security information for Australian-U.S. feeds to go directly across the enterprise network into a U.S. TOC; artificial

intelligence (AI) database sharing for combined AI target recognition data labeling program; sharing information relating to targeting data within the CJF AOR.

Location: TH353 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG06 Command and Control (C2)

66159 - Modeling Joint All-Domain Command and Control Critical Modeling and Simulation Components

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes an unclassified 6-month study that examined the critical components for a Joint All-Domain Command and Control (JADC2) operations research model. The study explores the research question, "What are the critical components of a Joint All-Domain Command and Control (JADC2) operations research model that adequately represents actors, information, and relationships?" Current JADC2 operations research models depend on representing information sharing between nodes and the dissemination of that information for individuals to make tactical, operational, and strategic decisions. Some models account for "perfect" command and control, which is the notion that command-and-control models collect, process, and disseminate information as efficiently and effectively as possible. However, this notion introduces a significant logical fallacy into JADC2 modeling and simulation, and no current campaign-level model exists to solve this analytical challenge. Capability and capacity gaps exist in mission-level and campaign-level modeling, which threaten the credibility of operations research models that use JADC2.

This research used conceptual maps to identify the relationships between JADC2 nodes: an actor, information, and a relationship. The actor is a human who makes a decision based on some input. Information is data that provides situational awareness about a domain. JADC2 nodes share relationships. For example, actors share and act upon information. Additionally, information describes an occurrence that possibly relates to another piece of information. These relationships become more important to accurately model as automation is introduced into JADC2 models. The researcher created a JADC2 conceptual map based on joint command and control doctrine, with particular emphasis on shared command and control components between the services. The researcher used linear regression to analyze the relationships between JADC2 nodes within the "actors-information-relationships" framework and established a list of critical components for a JADC2 model. The researcher determined the importance of nodes based on their interaction with other nodes.

This study is relevant to operations research because it potentially increases the confidence researchers place in JADC2 modeling and simulation. Models that include JADC2 allow analysts to account for a center of gravity in an operational force, which ultimately serves as a force multiplier for planning and contingencies. This research is relevant to this year's symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it clarifies how JACD2 is a system of systems, as it is advertised by Department of Defense officials and commercial stakeholders. The presentation will include a detailed summary of the study's conceptual map and findings.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

66002 - Joint High Energy Laser Vulnerability Interface

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Michael L Thomason		
Abstract: High Energy Lasers (HELs) have advanced from futuristic vision to tactical reality. Introduction of these systems on the battlefield provides a significantly different delivery mechanism for inflicting damage on opposing forces when compared against conventional kinetic kill capabilities. This is true on the battlefield and on the simulated battlefield, where defensive capabilities are evaluated for many purposes, e.g., assessment of Military Utility and development of Tactics, Techniques, and Procedures. For these evaluations, key aspects of the timeline to deliver an effect on a threat must be captured to provide an accurate performance of technologies on the battlefield and to maximize the effectiveness when a mix of technologies are available to counter a given threat. The time that the laser beam must dwell on the target to produce an effect is a major component of that timeline. The methodology for characterizing the vulnerability of a targeted system to the delivered laser energy has evolved over time. Under the direction of the Joint Directed Energy Transition Office, an API, the Vulnerability Module ICD, was developed as a standard mechanism to provide that information to support various needs. These needs cover the gamut of HEL technology including development, employment planning, TTP development, and even implications for fire control. This presentation will provide an overview of the evolution of the VM interface, example usage in EADSIM as a weapon system model accessing the VM, and an overview of some recently developed tools. One of these tools executes a VM through a number of tests to assist verification that a VM operates according to the standard. Another of these tools queries the VM providing a mechanism to evaluate the vulnerability of the target under specific HEL delivery conditions. Location: TH328 Classification: UNCLASSIFIED Working Group: WG06 Command and Control (C2)		

65438 - Offensive Cyberspace Operations: Using Markov Kill Chains to Justify Tactical Delegation Authority

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: LtCol Arun Shankar		
Abstract: Offensive cyberspace operations (OCO) play a crucial role in every phase of modern warfare, from competition to conflict to stability. Generally, geographic combatant commanders (COCOM), US Cyber Command (USCYBERCOM), or service-level components hold the authority to use these weapons. Though there are methods for tactical commanders to request OCO support from these operational level commands, they can be arduous, time-consuming, and impractical during active conflict. For this reason, conventional warfare demands organic OCO capabilities at the tactical level. Contrarians persist that this delegation is impossible, because cyberspace is so abstract and dimensionless that every OCO has the risk of undesired catastrophic effects, hence the need to maintain the capability at Fort Meade under close supervision. However, even an amateur understanding of networks will reveal that this premise is likely exaggerated. Though it is acknowledged that network structures often do not correspond with physical space, they do have a logical space defined by IP addresses. This logical space can be assigned to a MAGTF battlespace owner, much like airspace, sea lanes, and battlefields. Designated as a restricted operating zone, it could also constrain maneuver to reduce collateral damage. Tactical commanders could be permitted to execute OCOs within these constraints when missions are deemed to have an acceptable probability of success.		

We develop a mathematical model to calculate this probability of success by decomposing an OCO into a sequence of individual steps, forming a Continuous Time Markov Kill Chain. The probabilities of success between simulated tactical and operational level delegation scenarios are then compared. Tactical scenarios are characterized as preplanned targets using a linear kill chain, and operational scenarios reflect dynamic targeting using two-dimensional kill webs. Optimal parameters for the Markov Chain are determined through simple optimization. Improvements to law and policy are proposed from these results.

Location: TH328
Classification: UNCLASSIFIED
Working Group: WG06 Command and Control (C2)

WG07 Intelligence, Surveillance, and Reconnaissance

65513 - Autonomous Aircraft Identification (AACID)

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Raymond Scott Starsman; Aisha Chun; LCDR Robert Routely; Robert Gresham; Bradford Lott		
Abstract: This study examines the performance of a one-shot learning approach to identify 41 different classes of military aircraft as well as identifies a data pipeline to include additional classes. The proposed Autonomous Aircraft Identification (AACID) method, capable of multi-object detection and near-real-time predictions for video feed, achieves 78% test accuracy across the 41 classes which include military aircraft commonly used by the United States, Russian, Ukrainian, and Chinese Armed Forces as well as numerous defense partners of those nations. The U.S. Department of Defense's ability to collect data exceeds its ability to analyze that data and convert it to actionable information. In addition to near-real-time predictions, we consider a scenario in which a Processing Exploitation and Dissemination (PED) analyst maintains a backlog of image and video files requiring analysis. AACID may assist the analyst in determining which files to review first by creating a "file-tag" including potential aircraft classes and quantities. This has the potential to improve intel product creation time. This work is a direct result of the Department of Defense Chief Digital and Artificial Intelligence Office's (CDAO) first-ever Create AI training program. All data used in this study is captured from publicly available sources. Location: TH327 Classification: UNCLASSIFIED Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

66425 - Modeling Effects of Multipath on Radar Performance against low flying targets within the Tactical Intelligence, Surveillance and Reconnaissance (ISR) Performance Suite (TIPS)

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Eric Harclerode		
Abstract: The Combat Capabilities Development Command (DEVCOM) Analysis Center (DAC) has enhanced the modeling of Radar performance against low flying targets to include multipath effects within the Tactical ISR Performance Suite (TIPS), a reusable code library that encapsulates the DAC sensor performance models and behavior methodologies. The methodology accounts for the effects of the bouncing of the transmitted signal from the Radar to the target and back on both acquisition performance and location measurements. Options are included for possible multipath mitigation techniques that enable design of experiments and act as force multipliers for assessment of radar		

technologies against low flying targets. This briefing will discuss recent and future development updates and utilization of this methodology within TIPS in an end-to-end active protection system model use case.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

65689 - Proliferated Radar - Using Cell Networks to Detect Aerial Targets

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: James MacPherson; Wesley Jones

Abstract: With the increased proliferation of Internet connected sensors there are also increased opportunities for new sensing technologies and methodologies. This study focuses on the potential use of 5G "New Radio" NR as a sensor system intended to detect and identify aerial moving targets. 5G NR networks use a combination of low, mid, and high-frequency bands for various connectivity uses. NR offers many network channels within low and high frequency ranges, with 45 primary bands between 410-7125 MHz and 8 primary bands between 24.25-71.0 GHz. Cell networks also offer large area coverage spanning 120 degrees in the azimuth with transmit power capabilities up to 500 W. An AFSIM model is used to examine the potential capabilities of NR for surveillance and tracking of aircrafts. Using the industrial, scientific and medical (ISM) band (2.40-2.48 GHz), the model explores this non-traditional method to identify targets and reveal potential detection ranges.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

65595 - Quantitative Modeling of Text-Based Intelligence Source Uncertainty

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Adam Nesmith

Abstract: An all-source intelligence analyst’s primary job is delivering timely, well-sourced assessments on relevant targets based on uncertain and incomplete information. Each assessment includes a likelihood that the assessment is true, and a confidence level based on the uncertainty of the sources used. Quantitative all-source intelligence analysis is not widely implemented despite the acknowledged limitations of qualitative intelligence assessments and the existence of proposed quantitative methods. This is due to the challenge of quantitatively representing uncertainty in text-based intelligence reporting (i.e., HUMINT, OSINT, SIGINT), which limits the effectiveness and usability of previously suggested methods. This research creates a novel framework for quantitatively assessing text-based intelligence source uncertainty by adapting quantitative decision models used in multi-objective decision analysis. This novel model allows analysts to easily identify and mathematically account for the underlying causes of a source’s uncertainty, weight the importance of these causes, and output a single value in between 0 and 1 representing the source’s overall uncertainty. The analyst can then use this numerical output as an input into the previously proposed quantitative intelligence analysis methods. Ultimately, this framework for quantifying source uncertainty facilitates the use of previously proposed methods and creates more traceable and defendable intelligence assessments.

Location: TH327
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

65531 - Outsmarting AI: Army Camouflage of 2030

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: MAJ Jason Fabijanowicz; Mr. William Corson, Jr.

Abstract: The goal of 20th Century camouflage was to prevent detection from an adversarial human eye by breaking up patterns. But as modern technology adapts to focus on advanced analytics techniques in lieu of human analysis, camouflage also needs to adapt.

Camouflage for the Army of 2030 will need to be more advanced than merely using Chemical Agent Resistant Coating (CARC) paint in a woodland or desert color scheme. While this may have been effective against human detection in the past, the speed and ease of detection through satellite or unmanned vehicle imagery without a human-in-the-loop may render those methods obsolete. Therefore, preventing the enemy's ability to classify friendly vehicles without a human-in-the-loop provides an edge in the first battle of the next conflict where the United States Military has historically not achieved much success.

U.S. Army combat vehicle modernization efforts continue to conform to the historical appearance of an Abrams Tank of Bradley Fighting Vehicle. Images of these vehicles will continue to be added into commercial algorithms and allow for simplistic categorization. However, if the critical identification points on combat vehicles can be found, the Army can develop cheap solutions to degrade this effort and potentially afford friendly forces a brief period of anonymity.

The focus of this brief is to determine the exact areas on a vehicle that are most important in classifying it as a combat vehicle, in particular a tank. After determining these areas with image classification and saliency maps, potential solutions can be generated that thwart the enemy's detection systems from classifying them correctly. The benefits of camouflaging our most-casualty-producing direct fire weapon systems cannot be understated, most notably may be the ability to support the initial lodgment within the first 100 to 120 hours in large scale combat operations.

This brief will look at profile views of image classification as well as more common overhead photographs to determine if there is a difference in the most important areas for classification depending on the photograph angle. Finally, the brief will focus on potential cheap, practical solutions to foil classification algorithms before the enemy can update their training data set.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

66404 - Pacific WINDS II: A Tabletop Intelligence Wargame Suitable for use in Maneuver Centric Wargames

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Steve Sallot; CPT Gabriela Barrera; Scott Lynch

Abstract: The Center for Army Analysis (CAA) developed the Pacific Warning, Indications, and Deterrence System (WINDS) II wargame to support U.S. Army Pacific's Unified Pacific Wargame Series (UPWS) 2023. The authors will present the intelligence, surveillance, and reconnaissance (ISR) adjudication schema used in the wargame for consideration as an alternative option for potential use in operational fire and maneuver wargames in which enemy units are sensed/detected/revealed/targetable for wargame players. CAA designed the ISR adjudication schema to strike a balance between highly granular discrete event simulations designed to examine the capabilities of specific ISR platforms and the highly abstracted probabilistic models typical of most combat adjudication methods. The ISR adjudication schema includes a manner to determine both probability of detection and quality of intelligence collected in various regions. These characterizations were based on specifications and quantity of sensors present in a region, the analytical capacity assigned to a region, and the volume of enemy activity and deception in that region. The schema allowed for subsequent characterization of target development quality of enemy units in the wargame.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

65655 - AFSIM Sensor Coverage Diagram Tool

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Christopher Huffman; J. Scott Thompson		
Abstract: An understanding of the capabilities of sensor models against various signatures is essential to understanding model capabilities and mission-simulation results interpretation. A Sensor Coverage Diagram tool was developed as a diagnostic testbed to determine the capabilities of a sensor against both a baseline signature and a mission-specific threat signature. The tool allows the user to alter characteristics of the threat and analyze the effects of the threat's altitude and signature and the sensor's azimuth and elevation on the sensor's ability to detect the threat. The tool may be configured to produce both Vertical Coverage Diagrams (VCDs) and Horizontal Coverage Diagrams (HCDs) of sensor capability. Additionally, the VCD configuration may also run at off-centerline azimuths to observe the effects of beam-steering losses. VCDs and HCDs provide capability to confidently understand a sensor's "as-modeled" capability and insight into observed performance in mission-level analysis against a threat. This briefing focuses on the tool's methods employed, possible configurations, and types of results with emphasis on the utility of these results in a mission-simulation environment. Location: TH329 Classification: UNCLASSIFIED // FOUO Working Group: WG07 Intelligence, Surveillance, and Reconnaissance		

65923 - Multi-Domain Sensing M&S Architecture

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Robert Kewley; Jonathan Hixson		
Abstract: The Multi-Domain Sensing Modelling and Simulation (M&S) Architecture is an M&S as a service architecture to allow sensor models, communications models, and command and control (C2) models to cooperatively develop a common operating picture (COP) adjudicated by sensor and		

network effects. It provides a simulated data feed to simulated entities or to stimulate real C2 systems. We demonstrate a scenario where a combination of space, air, and ground sensors provide increasing fidelity to a common operational picture.

Location: TH329
Classification: UNCLASSIFIED // FOUO
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

66287 - A Method for Evaluating CisLunar Intelligence, Surveillance, and Tracking (ISR) Architectures

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr. Michael Steffens

Abstract: Interest in cislunar activity has increased dramatically in the last 10 years. Proposed missions range from lunar space stations to lunar surface activity to persistent presence at Lagrange points. One of the challenges of operating in cislunar space is consistently tracking activity. Cislunar space is very large, and therefore requires more accurate and higher numbers of sensors to cover when compare to tracking earth orbiting systems. Another challenge is the inherent instability of orbits in cislunar space. Most earth orbiting systems are in relatively stable orbits characterized almost entirely by earth's gravity. Cislunar orbits are subject the moon's gravity, which is much less uniform than earth's, as well as third-body effects from the earth and sun. Resulting trajectories are more difficult to predict, and therefore more difficult to track. The combination of unpredictable trajectories and vast distances (leading to higher measurement uncertainty) make tracking systems difficult. The difficulty is compounded when the assets being tracked are attempting to operate unnoticed. These could include potentially adversarial ISR (Intelligence, Surveillance, and Reconnaissance) or other systems. These systems could further change already unpredictable trajectories by maneuvering. The goal of this effort is to explore potential architectures for ISR systems to support tracking objects in cislunar space. This architecture will be made up of a set of satellites with ISR sensors orbiting anywhere in cislunar space. A method is developed to consider coverage of cislunar space, sensor accuracy vs revisit time, and track accuracy for target orbits of interest. Evaluation metrics can be based on general cislunar space coverage or tracking for specific orbits. This presentation will present the method and resulting architectures of interest. Future work includes integrating the steps of the method, increasing sensor model fidelity, and considering other track filters.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

65696 - Accelerating in Germany as a Government Technical Integrator (GTI)

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Youssef Ashraf Abubaker

Abstract: The National Reconnaissance Office (NRO) has begun to position Government Technical Integrators (GTI) across the globe to provide analytical support to the different military theatres. GTIs are capable of rapidly creating and improving upon the tools intelligence professionals rely on to perform their daily ISR analysis gathering (e.g. THRESHER, BODHI, FADE). This presentation will focus on the recent success of the first-ever GTI. The presentation will highlight the different customers and needs encountered in EUCOM, code that the GTI deployed in a big data environment to get NRO

capabilities embedded into the Army and Air Force's workflows, and the substantial effort the NRO is undertaking to improve the user feedback loop in order to better deliver products to the warfighter.

Location: TH355 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

66433 - Dynamic RF Signature Prediction for Helicopter Development

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Ms. Andrea S. Morris

Abstract: The DEVCOM Analysis Center (DAC) predicts the susceptibility of targets to radar detection with computer simulation tools, like the Air Force's Xpatch, that produce estimates of radio frequency (RF) reflective signature. A static signature in Radar Cross Section (RCS) has single values for each needed view, and a dynamic signature has a set of time-stepped values for each view, based on the expected sampling rate of the radar.
The sizable, relatively dynamic rotors of helicopters are highly visible to modern, fast sampling radar capable of Moving Target Indication (MTI). However, developing helicopter designs are typically compared with static rather than dynamic signature because of the additional time it can take to generate the thousands of additional time-step predictions necessary to capture flash, brief but detectable high reflection values.
DAC conducted a proof-of-concept effort to explore techniques to reduce the time to adequately estimate dynamic signatures. First, a legacy helicopter target's CAD geometry model was systematically hand simplified, to get each prediction run's time down to minutes. Based on threat analysis, the number of needed views were then pared down and distributed into sections that would run for a given frequency in two weeks, producing sufficient dynamic signature results in a couple months on a single available computer system, or quicker with multiple systems. Post processing is expected to result in both I&Q type files that can be compared with existing test data, and RCS files that can be averaged for comparison to existing averaged static predictions, or further processed to capture flash sustained long enough to be seen at the expected radar sampling rate.
With this approach of CAD model simplification and relevant threat analysis to focus on frequencies and views of interest, we have the tools and processes to perform adequate dynamic RF signature predictions in time to inform developing helicopter designs concurrent with input from other Technologies. Specific threat analysis will not be discussed.

Location: TH355 Classified
Classification: CONFIDENTIAL
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

66414 - Validation of DAC's new multipurpose TLE model

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Matthew Banta

Abstract: In order to complete their mission, the Warfighter can make use of a wide array of Positioning, Navigation, and Timing (PNT) sensors to find the location of a target of interest. The Department of Defense, along with the private sector, are proposing a wide array of PNT sensors to meet this need. The U.S. Army Combat Capabilities Development Command (DEVCOM) Analysis Center (DAC) developed a model that can estimate the performance of these novel PNT sensors even

if the exact algorithm that the sensor employs is proprietary or unknown. Currently, the model can find the Target Location Error (TLE) for several sensor types including Electro-optical/Infrared (EO/IR) sensors with Laser Range Finders (LRF), and Signals Intelligence (SIGINT) sensors. Because the model is extremely expandable and modular, it can be easily modified to estimate the performance of just about any PNT sensor, or combination of sensors, designed to find the location of some target of interest. All that is required to add an additional sensor type is an estimate of the sensor's raw measurements as a function of parameters that could affect the sensor's accuracy. This presentation outlines the DAC's effort to validate the model against performance data from actual PNT sensors. The validation process involved comparing the TLE that the model calculated to experimental results from actual sensors. DAC also set up a series simplified theoretical experiments whose TLE values could easily be determined independently and compared to the TLE values that the model calculated.

Location: TH355 Classified
Classification: CONFIDENTIAL
Working Group: WG07 Intelligence, Surveillance, and Reconnaissance

WG08 Space Acquisition, Testing and Operations

66008 - Space Weather Monitoring with the GPS Constellation

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Andrew Hoover		

Abstract: The Global Positioning System (GPS) constellation of satellites carries instruments that directly measure the space environment. As part of a 2016 Executive Order, data collected by LANL sensors from 2001 through 2018 has been released and is archived by the National Oceanic and Atmospheric Administration. With more than 20 satellites operating LANL instruments during this period, the dataset consists of more than 200 satellite-years of data covering an entire solar cycle that increases by roughly one satellite-year of data every two weeks. The GPS orbit at an inclination of 55 degrees samples a wide range of magnetic latitude and McIlwain L. The data product consists of electron and proton differential omnidirectional fluxes, selected ephemeris data, count rates, as well as geomagnetic parameters computed from established magnetic field models. Energetic charged particles in the space environment can affect spacecraft through surface/internal discharge, total dose effects, and single event effects. Data from the GPS constellation can be used to determine the causes of anomalies, specify current conditions, as well as predict remaining reliable operational lifetime. Due to the long span of data available historical studies of past events and their effects on space assets are also possible. We will describe the GPS Constellation from the perspective of its use as a monitor for space weather, including the electron radiation belts as well as Solar Energetic Particle events.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

65800 - Space Wargaming Analysis Tool (SWAT) - Overview

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr Steven Toler		

Abstract: Wargaming, Map Exercises (MAPEXs), and Tabletop Exercises (TTXs) are important tools in an analyst's tool kit. The Space Wargaming Analysis Tool (SWAT) is is a quick scenario generation and execution model to provide high-level analysis that includes space-based concepts.

SWAT enables rapid and dynamic creation and execution of multiple platforms for wargaming courses of action. SWAT generates critical data that can be used to inform commanders and decision makers regarding space concepts, capabilities, concept of operations, and tactics, techniques and procedures in environments with and without space-based capabilities.

SWAT supports space, air and ground maneuver (red and blue) forces in a wargaming environment, while providing data collection and reduction in real time; allowing the user to get an understanding of the impacts of planned and injected events and platforms.

SWAT is not focused on system engineering of detailed operational analysis but for quick looks. SWAT trades off fidelity for ease of use. It is tailorable for future capabilities, without the need of full system definition to run. The 3D map gives commanders and leaders a unique understanding of the contributions, benefits and limitations of space - both red and blue.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66023 - Developing a New Space Architecture Resiliency Assessment

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Christopher Wishon; Dr. John Dulin; Dr. Jason Reiter

Abstract: There has been a decisive shift in US military policy regarding the space domain over the past decade; the US can no longer rely on large, expensive, and exquisite space systems that have little to no redundant coverage or capabilities. The US Space Force has instead transitioned to placing an emphasis on designing future space constellations with a focus on resiliency. This has required a shift from nodal level resiliency analysis to constellation-level analysis. This shift, championed by the Space Warfighting Analysis Center (SWAC) through their study of force design alternatives and supported through analyses by the Space Security and Defense Program (SSDP), has resulted in a new mission-specific analysis paradigm focused on two branches: left of mission failure and right of mission failure. In left of mission failure, analysts seek to understand how a failure can be avoided and/or minimized, or how quickly a failure would be achieved through adversary intervention if avoidance is impossible. In right of mission failure analysis, the aim is to study the reoccurrence of mission failures and the ease with which further adversary action could induce additional failures. The tools and capabilities used for these analyses span methodologies from simple physics-based models to complex discrete event simulations. The approach has been successfully applied to the SWAC's proposed Missile Warning/Tracking and Ground Moving Target Indication constellations and has raised constellation level resiliency to be an equal decision criterion alongside performance and cost for future national space architectures.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66025 - Simulating Space Architecture Resilience Against Emerging Threats

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. John Dulin; Christopher Wishon; Dr. Jason Reiter		
Abstract: The resiliency of future US space systems has become a point of emphasis in the past decade, best demonstrated by the cancellation of future acquisitions which have been deemed to be insufficiently resilient to emerging threats. Leading the push to develop resilient space systems has been the Space Warfighting Analysis Center (SWAC) and the Space Security and Defense Program (SSDP), who propose new architecture concepts that balance resiliency, performance, and cost for a variety of missions. To assist the SWAC with this analysis, a custom discrete event simulation (DES) has been developed to test the candidate architectures against various threat CONOPs and strategies. With dozens of candidate architectures evaluated by the SWAC and a large trade space of possible adversary threats in future epochs, a DES implementation was required which could process thousands of iterations across a large set of conditions in an efficient manner. This environment can handle multiple threat types, satellite processes, and active mitigation strategies, all geared towards assessing the resiliency of a constellation given an adversary strategy for inducing mission failure. The environment, its components, and the nuances that set it apart from other simulation techniques will be discussed, along with the impact it has had on two of the SWAC's initial products: a Missile Warning/Tracking constellation and a Ground Moving Target Indication constellation. Location: TH329 Classification: UNCLASSIFIED Working Group: WG08 Space Acquisition, Testing and Operations		

65804 - Capturing Space Effects in a Joint Campaign Analysis Effort

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr. Michael Edward Terry, N/A		
Abstract: The U.S. Space Force (USSF) was established on 20 Dec 2019. As the newest Service, USSF does not have a long history of warfare, lessoned learned, and evolving warfighting doctrine, as do the other Services. So, the continual challenge is using common, campaign-level tools to articulate the value of "enabler-focused" capabilities like space. The Joint Space Warfighting Forum (JSWF) effort worked from 2016-2021 documenting warfighting effects using analysis of Joint Mission Threads (JMT) to capture space touchpoints. Once identified, a Delphi method amongst a group of mission experts was used to assess how to model effects in a Synthetic Theater Operations Research Model (STORM). So, for missile warning (MW); positioning, navigation, and timing (PNT); satellite communications (SATCOM) a mission analysis was conducted to capture order-of-battle, satellites/orbits, and expected effects. These inputs were used to develop a roadmap for space development within STORM based on considerations of leadership priorities and low hanging fruit – start with an early victory. Many engagements with experts were required to understand the space mission capabilities. Subsequently, warfighter vignettes or real-world scenarios were used to assess space mission area contributions to a selected warfighting tactical operation. Additionally, various space studies were leveraged. These space contributions were used to further inform space effects to the warfighting campaign. SpOC DCG-T S9's analytical benchmarking contributed to identifying space insights to the Joint Force Operating Scenarios (JFOS) modeling & simulation effort which was briefed up to the Deputies Management Action Group (Vice Service Chiefs). Low-hanging fruit was how space contributes to the Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance, and Targeting (C4ISRT) in an anti-access/area denial (A2AD) environment against a near peer. An orbitology model called Integrated Space Situational Awareness (ISSA) captured the		

National Reconnaissance Office architecture. Target grids were developed and the enemy laydown of forces was superimposed. Overflights were conducted to show probability of detection (Pd) and informed the target system analysis (find, fix, track, target, engage). This model shows various architectures including attrition to show the effect of Pd. Moving forward USSF will engage with other Services to capture space effects in models. A TTX captures a specific tactical operations. Vignettes are developed to discuss with tactical planners/experts the detailed key tasks and political, military, economic, social, information, infrastructure, physical environment and time (PMESII-PT) analysis. Space touchpoints are identified for the mission. Then a risk management analysis is conducted to determine impact of not having space capabilities against primary, alternate, contingency, and emergency options. This methodology will be briefed.

Location: TH353 Classified
Classification: SECRET NOFORN
Working Group: WG08 Space Acquisition, Testing and Operations

65826 - Space 4-Factor Study Replication in BEAM

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Zachary Shannon; Stephen Sturgeon; Michelle McGee; Dr. Mark A. Gallagher, FS		

Abstract: Space capabilities will obviously be critical in the next major conflict. Quantifying that impact has been a challenge in the current modelling toolset. Many of these challenges stem from the complex interactions between systems and difficulty in modeling those interactions. The Bilateral Enterprise Analysis Model (BEAM) takes a more aggregated approach to campaign modeling than other available tools. Using this more aggregated approach, we studied the impacts of 4 space-based capabilities in the JFOS 2.1 scenario. BEAM was able to run multiple excursions in a short timeframe that not only helped quantify space impacts, but also helped identify important aspects of the campaign and refine strategy throughout the campaign. This presentation focuses on the methodology, limitations, and results from this study.

Location: TH353 Classified
Classification: SECRET NOFORN
Working Group: WG08 Space Acquisition, Testing and Operations

66724 - Space Kill Web Timeline Analysis

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Robert Hugh Vasse; Mr. Ryan Pierce		

Abstract: Army Space decision makers have limited information as they resource, deploy, and employ the Multi Domain Effects Battalion (MDEB), Multi-Domain Task Force (MDTF), and Theater Strike Effects Group (TSEG) to support the kill-web during Joint multidomain operations. To assist with procurement decisions, the Space and Missile Defense Command Center of Excellence (SMDCoE) Studies and Analysis Division analyzed how a Space-focused C5ISR capability affects the kill-web's effectiveness and timeline. The study team modeled effects of the tool along with Space kill-web touch points to enable targeting development, coordination, and execution of converging effects in support of a theater commander. Computer-based modeling and simulation enabled military utility analysis to quantify Joint effects of a potential C5ISR capability on the kill-web. Results inform the SMDCoE master schedule and provide information for the Army Space community.

Location: TH353 Classified Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations

66723 - Army Advanced Navigation Warfare Study

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Shelby Rowe; Mr. Ryan Pierce		
Abstract: Due to the proliferation and expanded reliance on satellite-based Positioning, Navigation & Timing (PNT), the need has grown to assess current/expected, offensive/defensive NAVWAR capabilities. The SMDCOE Studies and Analysis Division analysis efforts being conducted investigate and identify the mid and long-term feasibility of existing Programs of Record (PORs) from Army and Joint and new proposed Army NAVWAR capabilities, Training, Tactics, and Procedures (TTPs), and employment strategies utilizing vetted vignettes/scenarios in force-on-force modeling, simulation, and analysis to gain better understanding of PNT-dependent systems and measure the military utility when employing Advanced NAVWAR capabilities and techniques to establish PNT dominance. Location: TH353 Classified Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

66725 - Space Demand Analysis Tool

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Martin Hooyer; Mr. Ryan Pierce		
Abstract: The Space and Missile Defense Center of Excellence (SMDCoE) commissioned the creation of a tool to produce quantitative results for a Space Control Electronic Weapon (SCEW) that will be fielded by the Army. The Space Demand tool will consider how many threat systems are present on the battlefield and how many SCEW systems would be required to sufficiently negate the threat while also considering other roles such a system may need to provide. The tool should allow the Center for Army Analysis (CAA) to come up with an evidence-supported requirement for Army needs. The tool also has the ability to measure the effectiveness of a user-defined number of systems against a threat force, which will provide force effectiveness that can be used in future CAA war-gaming events. Location: TH353 Classified Classification: SECRET NOFORN Working Group: WG08 Space Acquisition, Testing and Operations		

66086 - Architecting Experimentation Beyond the Karman Line

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Krystle Sawyer		
Abstract: To achieve experimentation goals within the Space Domain, stepping away from calcified mindsets and embracing new ideas and methods is a baseline requirement. As a new Combatant Command, the Joint Warfighting Development Division at USSPACECOM has begun the journey of building an Experimentation and Research Branch from the ground up. In this presentation we will talk about the unique challenges and limitations that impact how we conduct experimentation in space and the unorthodox steps taken to build a foundation that supports the integration of space		

domain systems and tools into Joint Experiments. We will share how USSC is partnering with industry, embraced innovating thinking within the organization and is challenging experts within the M&S community to think beyond what they are familiar with to help us address some of our challenges.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66207 - An Investigation into Utilizing Google Earth Engine and Convolutional Neural Networks to Actively Assess Burn Severity in Wildfires

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Garrett Chrisman

Abstract: The escalation of environmental and human impacts due to wildfires is becoming more pronounced, as evidenced by four out of the five largest Colorado wildfires occurring in the past five years amidst ongoing climate change. In the context of emergency response and fire control planning, the provision of real-time mapping and predictions is critical. In this study, we explore the potential of Synthetic Aperture Radar (SAR) capabilities of Sentinel-1 satellite in conjunction with visual imagery captured by Sentinel-2 to gain real-time insights into the current conditions and progression of wildfires. Our deep learning framework, based on a Convolutional Neural Network (CNN), aims to predict burn severity by training on Sentinel-1 and Sentinel-2 imagery obtained during the wildfire duration. To demonstrate the accuracy and plausibility of real-time burn severity prediction, we use five Colorado Wildfires: 2020 Middle Fork Fire, 2019 Cow Creek Fire, 2020 East Troublesome Fire, 2020 Pine Gulch Fire, and 2020 Grizzly Creek Fire. A proof-of-concept exploration, this study seeks to generate real-time output of burn severity from newly acquired imagery during an active wildfire. The findings demonstrate the potential of spaceborne imagery to predict real-time burn severity, offering crucial insight into effective wildfire management.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66178 - Scheduling algorithm for intentional constellation conjunctions

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Shane Vigil

Abstract: This presentation proposes a scheduling algorithm for intentional constellation conjunctions in support of rendezvous and proximity operations (RPO) between a maneuvering and fixed satellite constellation that minimizes the overall change in velocity (delta V) of the maneuvering constellation while constraining each satellite RPO to a specific window of time.
Satellite constellations have become an integral part of military communication, navigation, and remote sensing systems for the United States and adversaries alike. As our reliance on satellite technology grows, so does the risk and challenges of maintaining or degrading space-based services during military operations. In-service satellite operations are essential to maintain the functionality and longevity of our satellite infrastructure and if needed, anti-satellite operations are an important tool for ensuring the safety and security of friendly forces. Both physical forms of these operations entail well-timed dynamic maneuvers.

With the increasing proliferation of satellite constellations and their use in military applications, there is a growing need for an efficient constellation scheduling algorithm that can optimize satellite selection and timing to maneuver a given constellation to another for conjunction and subsequent RPO. This scheduling algorithm optimizes the timing and delta V requirements by considering the orbital parameters of the target satellite constellation, as well as the current and future positions of the operational satellites in the scheduling queue.
This presentation will include the methodology for developing the algorithm and the assessment of efficiency and effectiveness of its application through simulated scenarios aligned particularly to military applications where precision and rapid response are critical.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66285 - Developing Architectures for CisLunar Position, Navigation, and Timing (PNT) and Communication

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Michael Steffens		

Abstract: Interest in cislunar activity has increased dramatically in the last 10 years. Proposed missions range from lunar space stations to lunar surface activity to persistent presence at Lagrange points. One of the challenges of operating in cislunar space is the limited Position, Navigation, and Timing (PNT) and Communication capabilities. Current missions use architectures like the Deep Space Network, but current PNT and communication capabilities are very limited. The goal of this effort is to explore cislunar architectures to support PNT and communication in cislunar space. The initial focus is on the lunar surface, but the goal is to expand the analysis to consider larger areas, including lunar orbit and earth-to-moon transits. The coverage, accuracy, and availability of these services are all metrics to be considered in the architecture design study. Additionally, because lunar orbits are often unstable, there is a cost associate with selecting certain orbits; this cost may be in station-keeping maneuvers or lifetime of the satellite. A method to analyze architectures for this problem is presented, along with several architectures of interest. Future work includes incorporating optimization algorithms to find better architectures and developing higher fidelity PNT and communication analysis algorithms.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66286 - A Method for Evaluating CisLunar Intelligence, Surveillance, and Tracking (ISR) Architectures

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Michael Steffens		

Abstract: Interest in cislunar activity has increased dramatically in the last 10 years. Proposed missions range from lunar space stations to lunar surface activity to persistent presence at Lagrange points. One of the challenges of operating in cislunar space is consistently tracking activity. Cislunar space is very large, and therefore requires more accurate and higher numbers of sensors to cover when compare to tracking earth orbiting systems. Another challenge is the inherent instability of orbits in cislunar space. Most earth orbiting systems are in relatively stable orbits characterized

almost entirely by earth's gravity. Cislunar orbits are subject the moon's gravity, which is much less uniform than earth's, as well as third-body effects from the earth and sun. Resulting trajectories are more difficult to predict, and therefore more difficult to track. The combination of unpredictable trajectories and vast distances (leading to higher measurement uncertainty) make tracking systems difficult. The difficulty is compounded when the assets being tracked are attempting to operate unnoticed. These could include potentially adversarial ISR (Intelligence, Surveillance, and Reconnaissance) or other systems. These systems could further change already unpredictable trajectories by maneuvering. The goal of this effort is to explore potential architectures for ISR systems to support tracking objects in cislunar space. This architecture will be made up of a set of satellites with ISR sensors orbiting anywhere in cislunar space. A method is developed to consider coverage of cislunar space, sensor accuracy vs revisit time, and track accuracy for target orbits of interest. Evaluation metrics can be based on general cislunar space coverage or tracking for specific orbits. This presentation will present the method and resulting architectures of interest. Future work includes integrating the steps of the method, increasing sensor model fidelity, and considering other track filters.

Location: TH329
Classification: UNCLASSIFIED
Working Group: WG08 Space Acquisition, Testing and Operations

66208 - Chinese Space Program: Implication to the Great Power Competition

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Eric Liu; MAJ Sam Yoo		
Abstract: In early 2023, NASA claimed that the United States is "in a space race" against China due to increasing Chinese presence and ambition in the extraterrestrial realm. "Space race" is a term familiar to the United States due to its large impact on the Cold War and ultimately allowed the United States to become the premier world power. As the new space race emerges, it will certainly affect the ongoing US-China Great Power Competition and the future of the world order. This study aims to holistically analyze the current Chinese Space Program and compare it to the United States Space Program; it will specifically address the similarities and differences between the two programs pertaining to Space Stations, Moon Exploration, Military Application, and Commercial Application. Data for these studies is obtained through previous scholarly research, government sources, and experts in the field. Contrary to what has often been assumed, the rapidly developing Chinese Space Program poses a threat to the United States Space Program and will affect future decision-making for the United States within the Great Power Competition. Location: TH329 Classification: UNCLASSIFIED Working Group: WG08 Space Acquisition, Testing and Operations		

66331 - Analytic Challenges of the US Space Force

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Jerry Diaz, USAF (Ret)		
Abstract: The U.S. Space Force was signed into law in December 2019. Why was the Space Force (SF) created? What are the analytic challenges that the SF faces. Are those challenges unique to our newest Service? Does the current DoD modeling paradigm work for the SF? The DoD traditionally		

focuses its planning & programming modeling, simulation and analysis (MS&A) efforts on conflict operations – campaign analyses is the "Coin of the Realm". However, in current and future environments, adversaries have and will continue to challenge the resolve of US and its allies during deterrence phase (i.e. before D+0). As the lines between 'economic competition' and 'kinetic action' continue to blur, the USSF must create capabilities and evaluate TTPs that preserve stability, deter adversary aggression, and prevent debris-generating combat. How do we address the gap between mission level MS&A to support Joint Operations and DoD's focus is on campaign-level MS&A to inform OSD of DAF capabilities and capacity for warfight. What is the correct the framework, methodologies, measures, and data sets required to analyze and assess pre-D+0 actions to provide national leadership with insights and options to shape outcomes and reduce the risk of inadvertent escalation? This talk will explore the above topics and engage with the audience on their thoughts.

Location: TH329
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG08 Space Acquisition, Testing and Operations

WG09 Air and Missile Defense

64915 - Building a Run Matrix, or Just How Many Scenarios Do I Need to Execute to Address All My Variables With Statistical Confidence

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Woodrow Bevill		
Abstract: When setting out to solve a complex problem the creation of a run matrix is one of the most difficult tasks a new analyst will tackle. In this analysis a typical ballistic missile threat will be used as the example for creating a simplistic run matrix. The process begins with identification of independent variables such as launch points and aim points, then moves to dependent variables. One of the most important steps in creating a run matrix includes sorting out basic threat space (the dependent variables) that will be integral to the analysis problem. Exposure to a multitude of options and dependent variables can contribute to information overload for the new analyst. This paper will take an in depth look at how to develop and cultivate a run matrix for analysis with specific attention paid to the number of dependent variables that should be addressed. PIRA #: MAN202206006 Location: TH330 Classification: UNCLASSIFIED Working Group: WG09 Air and Missile Defense		

68664 - MAGE: Modeling Army Ground Effects

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Carla Ortega		
Abstract: Using the Advanced Framework for Simulation, Integration, and Modeling (AFSIM), the Center for Army Analysis (CAA) is developing a library to allow for a more effective and efficient method for conducting air and missile defense (AMD) and fires analysis. This initiative aims to provide AFSIM coders the ability to leverage past work and use previously developed capability models in developing new and updated modeling. MAGE is part of an enduring CAA internal study that will ensure ongoing updates and maintenance efforts for the MAGE library. In its initial year, it will focus		

on Army upper-tier AMD. This brief will outline the construction, design, and implementation of CAA's MAGE.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

66175 - Measuring transparency and trust in an airspace deconfliction engine

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dar-Wei Chen, Ph.D.; Craig Doescher

Abstract: Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) is a collaborative effort between MITRE Corporation and Raytheon that aims to use AI-driven decision algorithms and sensor networks to provide warfighters with dynamically-updated 4D airspace pictures, the ability to anticipate and solve airspace conflicts, recommended courses of action (COAs) based on varying priorities (much like Google Maps can recommend routes based on speed or tolls), and situation awareness of adversary airspace. Deconflicted airspace will enable warfighters to safely, efficiently, and quickly conduct simultaneous long-range fire missions as well as operate manned and unmanned aircrafts within and between airspaces.

ASTARTE, as with any automation, will be most useful to warfighters when they can appropriately calibrate their trust in the technology. Accurate trust calibration by warfighters requires that the automation is transparent enough regarding its limitations and technical processes. Both over- and under-trusting of automation can lead to sub-optimal automation use and decision-making: Over-trusting automation can lead to warfighter complacency, which could cause operator skill degradation (e.g., because the operators do not sufficiently practice the automated tasks) and loss of situation awareness (e.g., operators might not pay close attention if they believe that the automation is perfect); under-trusting automation can lead to operators undertaking unnecessarily high workload and not fully utilizing the benefits of automation.

To maximize the effectiveness of ASTARTE, MITRE will be assessing operator trust and automation transparency during upcoming ASTARTE exercises. MITRE is proposing that the following topics be covered in these assessments:

> Degree of trust in the development of ASTARTE and its recommendations
> Degree to which ASTARTE performs like a similar technology would and fits well into the rest of your operations
> Clarity of ASTARTE's presentation of information
> Degree to which operators understand how ASTARTE produces recommendations and how to evaluate those recommendations
> Degree to which operators under- or over-trust ASTARTE

This presentation will provide a brief overview of the ASTARTE program, define trust and transparency in the context of ASTARTE and airspace deconfliction, propose survey questions that can be administered to operators for the purpose of measuring trust and transparency, and highlight potential avenues for future work on ASTARTE to improve operator trust and automation transparency.

Location: TH330 Classification: UNCLASSIFIED Working Group: WG09 Air and Missile Defense

65873 - Concurrent Kriging for Efficient Creation of Many Similar Heat Maps

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Michael Deskevich; Dr. Benjamin G. Thengvall		
Abstract: The Missile Defense Agency (MDA) has created a new high-fidelity, high-accuracy digital simulation capability to model the Missile Defense System (MDS). This accuracy, however, comes at high computational expense. There are many more simulation trials desired to perform different types of analysis than there are computing resources available to execute them. As part of multiple Small Business Innovation Research efforts, OptTek Systems, Inc. is exploring how to use the high-fidelity digital simulation capability to generate defended area heat maps to measure the effectiveness of different MDS system configurations against various threats. Custom optimization algorithms have been created to generate accurate heat maps with a minimal number of simulation runs. This problem of efficiently generating heat maps can be more generally described as efficient response surface estimation. The techniques and software developed in this effort are being designed so that they can be used for heat map estimation and also solve more generally applicable response surface estimation problems. The approach being taken begins with optimized adaptive sampling of the operational space and then employs geospatially accurate regression and interpolation techniques that are derived from Kriging. This approach can take any number of sample points, and both estimate the heat map and measure the uncertainty in that estimate. Furthermore, computation expense is minimized with dynamic Monte Carlo run management to determine how many replications should be executed at any sample point. Since many similar studies are performed with minor configuration differences, recent work has focused on the development of algorithms to minimize the uncertainty across multiple studies simultaneously using concurrent Kriging. This presentation will review Kriging-based efficient heat map generation and present current work including our methodology and initial results from a concurrent Kriging approach for the simultaneous creation of many similar heat maps. Location: TH330 Classification: UNCLASSIFIED Working Group: WG09 Air and Missile Defense		

65997 - EADSIM: Understanding the Results

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Michael L Thomason		
Abstract: This presentation provides an overview of some of the integrated tools and techniques within the Extended Air Defense Simulation (EADSIM). These tools aid in deployment of systems as well as analysis of the performance of those deployed systems. Evaluations range from operating as a standalone capability or operating as an integrated, complementary capability across multiple domains against a given threat. The EADSIM is a force on force simulation of air, missile, and space warfare. It provides capability for analysis, training, test, and operational planning in a single, integrated package. EADSIM is capable of evaluating small vignettes of a few entities up to entire theaters with thousands of entities. A simulation can be executed as fast as possible (generally faster to much faster than real time) for a		

stochastic, multiple Monte Carlo evaluation of a scenario. It can also be slowed down to real time to allow interaction with an operator in the loop or interactions with live and simulated systems using embedded capabilities for DIS, HLA, and multiple tactical communications protocols. No matter the mode of operation, EADSIM records a plethora of data that is available for post simulation analysis and visualization.
This presentation will take a look at tools that assist with deployment of defensive and offensive systems. This will include tools such as sensor coverage diagrams, GPS jammer to signal levels, defended area and launch area denied footprints for missile threats, coordinating Time on Target, and the Defense Analysis Tool for air breathing threats. We will also cover capabilities for post simulation analysis. This will include examples of data extraction and overlays into the multiple visualization views. Expected overlays for demonstration include both truth and perception views with usage considerations, event plotting onto both geographic displays and timelines, and value overlays onto the path of an entity. Specific Monte Carlo results will also be demonstrated that provide rapid mechanisms for analyzing changes to either the defensive capability to interdict the threat or the offensive capability to penetrate the threat.
These tools and techniques will benefit those that use EADSIM, as well as those that are looking for additional ways to evaluate performance of systems in a force on force context.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

66003 - EADSIM Capability in Multidomain Operations Simulation

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Michael L Thomason

Abstract: This briefing provides an overview of Multidomain Operations within the Extended Air Defense Simulation (EADSIM) environment. We will discuss specific Multidomain Operations modeling cases, the extensive Multidomain Operations modeling available in EADSIM now, and the potential to better support land combat through federation to economically provide the robust consideration of this important topic.
Multidomain Operations require integrated consideration across the military branches. Considerations include blue and red Air and Missile Defense; Command and Control; Communications, Intelligence, Surveillance, and Reconnaissance (ISR); Long Range Precision Fires / Air Strike Operations; Space; Electronic Warfare (EW) and Cyber; Position / Navigation / Timing (PNT); and Intelligence Preparation of the Battlefield (IPB). These analyses must connect the operations in each of the domains to each other and ultimately to the usefully meaningful combat outcomes (the 'so what?' question). EADSIM provides this modeling, allowing confident analysis of the Multidomain Operations battlefield.
EADSIM has a current limitation in modeling maneuver warfare aspects of land and surface combat. EADSIM has participated in multiple federations, in some cases using HLA or DIS interfaces. In other cases, "sneaker" net is employed. The integrated nature of the effects makes it difficult to capture all interdependencies when crossing the federated boundaries. The federations so far have primarily considered lethal effects exchanged between the federates, and still need to be further extended to allow the full integration of effects to be presented in a realistic manner.

Location: TH330

Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

66232 - Impact Of Drone Autonomy On High Value Airborne Asset Defense Using High Energy Lasers

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Seth Allen; Dr Lance Champagne; Dr. Nathan Benjamin Gaw

Abstract: Autonomy remains at the forefront of new technology in every industry from medicine to war. However, literature has not settled on a precise definition. There are many definitions, and many conflict within themselves. The absence of a standard definition inhibits future research on the topic. We focus on contributing a robust and lasting framework of autonomy to standardize research on autonomy while also implementing our framework in a high value airborne asset defense scenario using simulation. AFSIM is employed to create a realistic environment to simulate airborne defense scenarios that may be seen operationally. In the HVAAD scenario, multiple dimensions of autonomy are tested at different levels. Simulation, design of experiments, and statistical techniques are used to measure the overall effect of changing levels of autonomy on how well drones equipped with high energy lasers perform when protecting high value airborne assets from swarms of enemy missiles. This research finds significant effects of autonomy and the engagement geometry of the respective HVAAD scenario.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

66001 - Joint High Energy Laser Vulnerability Interface

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Michael L Thomason

Abstract: High Energy Lasers (HELs) have advanced from futuristic vision to tactical reality. Introduction of these systems on the battlefield provides a significantly different delivery mechanism for inflicting damage on opposing forces when compared against conventional kinetic kill capabilities. This is true on the battlefield and on the simulated battlefield, where defensive capabilities are evaluated for many purposes, e.g., assessment of Military Utility and development of Tactics, Techniques, and Procedures. For these evaluations, key aspects of the timeline to deliver an effect on a threat must be captured to provide an accurate performance of technologies on the battlefield and to maximize the effectiveness when a mix of technologies are available to counter a given threat. The time that the laser beam must dwell on the target to produce an effect is a major component of that timeline. The methodology for characterizing the vulnerability of a targeted system to the delivered laser energy has evolved over time. Under the direction of the Joint Directed Energy Transition Office, an API, the Vulnerability Module ICD, was developed as a standard mechanism to provide that information to support various needs. These needs cover the gamut of HEL technology including development, employment planning, TTP development, and even implications for fire control. This presentation will provide an overview of the evolution of the VM interface, example usage in EADSIM as a weapon system model accessing the VM, and an overview of some recently developed tools. One of these tools executes a VM through a number of tests to assist verification that a VM

operates according to the standard. Another of these tools queries the VM providing a mechanism to evaluate the vulnerability of the target under specific HEL delivery conditions.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG09 Air and Missile Defense

65422 - Visualization and Analysis of Dynamic Deep-Strike Damage Results (VAD3R)

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dante Reid

Abstract: Overview: Visualization and Analysis of Dynamic Deep-Strike Damage Results (VAD3R) is a geospatially based deep-strike damage modeling and simulation (M&S) software, created using the R programming language in R Studio within U.S. Central Command J8 (USCENTCOM J8). VAD3R is designed to supplement existing high-fidelity kinetic M&S (i.e. Synthetic Theater Operations Research Model (STORM)) analysis, run independently in support of low to medium-fidelity wargames, and if necessary, travel easily to disparate planning locations in support of USCENTCOM.

Problem Statement: While high-fidelity M&S, namely STORM, perform well at the campaign level concerning integrated air and missile defense and associated missile leakers at friendly bases, a deeper more tactical level understanding of what happened to those STORM leakers, in particular where did those leakers impact on a base, subsequent damage to base infrastructure and aircraft, and the number of personnel casualties, was lacking. Furthermore, a Google Earth-like visualization of the impact of STORM leakers at a friendly base was also lacking. Finally, the ability to perform quick-turn wargame damage assessment adjudication and visualization of STORM missile leakers at a friendly base was also lacking within the USCENTCOM Headquarters and component commands.

Methodology: The primary function of the VAD3R model is to generate stochastically determined impact points for adversary deep-strike threats such as ballistic missiles or one-way-attack unmanned aircraft systems (UAS) and then compute the expected battle damage resulting from those impacts. Impact point determination results from several factors such as the user-defined threat fire plan (intended targets), prescribed threat operational parameters (circular error probable (CEP), explosive charge), and desired target location and density within the scenario. Target specific data is managed in a base/facility specific database of KML files. Each target is assigned attributes that allow the model to calculate metrics such as infrastructure damage, aircraft lost, supplies lost, and personnel casualties. Lastly, VAD3R generates two kinds of output – tabular and visual. Tabular output consists of CSV files containing a wide range of base damage statistics while KML files are produced for visualization for use in platforms such as Google Earth.

Conclusions: VAD3R is a unique capability within the DoD M&S community. It enables a much more comprehensive understanding of risk than high end campaign models and traditional wargames can achieve alone and does so quickly and flexibly. Within the USCENTCOM Headquarters, VAD3R has become a critical element of the M&S culture and is featured as a standard requirement of M&S results and findings presented to the USCENTCOM Commander & staff and now, with the release of the online web application, is available to analysts and planners across the USCENTCOM enterprise.

Location: TH355 Classified

Classification: SECRET NOFORN Working Group: WG09 Air and Missile Defense

65629 - Classified Air and Missile Defense (AMD) Planning and Analysis with Allies

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr Scott Meyerhoff; David Halloran; Robert Smith		
Abstract: The 2022 National Defense Strategy states that it "is a call to action for the defense enterprise to incorporate Allies and partners at every stage of defense planning." This concept is further emphasized in the Missile Defense Review providing strategic level direction for enhanced cooperation with our allies. This cooperation is expected to enhance U.S. capabilities and capacities functioning as a force multiplier, while also more accurately representing how we expect to fight with our allies. Even with this guidance, there is minimal integrated air and missile defense (IAMD) classified planning and analysis efforts during a non-wartime environment. While conducting IAMD studies, the United States Army Space and Missile Defense Command (USASMDC) also identified the lack of data on how the coalition would execute the IAMD mission against regional air and missile threats. Given the IAMD mission can execute in critical seconds and minutes, it is imperative that IAMD planning is completed well in advance of the need to execute the mission. Joint Functional Component Command for Integrated Missile Defense (JFCC IMD) is addressing this need through an initiative called Titan Shield which is a classified planning and analysis effort with a multi-nation coalition. This briefing will outline the challenges and successes of the SMD Center of Excellence (SMD CoE) Studies and Analysis team, supporting JFCC IMD, of working in a classified environment with allies, highlighting existing gaps and solutions that have been identified to further this vital analysis. Location: TH355 Classified Classification: SECRET NOFORN Working Group: WG09 Air and Missile Defense		

65622 - High Energy Laser Modeling 201: Additional Considerations for Force-on-Force HEL Modeling

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr Scott Meyerhoff; Robert Smith		
Abstract: Rapid advancements and scalability of solid-state lasers are producing a growing list of evermore powerful High Energy Laser (HEL) prototypes and concepts across the US DoD. As HEL systems continue increasing in power, additional atmospheric considerations and system performance criteria must be incorporated into their force-on-force Modeling, Simulation, and Analysis (MS&A). The US Army Space and Missile Defense Center of Excellence (SMD CoE) will present these criteria through discussion of the challenges and lessons learned from their recently completed High Energy Laser Mass Threat Assessment (HEL-MTA) effort, which analyzed the performance of "beyond current state of the art" HEL concepts against raid and swarm attacks. This briefing aims to inform analysts and modelers about additional impacts of atmospherics and HEL performance parameters to consider, beyond just spot size and fluence on target, when conducting force-on-force MS&A. Location: TH355 Classified		

Classification: SECRET NOFORN Working Group: WG09 Air and Missile Defense

65885 - II MEF Fires EAB IAMD Study

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Jeff Tkacheff; Caleb M. Kadrmas		
Abstract: Title: II MEF Fires EAB IAMD Study Briefer: Capt Caleb Kadrmas, USMC/CD&I/OAD Purpose The study evaluated the expanded applicability of Expeditionary Advanced Base Operations (EABO), thereby identifying potential gaps in capability or capacity, by applying Force Design concepts to alternate threats in different theaters. Background The Commandant's Planning Guidance outlines a future operating environment that requires improvements to the ground and air-based air defenses of the Fleet Marine Force. Effective Integrated Air and Missile Defense (IAMD) will support survivability inside the weapons engagement zone (WEZ), providing an opportunity to persist within range of enemy fires. It is critical that a Fires EAB possess the organic capability to survive air and missile attack in order to remain a credible threat to enemy littoral maneuver and to continue contributions to the joint force from key maritime terrain. Study Question What can organic EAB air defense, as designed in Force Design 2030, provide against a near-peer threat in the U.S. European Command (EUCOM) area of operations? Objective Assess IAMD capability and identify capacity gaps of a Fires EAB when employed in EUCOM within the context of the Large-Scale Exercise 2021 (LSE21) scenario. Scope This study focused on organic air defense of Fires EAB's ability to employ air defense capabilities envisioned in FY21 Naval Capabilities Integration Process-Marine Corps Science & Technology case – specifically, the Medium Range Intercept Capability (MRIC) and its capacity to successfully interdict and destroy threats. This presentation will be of the results of this study at the SECRET//NOFORN level. Location: TH355 Classified Classification: SECRET NOFORN Working Group: WG09 Air and Missile Defense		

66136 - Using Particle Swarm to Optimize Base Defense

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Stephen Paul Jones		
Abstract: Determining appropriate placements of defensive assets in an ABAD environment is an overwhelming problem for a SME, especially when the types, capabilities, and quantities of these assets vary greatly. In order to augment SME judgment, a novel approach was developed to place combinations of defensive assets based on machine-learning informed analysis. This brief will cover the swarming methodology created using AFSIM and Python to find a more optimal position for each asset within a defensive laydown. The material presented will also cover some of the pitfalls and		

tradeoffs, as well as a comparison of various assets and the specific hurdles when utilizing a swarming solution based on AFSIM simulations.

Location: TH355 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG09 Air and Missile Defense

WG10 Joint Campaign Analysis

65224 - Planned Force Testing 9

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr Kit Waterman		

Abstract: Planned Force Testing 9 (PFT9) is a force development analysis exercise underway for the British Ministry of Defence. The exercise is designed to assess the UK's 'Integrated Force 30' through the lens of a 'Medium Scale Crisis Response'. Including a large wargame, played by the UK's Commander UK Strike Force, the exercise scenario involves a complex force aggregation problem followed by a high intensity combat operations phase.

Running from April 2022 to October 2023, PFT9 has developed and blended Strategic and Operational design aspects to deliver a comprehensive force development exercise with stakeholders across the Front Line Commands in Defence, and throughout broader government. With participants up to 4* level from across UK Defence and Security, and activity taking place in the UK's Defence Wargaming Centre and the MOD itself, the analysis is expected to enable Defence to understand the strengths and weaknesses of the planned force, enabling reprioritisation of policy, resources and effects ahead of the next Integrated Defence and Security review.

This presentation will focus on the design, development, and delivery of PFT9 from Strategic Guidance and Campaign Planning, to the Execution Wargame, and through to the campaign analysis due to be delivered in October of 2023.

Location: TH355 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG10 Joint Campaign Analysis

66160 - Modeling Joint All-Domain Command and Control Critical Modeling and Simulation Components

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Donald Williams, Jr.		

Abstract: This abstract describes an unclassified 6-month study that examined the critical components for a Joint All-Domain Command and Control (JADC2) operations research model. The study explores the research question, "What are the critical components of a Joint All-Domain Command and Control (JADC2) operations research model that adequately represents actors, information, and relationships?" Current JADC2 operations research models depend on representing information sharing between nodes and the dissemination of that information for individuals to make tactical, operational, and strategic decisions. Some models account for "perfect" command and control, which is the notion that command-and-control models collect, process, and disseminate information as efficiently and effectively as possible. However, this notion introduces a significant logical fallacy into

JADC2 modeling and simulation, and no current campaign-level model exists to solve this analytical challenge. Capability and capacity gaps exist in mission-level and campaign-level modeling, which threaten the credibility of operations research models that use JADC2.
This research used conceptual maps to identify the relationships between JADC2 nodes: an actor, information, and a relationship. The actor is a human who makes a decision based on some input. Information is data that provides situational awareness about a domain. JADC2 nodes share relationships. For example, actors share and act upon information. Additionally, information describes an occurrence that possibly relates to another piece of information. These relationships become more important to accurately model as automation is introduced into JADC2 models. The researcher created a JADC2 conceptual map based on joint command and control doctrine, with particular emphasis on shared command and control components between the services. The researcher used linear regression to analyze the relationships between JADC2 nodes within the "actors-information-relationships" framework and established a list of critical components for a JADC2 model. The researcher determined the importance of nodes based on their interaction with other nodes.
This study is relevant to operations research because it potentially increases the confidence researchers place in JADC2 modeling and simulation. Models that include JADC2 allow analysts to account for a center of gravity in an operational force, which ultimately serves as a force multiplier for planning and contingencies. This research is relevant to this year's symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it clarifies how JACD2 is a system of systems, as it is advertised by Department of Defense officials and commercial stakeholders. The presentation will include a detailed summary of the study's conceptual map and findings.

Location: TH332
Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

66692 - OPNAV N81's Approach to Analytic Robustness

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Jillian R Hannah		
Abstract: The Analytic Working Group tasked organizations to conduct robust analysis and deliberate exploration of alternative approaches and future uncertainty. The Campaign Branch of the Assessments Division of OPNAV is authoring the Navy's Battle Force Ship Assessment and Requirement (BFSAR) report. As part of the effort, OPNAV employed a series of experiments, designed to examine a large number of parameters of interest at the campaign level. This briefing will provide an overview of how OPNAV is meeting the Analytic Working Group's guidance and requirements. Location: TH355 Classified Classification: SECRET NOFORN Working Group: WG10 Joint Campaign Analysis		

66106 - Resilient Tasking and Basing Model (RTBM) – a unique capability for modeling air power basing and force projection in peer-to-peer conflicts

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Fred Woodaman		

Abstract: Rather than making tasking and basing decisions sequentially, RTBM simultaneously computes optimal mission aircraft and tanker requirements, mission taskings, beddowns for those aircraft and air defenses, as well as the optimal Red missile attack plan against those bases and defenses. RTBM solves concurrently for both Blue and Red, as RTBM is an example of the Defender-Attacker-Defender Problem (DADP), which is itself a special case of the two-person zero-sum game. In RTBM, Red seeks to maximize the damage inflicted on Blue subject to its available base attack resources, while Blue seeks to minimize this damage, which consists of expected losses and inability to fly the required missions. RTBM users can choose to maximize mission accomplishment, minimize risk to force, or a convex combination of the two. RTBM analyses since 2016 have ranged from OPLAN assessment to future concept evaluation. RTBM is a large scale, mixed-integer program implemented using GAMS/CPLEX, Excel for input and output, and Tableau for visualization. Typical scenarios involve scores of bases, hundreds of aircraft and defense systems, thousands of threat weapons, and theaters covering 20-30% of the Earth's surface. Presentation will cover formulation highlights, typical analytical workflow, and describe recent analytical applications.

Location: TH332
Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

65452 - Prometheus' Gift: Decanting Smaller Conflicts from Larger Wars

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: William Buppert

Abstract: Campaign planning and analysis requires the examination of all the possible branches and sequels that emerge when war commences and wargaming requires the extrapolation of probable and possible excursion and departures from the plans for initial conflict.

This presentation will make the case to make the acceptance and examination of potential flashpoints and second and third order effects a necessary part of war planning.

It will examine the reasons for this, historical cases from the European conflicts from 1939-1950, the case study of the Iraq invasion of 2003 and the complete absence of necessary planning to tackle the post-conflict scenarios that emerge.

I will conclude by offering possible solution sets to ameliorate what has become a perennial operational shortfall in contemporary war planning.

Location: TH332
Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

66405 - Scenario 7.X Campaign Analysis Design of Experiments

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: CPT Ryan Capelli
Abstract: Campaign Analysis Division, Center for Army Analysis (CAA) conducted a design of experiments for Scenario 7.X upon completion of campaign analysis in support of Total Army Analysis (TAA) 26-30 utilizing the base models instantiated in the Joint Integrated Contingency Model (JICM). The intent of this presentation is to discuss the methodology used to design this set of experiments and to cover lessons learned throughout the process. Location: TH355 Classified Classification: SECRET NOFORN Working Group: WG10 Joint Campaign Analysis

65663 - Capturing Space Effects in a Joint Campaign Analysis Effort

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Michael Edward Terry, N/A		
Abstract: The U.S. Space Force (USSF) was established on 20 Dec 2019. As the newest Service, USSF does not have a long history of warfare, lessoned learned, and evolving warfighting doctrine, as do the other Services. So, the continual challenge is using common, campaign-level tools to articulate the value of "enabler-focused" capabilities like space. The Joint Space Warfighting Forum (JSWF) effort worked from 2016-2021 documenting warfighting effects using analysis of Joint Mission Threads (JMT) to capture space touchpoints. Once identified, a Delphi method amongst a group of mission experts was used to assess how to model effects in a Synthetic Theater Operations Research Model (STORM). So, for missile warning (MW); positioning, navigation, and timing (PNT); satellite communications (SATCOM) a mission analysis was conducted to capture order-of-battle, satellites/orbits, and expected effects. These inputs were used to develop a roadmap for space development within STORM based on considerations of leadership priorities and low hanging fruit – start with an early victory. Many engagements with experts were required to understand the space mission capabilities. Subsequently, warfighter vignettes or real-world scenarios were used to assess space mission area contributions to a selected warfighting tactical operation. Additionally, various space studies were leveraged. These space contributions were used to further inform space effects to the warfighting campaign. SpOC DCG-T S9's analytical benchmarking contributed to identifying space insights to the Joint Force Operating Scenarios (JFOS) modeling & simulation effort which was briefed up to the Deputies Management Action Group (Vice Service Chiefs). Low-hanging fruit was how space contributes to the Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance, and Targeting (C4ISRT) in an anti-access/area denial (A2AD) environment against a near peer. An orbitology model called Integrated Space Situational Awareness (ISSA) captured the National Reconnaissance Office architecture. Target grids were developed and the enemy laydown of forces was superimposed. Overflights were conducted to show probability of detection (Pd) and informed the kill chain (find, fix, track, target, engage). This model shows various architectures including attrition to show the effect of Pd. Moving forward USSF will engage with other Services to capture space effects in models. A TTX captures a specific tactical operations. Vignettes are developed to discuss with tactical planners/experts the detailed key tasks and political, military, economic, social, information, infrastructure, physical environment and time (PMESII-PT) analysis. Space touchpoints are identified for the mission. Then a risk management analysis is conducted to determine impact of not having space capabilities against primary, alternate, contingency, and emergency options. This methodology will be briefed. Location: TH355 Classified		

Classification: SECRET NOFORN Working Group: WG10 Joint Campaign Analysis

66277 - Joint Force Operating Scenario

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Robert Platt		
Abstract: What began in 2019 as the 2030 Joint Force Operating Scenario (JFOS) has since become an initiative among the services to develop a Concept of Operations (CONOPS) paired with given scenarios based on the most recent Defense Planning Scenarios (DPS). These CONOPS provide the level of detail and context needed to conduct war gaming, modeling and simulation, and other analysis to inform senior military leaders, Program Objective Memorandums (POMs), force structure decisions, and concept development. To create a JFOS, the Joint Working Group (JWG), consisting of planners and analysts from the Services, intelligence community, and several supporting commands and organizations, take existing scenarios and CONOPS, updated threat information, and future capabilities and capacities and leverages them to develop a robust scenario and associated CONOPS set in a future time frame. The JFOS process has completed three baseline iterations. Most recently, in February 2023, the services completed the first comprehensive JFOS excursion CONOPS development, with emphasis on varying degrees of allied support. Location: TH355 Classified Classification: SECRET NOFORN Working Group: WG10 Joint Campaign Analysis		

66152 - "Potential Contributions of Special Operations, Asymmetric and Irregular Warfare Forces to a Defense of Taiwan"

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: William Buppert		
Abstract: In this talk, we will differentiate and discuss the modalities of irregular and asymmetric warfare in the context of assistance with a defense of Taiwan from an attempted forcible reunification by the People's Republic of China, appropriately contextualized by an examination of historical U.S. successes and failures in this area. We will elicit discussion from the community about possible classes of contribution by the special operations community to the generation of operational effects in time and space, before and after the advent of overt hostilities. In a continuing partnership between working groups 32 (Special Operations and Asymmetric Warfare) and 10 (Joint Campaign Analysis), we will open dialogue regarding systematic but appropriately aggregated analysis and simulation of the detailed and localized effects produced by these forces, and the measurable operational impacts they might have at the theater/campaign level. Location: TH355 Classified Classification: UNCLASSIFIED Working Group: WG10 Joint Campaign Analysis		

65415 - The Russian invasion of Ukraine: Using Tableau to develop courses of action and contingency plans during an emerging crisis.

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Gregory J. Garcia		
Abstract: On February 24, 2022, the Russian Federation invaded Ukraine and in doing so upset the balance of power in Europe. While the United States possessed some premonition that this may occur, until the tanks crossed the border in Ukraine it remained a theoretical but dangerous possibility only. The ability of joint combatant commands, such as US European Command (USEUCOM) in the case of the Russian-Ukraine war, to respond with speed and efficacy to fluid conditions on the ground during a crisis, develop contingency plans, and thus provide realistic courses of action to commanders and political decision-makers, is paramount. In this presentation, I will demonstrate how industry's leading analytics platform, Tableau, is used to develop and inform hypothetical courses of action for Ukraine using time-phased force deployment data (TPFDD). TPFDD's are jointly developed components for the deployment of forces to a contingency operating area. The commander directs their development as part of his or her overall campaign plan for the region in expectation of or due to the actual occurrence of various real-world crises. In the case of Russia's incursion into Ukraine, preparation for that fateful day undoubtedly began long before with the pre-placement of forces and logistics in expectation of some manner of Russian aggression consistent with the USEUCOM's commander's intent. TPFDD's determine the Who, What, When and Where. Who is deploying, what equipment and cargo does it possess, when is it departing from the port of embarkation and arriving at the port of debarkation, and where is it ultimately going to in theater. Using Tableau, pre-existing contingency plan data are rapidly adapted, cleaned and made ready for analysis to support a response to these changing conditions on the ground. From this several courses of action, each with different planning assumptions and factors, are developed expeditiously and in a manner consistent with what an emerging crisis demands. From these the commander's critical information requirements such as "how much personnel and cargo is arriving by air in the first 10 days" or "what is the impact if a crucial ally's air and seaports are closed to US military transport?" may be answered with speed and efficacy to support feasibility analysis of the COCOM plan and inform the commander's decision-making. Tableau's ease of use and wide-spread adoption both in industry and in the DoD make it an accessible and useful tool in the analyst's toolkit. Armed with analytic capabilities like Tableau, the commander and his or her staff are able to regain the operational initiative against rivals such as Russia in developing their campaign and contingency plans. Location: TH319 Classification: UNCLASSIFIED Working Group: WG10 Joint Campaign Analysis		

66065 - Rigor and Prediction in Campaign Analysis using Computer Simulations and Games

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. John Thomas Hanley, Jr, PhD		
Abstract: This session will provide a framework for addressing what constitutes rigor using mathematics, quantification, and history and address foundations for prediction. In particular, it will contrast compressive mathematical forms such as Wayne Hughes' salvo equations and Glenn Kent's similar analytical approach to campaign models involving thousands of variables. It will address Bernard Koopman's "A Study of the Logic of Combat Simulation" and the effects of uncertainty. It will then address the logical basis of both computer and game simulations for prediction. This framework		

establishes the basis for employing both critical analysis and games to develop conjectures requiring the evaluation of prototype concepts and technology in field/fleet exercises and operations to provide firm foundations for selecting courses of action with respect to both operations and equipping.

Location: TH319
Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

65926 - Joint Long Range Strike in CFAM

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Major Taylor Leonard		

Abstract: Combat Forces Assessment Model (CFAM) is a mixed-integer linear program that pits a set of aircraft and weapon loads against “enemy” targets at the campaign level. The goal of the model is to destroy the targets as quickly as possible, subject to several constraints, such as the number of aircraft, how far they can fly on a full load of fuel, how fast they fly, their susceptibility to being shot down, how effective a given weapons loadout is against the targets, the aircraft beddown plan (basing) in relation to target locations, the quantity of weapons of each type, and many, many other constraints. As a campaign-level model, CFAM takes inputs from other models such as STORM (target data), TAMS (attrition data), Brawler (attrition and effects data), and the Air Force Research Labs WEAPS office (for weapons effects). Originally formulated in the 1990’s, CFAM has undergone dozens of major updates, and now CFAM 3.2 is available for users to install. Here we present how the latest CFAM enhancements allowed us to robustly model Air Force and Army long range strike in a contested environment and how we analyzed those results to determine future force projections.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

66523 - The Application of Logistics Analytics to Campaign Analysis using Combat Support Planning, Execution and Control (CSPEC)

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Wyatt Blatti; Richard Moore; Nicholas R Hofacker; Chad Kimmel		

Abstract: Many operational plans are developed with thin consideration of the implications of logistics and sustainment. Air Force leadership has recognized this issue, which was highlighted in 4-star level contested logistics table top exercises. To address that concern, the AF A4 Enterprise Council directed the development and implementation of Combat Support Planning, Execution and Control (CSPEC), a logistics analytics capability to relate logistics resourcing and plans to operational metrics. The CSPEC capability includes dedicated logistics operations research analysts, a suite of existing and emerging analytic models, and robust enterprise data. The current scope of CSPEC is Class III (fuel), Class V (munitions), Class VII (major end items), and Class IX (spares). The purpose of this presentation is to highlight the capabilities of CSPEC, including showing results from various war plan analyses. We look forward

to collaborating with other DoD log analysts who are addressing logistics and sustainment supportability for war plans.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

66278 - UUV Concept of Employment Development

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Jonathan Conner

Abstract: Unmanned Underwater Vehicles (UUVs) are emerging as a solution to some of the Navy's most difficult and crucial objectives.
Supplementing the main Joint Force Operating Scenario (JFOS) effort, N81 incorporated the latest innovations in Undersea Warfare (USW) by developing novel Concepts of Employment (CONEMPS) for UUVs to improve the effectiveness of the US forces in modeled scenarios.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

66165 - Achieving Multi-Resolution Campaign Modeling in AFSIM – Framework Update

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Alexander Braafladt; Sai-Aksharah Sriraman; Dr. Alicia Sudol; Professor Dimitri Mavris

Abstract: This work is a continuation of the efforts presented previously at MORS Symposiums evolving a 'Campaign-Lite' methodology for aggregating information across fidelity levels in simulation. This aggregation supports effective analysis of means and ways options in a design context for large-scale military operations. The aggregation of information is used to provide analysis scope at the decision-level of interest (e.g., campaign-level), while maintaining technical credibility and transparency through traceable connection to the other levels (e.g., physics, engagement, and mission). Ongoing research efforts are working to better support analysis by tailoring fidelity – resolution, scope, and abstraction – to the specifics of the case, while working within runtime constraints and providing improved re-usability and re-configurability of simulation. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) provides an open architecture for these efforts and is successfully in use supporting simulation and analysis focused on the engagement and mission levels. Building on previous Campaign-Lite efforts for modeling larger-scale operations in AFSIM using execution control, mission modularity, and multi-level information objects, this work focuses on greatly improving scalability and reconfigurability with enhancements to the modular, object-oriented Command and Control (C2) and intelligence information management framework. These changes support improved plug-and-play modeling for decision-making algorithms and modular missions in a simulated multi-domain tasking cycle. Specifically, object-oriented encapsulation and inheritance techniques are used with updated information models to make managing target, geographic, resource, and sortie databases and behaviors for campaign-level, airbase-level, and squadron-level activities more flexible with clearer interfaces and intent. These new simulation capabilities are showcased in a proof-of-concept, multi-domain, large-scale operation, with new vignettes looking at space communications and the impacts of Electromagnetic Warfare (EW), and looking as well at joint strike packages that combine assets from multiple geographically

separated airbases. The analysis considerations are based in an updated data-driven dashboard with closer linkage to Mystic visualization and geographic campaign outcomes.

Location: TH322
Classification: UNCLASSIFIED // NOFORN
Working Group: WG10 Joint Campaign Analysis

66167 - Modeling, Simulation, and Analysis for EMS Mission Thread Interdependencies in Large-Scale Operations

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: John Robinson; Dr. Alicia Sudol; Professor Dimitri Mavris

Abstract: The integration of missions across the joint activities that make up a campaign is a central part of decision-making in the context of large-scale operations. Support for planning, investment, and acquisition decision-making through modeling, simulation, and analysis is underway in a variety of lines of effort to improve understanding of how alternatives impact the integration and interactions that roll up to the campaign level. The work presented here focuses on the key importance of the Electromagnetic Spectrum (EMS) in enabling the integration of future operations, where the ability to operate effectively is expected to be impacted by a more congested, contested, and constrained EMS environment. The existing modeling, simulation, and analysis of Joint Mission Threads (JMTs) individually has been very effective at providing insights to support decisions on improving mission effectiveness; however, with a shift in focus to larger-scale operations, new techniques are required to understand the interdependencies and connections between the JMTs. This prompts a need to enable analysis that includes the EMS interdependencies between JMTs, as well as the impacts of the integration of JMTs on the outcomes in campaigns. Leveraging recent development of the 'Campaign-Lite' methodology for agent-based simulation of large-scale operations in the Advanced Framework for Simulation, Integration and Modeling (AFSIM), and the recent architecting approaches developed using the Unified Architecture Framework (UAF), this work proposes a data-driven approach to analyzing JMT EMS interdependencies. The JMTs and their interconnections are modeled using a UAF architecting approach and the interconnections are simulated in AFSIM resulting in data on the outcomes in the JMTs and in the overall large-scale operation. To work effectively with the resultant data in analysis, the work presented here uses models of the combined mission threads using Dynamic Bayesian Networks (DBN). This allows scenarios of conditional interdependencies to be directly inferred and visualized between the dynamic events and outcomes using the simulation-based outcome distributions. The modeling, simulation, and analysis approach is demonstrated in a proof-of-concept, large-scale, multi-domain scenario with example analysis vignettes focusing on electromagnetic warfare (EW) impacts on a set of JMTs, the dynamic mission tasking cycle, and campaign-level outcomes.

Location: TH322
Classification: UNCLASSIFIED // FOUO
Working Group: WG10 Joint Campaign Analysis

66009 - Strategic Influence: What it is, how to generate it, and measure it.

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr Pat Blannin

Abstract: The Indo-Pacific is undergoing significant strategic realignment. Strategic competition, military modernisation, technological disruption, the risk of state-on-state conflict and an increasing range of non-traditional security challenges are complicating Australia's strategic circumstances. This realignment demands the Australian Government revisit how it competes for influence through regional engagement. Whilst meeting the Department of Defence's (Defence) regional security objectives, Defence international engagement and Australian Defence Force (ADF) operations, actions and activities (OAA) with Australia's allies and other key partners must also complement whole-of-government efforts to influence favourably the Indo-Pacific.

The paper posits that in strategic competition, influence is a product of actualised power relative to a competitor in a particular context (country or target audience). Grounded on the premise that enhanced horizontal and vertical integration creates a robust, resilient yet agile system (anti-fragile), this paper presents a novel influence pathways framework. Through application of this framework, it can show how 'Influential' states effectively deploy their absolute national power potential (a portfolio of instruments-of-influence) along available pathways to modify the beliefs and behaviours of other actors. The paper demonstrates that a framework based on absolute, relative and comparative power is an appropriate decision support methodology to identify influence potential, and to plan, monitor and assess strategic influence.

Based upon the observations and findings from recent research this paper contributes to building a deeper understanding of the various aspects of strategic competition, strategic influence and whole-of-government integration. This research supports ongoing efforts to identify and implement adaptation mechanisms that enable Defence policy, strategy and force elements to manage strategic risk and assure strategic outcomes. The strategic influence framework discussed in this paper is a step towards a decision support methodology (technique and tools) that situates, contextualises and informs planning and evaluations of influence and information-based advantage gained through a strategy-driven influence campaign.

Location: TH322
Classification: UNCLASSIFIED
Working Group: WG10 Joint Campaign Analysis

65821 - Space 4-Factor Study Replication in BEAM

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Zachary Shannon; Stephen Sturgeon; Michelle McGee; Dr. Mark A. Gallagher, FS

Abstract: Space capabilities will obviously be critical in the next major conflict. Quantifying that impact has been a challenge in the current modelling toolset. Many of these challenges stem from the complex interactions between systems and difficulty in modeling those interactions. The Bilateral Enterprise Analysis Model (BEAM) takes a more aggregated approach to campaign modeling than other available tools. Using this more aggregated approach, we studied the impacts of 4 space-based capabilities in the JFOS 2.1 scenario. BEAM was able to run multiple excursions in a short timeframe that not only helped quantify space impacts, but also helped identify important aspects of the campaign and refine strategy throughout the campaign. This presentation focuses on the methodology, limitations, and results from this study.

Location: TH356 Classified

Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

65829 - BEAM: Exploring A Larger JFOS Tradespace

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Zachary Shannon; Stephen Sturgeon; Dr. Mark A. Gallagher, FS

Abstract: Force structure studies have been and will continue to be run continuously at the campaign level. However, there are several aspects of the campaign that are difficult to study with current tools. What about military strategy? What about Red's strategy and their adaptation? What about force readiness? What about international basing issues? What if we widen the lens to consider a significantly different fight? The Bilateral Enterprise Analysis Model (BEAM) provides us that capability. In the winter of 2023, we used BEAM to study these factors in the JFOS 2.1 scenario. We scanned the tradespace at a lower resolution and identified interesting factors driving the campaign. We demonstrate how to use BEAM to guide deeper analysis into a scenario. This presentation shows the breath and ease of a BEAM analysis and what kind of insights can be gained from the model.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG10 Joint Campaign Analysis

WG11 Land and Expeditionary Warfare

66019 - Operational Research to support the British Field Army

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Mr Martyn Law

Abstract: Over the last three years, Dstl has worked with the British Army's Land Warfare Centre Operational Research Branch (LWC ORB) to deliver impactful analysis that has shaped development and force optimisation.

Centred on Warfare Development (WARDEV), the LWC ORB has been focused on the 'here-and-now' that affects the British Army as it would 'Fight Tonight'. The operational research has covered a wide breadth of studies, ranging from tactical-level experimentation up to Corps-level wargaming, as well as keeping the Field Army informed of current real-world events.

Studies and support has included: optimisation of Light Infantry forces as the British Army transitions to Brigade Combat Teams under Future Soldier; understanding the role of NATO ARRC as a Corps HQ, if it were to engage in offensive Urban operations, and understanding the implications of high-level Logistics in warfighting; timely reporting on the Ukraine conflict, including how the conflict has progressed, and what some of those observations could mean for the British Army; and support to Land Exercises and Operations through Deployable Operational Analyst and Scientific Advisor support.

The studies have been conducted through a number of means, including Historical and Literature Analysis, Wargaming, OSINT collection and Table-Top Exercises. Our wargames have included both manual table-top games and computerised simulations, looking at how the force fights from the Platoon level all the way to Corps level conflicts.

Location: TH304/306
Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

66102 - Mission Planning Optimization for Infantry Operations

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ryan A Helm

Abstract: The modern battlespace is characterized by large volumes of multi-domain intelligence that must be processed into useful information for decision-makers. For decision-makers at the small unit level, there are few tools available to help analyze and process geospatial intelligence for infantry operations. In time constrained or distributed planning environments, small unit leaders lack the decision-support tools required to make a comprehensive, precise, and timely terrain and mission analysis. To solve this, we are using open-source data from the Google Earth Engine API to create terrain analysis models for infantry mission planning. The proposed models will include quantifiable risk-effectiveness trade-offs for mission planning decisions such as landing zone selection, maneuver route planning, and fire support. A multi-objective optimization will be formulated to provide a mission planning tool for the combined decision points. To solve this optimization, the spatial decisions will be formulated as an acyclic network and solved with topographic sort. These models will be implemented on a distributable Python dashboard for use on computers or tactical tablets. Additional work is being done by Naval Research Lab-Stennis to integrate the proposed models into a plugin for the Android Tactical Assault Kit.

Location: TH304/306
Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

65836 - NextGen Launcher Throughput Model

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dean Mengel

Abstract: As the Army looks to design and build the next generation of rocket and missile launchers, many design features of current systems are being considered as possible trades to gain new features such as autonomous operations. This new design could impact other features such as loadout and reload times for the launcher. As a result, the ability of a battery to service fire missions over a specified time period could be impacted.
This study estimated the throughput that could be expected from a battery of launchers. A spreadsheet model was used to replicate the requests for missions and the ability of launchers in a unit to service the requests. The model incorporated the reload times for empty launchers, the time to move to and from hide, firing and reload positions and the time a launcher is otherwise inactive. Distributions for the various parameters were established in the model to allow for Monte Carlo analysis. Three metrics were tracked and reported; the number of missiles required by the missions over a three-day period, the number of missiles fired, and the percentage of the missions that were successfully serviced.
The model provided an easy way to explore the trades between reload times and launcher loadout and examine other factors such demand rates for missions and number of rounds per mission.

Location: TH332

Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

65631 - Operation Arrowhead Ripper: The Battle for Baquba as told by Data Storytelling

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Gregory J. Garcia

Abstract: On June 19th, 2007 the Arrowhead Brigade - 3rd Stryker Brigade Combat Team, 2nd Infantry Division - commenced a major military operation to retake the enemy-held western half of Baquba: Operation Arrowhead Ripper. To that point Baquba, indeed all of Diyala Province, had vexed the Coalition going back to the earliest days of the invasion. Former Al Qaeda in Iraq leader Abu Musab Zarqawi was killed by airstrike just 3km from the primary US military forward operating base and Baquba boasted a significant density of insurgents. Occupying key terrain near a main supply route (ASR Dover) and transit to the Diyala River Valley and Iranian border, retaking Baquba was a core objective of the 2007 Corps-level offensive (Phantom Thunder) known more commonly as the Surge. The full story of this significant milestone in military warfare is told in parts across multiple sources, including first-hand accounts from the former 1SG of B Co, 1-12 Cavalry from the 1st Cavalry Division, embedded reporters in 5-73 Cavalry from the 82nd Airborne, and the former deputy brigade commander of 3/2 SBCT among others. In this presentation, I use Tableau, industry's leading analytics platform, to weave their combined accounts into a cohesive and concise data story of this battle that will inform and advance analysts' understanding of military operations using cutting edge analytic tools and technology.

Location: TH332
Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

65592 - 2030 Marine Expeditionary Unit Munitions Phase Zero Study

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Steven Heinlein

Abstract: The design of the 2030 Marine Expeditionary Unit (MEU) features munitions requirements that affect both the capacity and handling capabilities of amphibious warfare ships. The Force Design (FD) of the 2030 MEU will subsequently impact the configuration of landing force operational reserve material and Marine Training Authorization, to include its dimensions and weight. Specifically, these new munitions requirements affect both embarkation munition dependencies and storage areas) and handling (materiel handling equipment capability to lift and move munitions) for the future amphibious ready group (ARG). Analysis is required to inform decision makers whether current amphibious warfare ships and their cargo handling mechanisms can support the embarkation of the 2030 MEU's munitions.

This briefing will overview the baseline modeling that uncovered potential limitations and compatibility issues of amphibious ship platforms and the FD 2030 MEU. In phase zero, analysts are using Blender, a free open-source three-dimensional (3D) computer graphics software tool set, to render a 3D baseline stowage configuration for a 3-ship ARG, allowing the visualization of cargo hold spaces, constraints, and dependencies. Analysts seek to identify stowage issues in terms of volume, weight, compatibility, and movement given the current cargo material handling systems, i.e., forklifts, cranes, elevators, stowage areas. The baseline configuration will then be modified in a follow-on

phase one effort with the assumed shift in 2030 MEU maneuver and aviation munition types and requirements assessed with other exploration techniques focusing on cargo flow to points of debarkation and points of use, and ability of handling systems to support sortie generation rates of the future force.

Location: TH332
Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

65991 - Long Range Precision Munition (LRPM) Trades Analysis

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Bryant Austin Hummel

Abstract: "Which comes first: the sensor or the munition?" is an issue that militaries around the world wrestled with at every modernization and transformation opportunity. Many different capabilities on both sides of the equation are part of the U.S. Army's plans for transforming the force for 2030 and beyond. One such capability is the Long-Range Precision Munition (LRPM). LRPM is an Army Aviation-delivered lethal capability that compliments the extended-range sensing capabilities offered by another Army transformational capability, air-launched effects (ALE). Paired together, the LRPM and ALE substantially extend the reach of Army Aviation to organically find and prosecute targets, offering an answer to the initial question – the sensor and the munition can be developed at the same time. Ensuring complementary capabilities is an important factor in simultaneous developments which led to the LRPM Requirement and Framing Analysis (RFA) study to determine the attributes, performance levels, and potential solutions for the munition. The TRAC-led LRPM RFA team drew from across the Army Analytic and Aviation communities to explore trade-space among system attributes, operational attributes, cost, and schedule risk to help refine requirements and inform senior leader decisions.

A key output of the study was the identification of two functionally different ways to create the LRPM capability – missile-like munitions and loitering munitions. The trades analysis generated over 150 potential design points across these two approaches, identifying the estimated cost, schedule, and performance impacts, risks associated with changing attribute levels and technologies, and the effect on operational outcomes. The trades analysis provided LRPM operational risks and benefits regarding materiel solution suitability, acceptability, and feasibility that balance benefit, cost, and technical risk.

This presentation describes the techniques used to conduct the trades analysis for LRPM and the methods and tools used during the trades analysis.

Location: TH332
Classification: UNCLASSIFIED // FOUO
Working Group: WG11 Land and Expeditionary Warfare

65996 - Command Post Survivability: Using Simulation to Identify Trades between Situational Understanding and Network Requirements

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Matthew Wesloh

Abstract: A division command post (CP) manages the planning and execution of operations. Traditionally, CPs are a single entity. However, the threat of enemy interdiction poses a risk to a

consolidated structure. The Army introduced a new dispersed CP concept to reduce the risk of losing any one location. However, dispersing the CP inhibits face-to-face communication, reducing situational understanding. The Research and Analysis Center (TRAC) and Mission Command Battle Lab (MCBL) undertook an effort to simulate and define the trades between situational understanding and network requirements. The study team built a representative set of intra-CP communications and used discrete event simulations to determine the operational impacts of potential requirement levels. The study team found that the Army requires updated CP doctrine and TTPs to enable dispersed command post operations. This presentation will summarize the approach to enumerating and simulating the communications demands and will provide an overview of lessons learned from the process.

Location: TH304/306
Classification: UNCLASSIFIED // NOFORN
Working Group: WG11 Land and Expeditionary Warfare

65994 - Enhancing Live Experimentation: Using Simulation to Scale Satellite Communications for Large Scale Combat Operations

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Matthew Wesloh		

Abstract: The Army Futures Command (AFC) launched Project Convergence 22 to assess the evolution of Army transformation for future Large Scale Combat Operations (LSCO). The Research and Analysis Center (TRAC) spearheaded data collection and analysis, identifying network integration and interoperability as crucial areas to focus on during the field experiment. However, the study team encountered two major obstacles: the experimental effects on a network differ from combat operations, and the data collected only represented the experimental scope which provided incomplete views of prototype technologies and procedures. To surmount these obstacles, the study team employed large-scale operational communications simulations. Experimental data was primarily collected through observational and instrumented systems which would usually necessitate months to clean and prepare before incorporation into simulation; however, results were due six weeks after the experiment. This presentation will describe how the study team used simulation to overcome these obstacles within the required timeline. It will also describe the lessons learned along the way.

Location: TH304/306
Classification: UNCLASSIFIED // FOUO
Working Group: WG11 Land and Expeditionary Warfare

66082 - Maintenance Operating Periods in Large Scale Combat Operation

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Andrew Bellocchio; Kyle Ditonto; Mr. Daniel C Finch; MAJ Sam Yoo		

Abstract: The U.S. Army's new doctrine developed for Multi-Domain Operations and arrival of the next generation of rotorcraft, Future Vertical Lift, creates an opportunity to change the way the Army maintains its aircraft. The presented work explores the use of maintenance operating periods to improve Future Vertical Lift's survivability against near-peer competitors. Operating periods are an attractive sustainment strategy in large scale combat operations because they offer an assurance of flight operations over a given number of operating hours that are undisrupted by maintenance

actions and unencumbered by a heavy sustainment tail. Fewer maintainers forward present less risk to personnel while lighter sustainment packages generate the agility needed for frequent survivability moves in the tactical support and close areas, which are within range of enemy air and fires.

An examination of the Army's evolving doctrine, including 2022's Field Manual 3.0 Operations, highlight the need for Army forces to operate dispersed for extended periods without continuous support in Multi-Domain Operations. The authors introduce the conceptual approaches and the analytical techniques needed for maintenance operating periods. Presented works and analysis provide compelling evidence that predictive maintenance and technologies such as health monitoring systems are now ready to enable Army Aviation to implement shorter, limited operating periods. As Future Vertical Lift matures in future increments, operating periods will likely grow to provide even greater capability to extend operations while dispersed.

Location: TH304/306
Classification: UNCLASSIFIED
Working Group: WG11 Land and Expeditionary Warfare

WG12 Maritime Operations

64966 - Improving search efficiency via real-time Bayesian sequential learning

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr. Liang Hong		
Abstract: How to optimally allocate given resources to find a target is one fundamental operations research problem faced by any naval force in the world. Current methods account for the uncertainty in a search, but only partially assimilate real-time feedback during the search, leaving room for significant improvements. We propose a new method of optimal search, via sequential Bayesian learning, which fully incorporates real-time feedback into its operational algorithm. Location: TH322 Classification: UNCLASSIFIED Working Group: WG12 Maritime Operations		

66073 - Redistributing naval forces in contested environments: Work in progress

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: KATRINA BERNAL; Prof. Gerald G. Brown; CAPT Jeffrey E. Kline, (Ret.)		
Abstract: The Panama Canal is a critical maritime passage that allows merchant ships and naval vessels to transit between the Pacific and Atlantic oceans. If the Panama Canal route is restricted or blocked for any reason, alternative world-wide naval ship routing must be planned to enable in the redistribution of naval forces from one theatre to another. Recent work analyzes world-wide sustainment routes from ocean to ocean to include lost mission days due to adversary interdiction among critical maritime passageways. There are no current plans on analyzing sustainment routes through uncommon passageways such as the Northwest passage and the Cape of Good Hope. In addition, little work has been done on analyzing refueling support within these regions along with potential adversary action against potential sustainment ports and restricted waterways. This study continues analyzing sustainment routes by using a world-wide routing network with an attacker-defender construct that demonstrates the redistribution of naval forces from the east coast to the western Pacific Ocean. Our work will address feasibility of logistics support on alternative routes,		

time, distance, climatology, and risk of adversary action against ports and restricted waterways. We will assume that conflict with one or two peer competitors will result in the loss of sanctuaries worldwide. Overall, our purpose is to generate the best routing options for naval ships from the factors above to aid planners in securing critical port facility support and route ships between theatres.

Location: TH322
Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

66020 - Modeling Contested Logistics in Distributed Operations

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Michael P Huck; Tristen Leinbach

Abstract: In response to challenges posed by a return to strategic global competition, Navy and Marine Corps developed Distributed Maritime Operations (DMO) and Expeditionary Advanced Base Operations (EABO) concepts for conducting far forward combat operations in contested environments. Systems Planning and Analysis (SPA) has developed a logistics force level model accounting for refuel, resupply, and rearming of maritime combat forces supporting these concepts in a future-year, campaign-level, Pacific theater warfighting scenario.

The maturation of this logistic analysis has been ongoing since 2018, supporting Navy force design efforts for the surface combatant and future fleet afloat logistics elements. Initially, this work examined fleet ship and aviation fuel demand and the relationship between survivability of the combat logistics force against the overall combat effectiveness of the surface force in a campaign-level warfight. This NAVSEA supported logistics analysis, required development of fuel burn curves for new surface combatants operating through an intense limited duration wartime scheme of maneuver. NAVAIR also provided the projected fuel demand from the integration of the F-35 into carrier air wings, to calculate JP-5 fuel requirements.

In 2020, the analysis expanded in scope, examining all logistics elements in order to support ICD development capturing afloat logistics requirements necessary to meet a theatre level wartime scenario - from the warehouse to the front line. In response to the expanded scope, SPA developed a nodal analysis for fuel, supplies, ordnance, rescue, and repair demand across the force using a theater-level warfighting campaign scenario. This broader treatment of operational logistics was applied to future force level analysis in a series of Navy AoA's. The AoA's showed changes in campaign-level combat produced by Navy ships as a function of the degree of interruption of the logistics flow relative to enemy attacks on logistics units.

SPA continues to support the Navy analysis utilizing the JFOS 2.2040 scenario, which includes logistically supporting the entire afloat force as well as Marine Corps Expeditionary Advance Base Operations. This longer scenario has required a better understanding of how to logistically model a force that dynamically maneuvers from one phase of operations to another and has explored different concept of operations that would ensure the success of the force by more efficiently protecting the logistic force.

Location: TH322
Classification: UNCLASSIFIED // FOUO
Working Group: WG12 Maritime Operations

65990 - Maneuver Support Vessel (Heavy) Trades Analysis Process

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Wayne Vornholt		

Abstract: Current and emerging Army doctrine, as well as current national military strategy, highlight the importance of the Army's ability to control critical land masses in maritime operational environments. To accomplish this, the Army must be prepared to quickly move units and provide sustainment over potentially long maritime distances. The Army's current vessel, the Logistics Support Vessel (LSV) is nearing its end of economic useful life (EUL) and does not have the ability to meet the expected Multi-Domain Operations (MDO) requirements for maritime operations. The Maneuver Support Vessel (Heavy) (MSV(H)) is a future materiel concept designed to move company size equipment and personnel under these conditions successfully. The MSV(H) concept of operations consist of three primary missions: intra-theater lift, maneuver support and sustainment.

TRAC conducted a framing analysis based on emerging requirements from the Sustainment Capabilities Development and Integration Directorate (S-CDID) to explore the trade-space among operational attributes, cost, and schedule risk to refine requirements and inform acquisition approaches. Projected development and fielding schedules were assessed during the analysis to all meet desired Army timelines, and since the Army had not yet provided a cost target, the study team focused on identifying opportunities to reduce cost, without impacting schedule, while still maintaining operational utility.

This presentation describes the techniques used to conduct the trades analysis for the MSV(H) to include the input from other lines of effort to methods and tools used during the trades analysis.

Location: TH322
Classification: UNCLASSIFIED // FOUO
Working Group: WG12 Maritime Operations

65434 - Integrating M&S Analysis in Adjudication of Maritime Wargames

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Christopher Kona		

Abstract: Simulation is an attractive addition to naval wargames, especially the promise of being able to simulate explicit actions live during the conduct of a wargame. However, its use must be able to serve the wargame purpose and design. There are a number of pitfalls that need to be considered when simulation results are used to inform wargame adjudication. First, models and simulations are only approximations of the real world, and the extent to which they address questions in a relevant manner to the wargame needs to be considered. Second, the context in which the simulations are analyzed may be different than the context employed by the players. Lastly, accurate simulations require careful verification, and late changes to inputs or tactics used in simulation may result in unpredictable behaviors. For these reasons, the way modeling and simulation is integrated with wargame design requires careful contemplation.

Under certain circumstances, the addition of modeling and simulation-based analysis can improve the ability for a wargame to inform a particular research question. It can help to shape the spread of likely outcomes in a particular interaction, which is useful in educational wargames or those where the audience may have a bias about interaction results. When applied carefully, it can also act as a tool to resolve common interactions that occur under contexts similar to those used in the models. This talk

will illustrate a successful example of using modeling and simulation within an operational-level wargame conducted in 2021. The talk will present the design approach and describe how the team managed the associated contexts to ensure consistency between the model outputs and the wargame interactions.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG12 Maritime Operations

65669 - Hybridizing Digital Engineering and Operational Wargaming

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Brendan Bongi

Abstract: Mission engineering brings the potential to manage complexity while evaluating a system of systems. Recently digital engineering has provided a number of powerful tools in this area, readily capturing information flows and mapping relationships between and within systems. Wargaming has provided valuable insights to the mission engineer as well, acting a venue to examine future warfare interactions, decisions, and stressors across the levels of warfare. However, to date these methodologies have remained largely separate within the mission engineering discipline. It has not been readily apparent how the two might overlap in the analytic process, as each has distinct strengths and weaknesses that could seem mutually exclusive or dissonant. For example, a digital engineering model might assign a high level of importance to the specifics of a system's precise software configuration to ensure accurate mapping of the system's capabilities, while in a wargame the same information might be considered too detailed to facilitate player decision making.
With these circumstances in mind, this presentation will describe a recent project that successfully integrated the mechanics of an operational tabletop wargame with the architecture of a digital engineering model in order to relate the contributions of systems to a force's creation of operational effects. The artifacts from the wargame captured by the model were also used to explore the impacts of force composition, sequencing, and novel capabilities on warfighting effects in the context of the wargame's scenario. We will cover the process of developing and integrating the model and wargame, lessons learned during execution, and additional cross-discipline opportunities that could further expand upon this approach.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG12 Maritime Operations

66242 - Limiting Lines of Approach Risk-Based Assessment Model

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Sandra Beaulieu; Lauren Boulay

Abstract: The issue of clearing a lane for moving units against slower aggressor threats is classically referred to as a limiting lines of approach (LLOA) problem. The current model was developed as an addition to existing tools, such as Advanced Framework for Simulation, Integration, and Modeling (AFSIM) and Naval System Simulation (NSS) that are used to analyze the effectiveness of future air anti-submarine systems as part of the overall warfare analysis process. The LLOA tool was developed in Matlab to quantify and visualize the risk score for the LLOA using a variety of sensors and tactics over distance and time. The specific features are: to determine, quantify, and visualize threat

environment for moving units; to quantify and visualize potential clearing screens in front of moving units; to combine threat environment and clearing analysis to produce overall dynamic risk score for a given instantaneous configuration; to determine appropriate roll-up metrics for evaluating engagement scenarios; and to explore effectiveness of various tactics against specific threat configurations. The study approach began with quantifying the threat environment using the key metric of intercept time for a threat at a given position against the moving unit. Next, the effect of the clearing screen using a variety of sensors was addressed. The key metric was the probability of the target being at a given location at a given time. Third, the target probability at each location was adjusted over time based on a combination of the initial probability, the target speed and grid spacing, and proximity to regions of greater or lesser probability using a diffusion model of target movement. Then, target probability and threat environment were combined to determine dynamic risk score at each time step of the simulation. At each time step, the roll-up score was determined by taking the average score across all locations with non-zero risk. For each scenario, a baseline score was determined by running the model with no clearing screen (no sensors). The score of the scenario using a clearing screen was compared with the baseline to quantify and visualize the reduction of risk based on tactics and sensors. The risk scores and visualization of various combinations of notional sensors and tactics are shown for illustrative purposes and do not reflect the performance or actual risk of any specific system.

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Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG12 Maritime Operations

66128 - Wargaming Counternarcotics in Central and South America via First Stop

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Jeffrey Dan Havlicek; Franklin Kenter

Abstract: It is estimated that over 2,000 metric tons of cocaine is transported toward North America. The main obstacle for narcotic traffickers is law enforcement interdiction during the first transit from the source zone in northern South America into Central America. This transit is the focus of interdiction law enforcement agencies as once shipments reach Central America, the shipments are divided into smaller movements for northward distribution.

One of the major considerations in this scenario is the cooperation required to interdict narcotic traffickers. No one country can tackle the issue of narcotic trafficking on their own as the sheer size of the geographical domain; the minimal number of detection, monitoring, and interdiction assets; and the number of sovereign nations traversed make interdiction a challenge. The Joint Interagency Task Force - South aims to catalyze this cooperation between U.S. Government Agencies and Partner Nations for successful interdiction and detention pending prosecution as well.

We have developed First Stop a narcotics transport wargame to emulate this scenario emphasizing the with emphasis on the diplomatic and tactical operational aspects of the mission. This game differs from traditional wargaming as cooperative predator dynamics are pitted against a well-resourced and well-concealed prey.

This game features three truly asymmetric sides: BLUE, GREEN and RED representing the US, Partner Nations, and narcotics cartels, respectively. The design goal of this game is to emphasize the operational and cooperative aspects of Western Hemisphere operations in the Eastern Pacific Ocean especially for new partners to the JIATF-S mission.

The impact on this game is manyfold. First, a version of this game is planned for use during employee orientation at JIATF-S. Also, the game has been implemented in a senior research capstone course in operations research at the United States Naval Academy. We discuss the results, findings, and challenges of this ongoing endeavor.

As a separate event, a tutorial demo will be offered for this game.

Location: TH338
Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

66216 - Exponential Impact: Deploying Analysts on UK Maritime Ops

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Keren Dunn; Mr Richard Peter Hoyes		
Abstract: There is a long history of Operational Research analysts deploying on UK military Operations. In recent decades this has been a land centric game. However, the UK has been developing its concept of sending analysts on board Royal Navy ships. The new aircraft carriers have provided an opportunity to gain experience and evolve, along with a number of amphibious operations and exercises. Going through a journey with our Royal Navy colleagues has allowed Dstl to explore how some support is significantly different afloat compared to Joint or Land domains. Dstl have now developed an approach on how we can prepare and train analysts for maritime Ops. Furthermore, we have built up experience demonstrating how one analyst can have an almost exponential force multiplier effect on the military operations and resources around them. This talk will discuss how the UK has approached the evolution of analytic support and interesting examples of how civilian analysts on ships have had this significant impact. Location: TH338 Classification: UNCLASSIFIED Working Group: WG12 Maritime Operations		

66104 - High Altitude Balloon Contributions to Maritime Operations and 'Kill-Chain' Resilience

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Jeffrey Thomas Painter		
Abstract: High Altitude Balloons (HAB) enable the Joint Force and its adversaries to deploy a portfolio of capabilities at varying altitudes for many operational purposes. Payloads may include systems that aid communications, command and control, observation, intelligence gathering, targeting, weather forecasting and other critical military planning tasks. The relative low cost, deniability, stealth and versatile application of these devices have elevated navigable high altitude balloon deployment to the apex of international intrigue. The Joint Force deployed these devices throughout recent operations in CENTCOM theater of operations including the AEROSTAT and similar observation platforms.		

Recent development has increased the versatility of these systems within military operations, particularly the Maritime Theater.
Employment of High Altitude Balloons against Maritime problems introduces capabilities that employ sensor and weapons technology to address all aspects of the dynamic targeting cycle. The dynamic targeting cycle includes the kill chain process of 'Find, Fix, Track, Target, Engage, Assess' (F2T2EA). The endurance, aperture, redundancy, deception capabilities and relative cost of HAB solutions create enormous opportunity against complex dynamic targeting problems presented by the vastness and unpredictability of the Maritime Domain. Advanced HAB communications packages could address challenges with range, bandwidth, and reliability within the command and control architecture necessary to maintain information flow across maritime distances.
The ability to conduct portions of the kill-chain using appropriate payloads on HAB platforms enhances operational resilience across multiple domains, including the Maritime environment. The observed impact of these balloons within an operational context appears across a series of recent Joint Force Exercises. Balloon representation within Joint Exercises provides the most detailed assessment of the impact of these platforms across the multi-domain spectrum and as an important component of Maritime operations.
This presentation will capture lessons from HAB Operations in a series of Joint Exercises conducted in the Maritime Domain. Observations, assessments and experimentation results from these exercises will inform the audience regarding the contributions, challenges and potential for developmental technology packages deployed on HABs.

Location: TH338
Classification: UNCLASSIFIED
Working Group: WG12 Maritime Operations

65764 - Redistributing naval forces in contested environments: Work in progress

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: KATRINA BERNAL

Abstract: The Panama Canal is a critical maritime passage that allows merchant ships and naval vessels to transit between the Pacific and Atlantic oceans. If the Panama Canal route is restricted or blocked for any reason, alternative world-wide naval ship routing must be planned to enable in the redistribution of naval forces from one theatre to another. Recent work analyzes world-wide sustainment routes from ocean to ocean to include lost mission days due to adversary interdiction among critical maritime passageways. There are no current plans on analyzing sustainment routes through uncommon passageways such as the Northwest passage and the Cape of Good Hope. In addition, little work has been done on analyzing refueling support within these regions along with potential adversary action against potential sustainment ports and restricted waterways. This study continues analyzing sustainment routes by using a world-wide routing network with an attacker-defender construct that demonstrates the redistribution of naval forces from the east coast to the western Pacific Ocean. Our work will address feasibility of logistics support on alternative routes, time, distance, climatology, and risk of adversary action against ports and restricted waterways. We will assume that conflict with one or two peer competitors will result in the loss of sanctuaries worldwide. Overall, our purpose is to generate the best routing options for naval ships from the factors above to aid planners in securing critical port facility support and route ships between theatres.

Location: TH338

Classification: UNCLASSIFIED Working Group: WG12 Maritime Operations

WG13 Power Projection and Strike Warfare

66424 - The Smart Munition Effectiveness Model (SMEM): Enhanced Effectiveness Modeling for Advanced Weapon Concepts

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Richard P Haberstroh		
Abstract: Accurate modeling of smart munition effectiveness requires consideration of unique characteristics that conventional effectiveness models do not address. Previously, smart munition analyses at the U.S. Army Combat Capabilities Development Command (DEVCOM) Analysis Center (DAC) were conducted piecemeal and relied on contractor generated data. Given current and future programs of record, DAC required a new standard model to evaluate smart munitions. DAC and DEVCOM Armaments Center (AC) developed the Smart Munition Effectiveness Model (SMEM) to evaluate smart submunition lethality, while meeting a variety of input and schedule constrained environments. SMEM provides both low- and high-fidelity capability for simulated delivery, dispense, fly-out/scanning, target detection, selection logic, and lethality for submunitions with a range of complexity, such as Hit-to-Kill (HTK) and Sensor-fused Munitions (SFM). SMEM will play a critical role in supporting future studies and analyses. Location: TH338 Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike Warfare		

66209 - Chinese Space Program: Implication to the Great Power Competition

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Eric Liu; MAJ Sam Yoo		
Abstract: In early 2023, NASA claimed that the United States is “in a space race” against China due to increasing Chinese presence and ambition in the extraterrestrial realm. “Space race” is a term familiar to the United States due to its large impact on the Cold War and ultimately allowed the United States to become the premier world power. As the new space race emerges, it will certainly affect the ongoing US-China Great Power Competition and the future of the world order. This study aims to holistically analyze the current Chinese Space Program and compare it to the United States Space Program; it will specifically address the similarities and differences between the two programs pertaining to Space Stations, Moon Exploration, Military Application, and Commercial Application. Data for these studies is obtained through previous scholarly research, government sources, and experts in the field. Contrary to what has often been assumed, the rapidly developing Chinese Space Program poses a threat to the United States Space Program and will affect future decision-making for the United States within the Great Power Competition. Location: TH338 Classification: UNCLASSIFIED Working Group: WG13 Power Projection and Strike Warfare		

66674 - An Intuitive Interface for AFSIM to Support Analysis and Optimization

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Chris R. Linhardt; Shane N Hall, PhD; Jon Vigil		
Abstract: Hypersonic weapon systems are designed to travel long ranges at high speeds (above Mach 5) offering the potential to strike defended targets with large amounts of kinetic energy. The strike performance of a system configuration within the context of a specific mission can be represented by the Probability of Kill (PK) against the intended target. Evaluating PK in contested scenarios through modeling and simulation is useful for rapidly evaluating performance of different technology options in a variety of scenarios, but can be challenging as the components of PK, Probability of Arrival (PA) and Probability of Damage (PD) are sensitive to parameters that define the system design as well as the mission scenario. This study uses simulation and optimization to improve the Navy's capability to rapidly study, design and field hypersonic systems that have increased performance and employment flexibility for future military operations. The analysis framework features the optimization and experimentation capabilities provided by OptDef driving the Advanced Framework for Simulation, Integration, and Modeling (AFSIM) and lethality simulations such as the Air Force Targeting and Effects Software - Exploratory (AFTES-X) or Advanced Joint Effectiveness Model (AJEM). A major element of the simulation environment is a Graphical User Interface (GUI) for users that may have little or no experience with AFSIM. This briefing will describe the existing and planned features and capabilities for the GUI that includes integration with OptDef, a simulation optimization, experimentation, and post-run analysis tool. The briefing will also discuss the impact of this analysis framework for the end user of the environment. Location: TH338 Classification: UNCLASSIFIED // FOUO Working Group: WG13 Power Projection and Strike Warfare		

66105 - Resilient Tasking and Basing Model (RTBM) – a unique capability for modeling air power basing and force projection in peer-to-peer conflicts

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Fred Woodaman; Dr. Kirk A. Yost; David Gerber		
Abstract: Rather than making tasking and basing decisions sequentially, RTBM simultaneously computes optimal mission aircraft and tanker requirements, mission taskings, beddowns for those aircraft and air defenses, as well as the optimal Red missile attack plan against those bases and defenses. RTBM solves concurrently for both Blue and Red, as RTBM is an example of the Defender-Attacker-Defender Problem (DADP), which is itself a special case of the two-person zero-sum game. In RTBM, Red seeks to maximize the damage inflicted on Blue subject to its available base attack resources, while Blue seeks to minimize this damage, which consists of expected losses and inability to fly the required missions. RTBM users can choose to maximize mission accomplishment, minimize risk to force, or a convex combination of the two. RTBM analyses since 2016 have ranged from OPLAN assessment to future concept evaluation. RTBM is a large scale, mixed-integer program implemented using GAMS/CPLEX, Excel for input and output, and Tableau for visualization. Typical scenarios involve scores of bases, hundreds of aircraft and defense systems, thousands of threat weapons, and theaters covering 20-30% of the Earth's surface. Presentation will cover formulation highlights, typical analytical workflow, and describe recent analytical applications. Approved for Public Release; Distribution Unlimited. Public Release Case Number 23-0312 This software was produced for the U. S. Government under Basic Contract No. W56KGU-18-D-0004, and is subject to the Rights in Noncommercial Computer Software. 		

Location: TH338
Classification: UNCLASSIFIED
Working Group: WG13 Power Projection and Strike Warfare

66438 - DEVCOM Analysis Center: Modeling Multidomain Operations in OneSAF with Multidiscipline Support

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Wesley Weaver		

Abstract: DEVCOM Analysis Center continues its development of a One Semi-Automated Forces (OneSAF) vignette to provide a means of demonstrating, in an operational context, the comparative effects of multiple disciplines within a multidomain environment for the Active Defense Analysis Methods (ADAM) project. Domains of interest include Ballistics, Electro-Optical / Infrared, Electronic Warfare / Radio Frequency, Cyber Security, Human Systems Integration, and Reliability. This brief will discuss the ongoing efforts to improve on combat simulation modeling with additional methodologies. These updates and refinement to enable modeling Multidomain Operations in OneSAF to evaluate holistic vulnerabilities of combat vehicle concepts will aid in important program decisions for Cross-Functional Teams (CFTs), research labs, engineering efforts, and other areas.

Location: TH338
Classification: UNCLASSIFIED
Working Group: WG13 Power Projection and Strike Warfare

65704 - Employing Nearly Orthogonal Latin Hypercube (NOLH) in AFSIM Modeling and Simulation

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: CDR Phillip E. Pournelle, USN Retired		

Abstract: Group W supporting the USMC conducted a study to evaluate Anti-Surface Warfare (ASuW) using the Advanced Framework for Simulation, Integration and Modeling (AFSIM). The study faced a large set of capabilities with unknown characteristics, requiring extensive parametric analysis. The team employed a Nearly Orthogonal Latin Hypercube (NOLH) designs of experiment within to properly capture the implications of these factors on the simulated. The results were then assessed employing JMP, including a Neural Network Model Fitting. The resulting regression analysis then guided the efficient use of AFSIM to address the study questions and provide the right answers. This presentation will explore the use of NOLH to guide modeling, simulation, and analysis where there are many unknown factors. Note, this presentation will be proceeded by an examination of AFSIM use in Anti-Surface Warfare (ASuW) analysis.

Location: TH357 Classified
Classification: SECRET NOFORN
Working Group: WG13 Power Projection and Strike Warfare

66385 - Modeling Theater-level Intelligence Collection for Wargaming

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Robert Ward		

Abstract: To inform measures of intelligence “access” in the Pacific Warning, Intelligence, and Deterrence System (WINDS) II wargame, the Center for Army Analysis (CAA) built the Theater Intelligence Model (TIM), a simple quantitative model of theater-level intelligence collection in the Pacific. The model uses readily available data on the capabilities and usage of intelligence, surveillance, and reconnaissance (ISR) platforms across all domains to estimate the extent to which the United States and its partners and allies have persistent, layered ISR access to the regions on the wargame’s map. The team also created a user-friendly, cloud-hosted frontend that enables analysts to rapidly explore a variety of wargame starting conditions with different investments in future ISR capabilities, adjudicate the effects of in-game operational decisions on intelligence collection, and display the results to wargame participants. This talk will address the model’s methodology, interface, and role in the wargame, as well as the potential for enhancements to the model’s fidelity and application to other games and geographic regions.

Location: TH357 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG13 Power Projection and Strike Warfare

66108 - All Domain Analysis and Modeling

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: James Wyllie		

Abstract: ADAM (All Domain Analysis and Modeling) is an AFSIM-based project intended to flexibly model a wide range of scenarios with varying scales, fidelities, platform types, and command structures. ADAM modeling focuses on the use of perception for both friendly and hostile entities as well as explicit communication between players to study high-level command and control and information flow. Air, land, space, subsurface, and subsurface domains are all modeled within ADAM. The underling architectural approach has simplified the reuse and integration of models from other efforts and has allowed for easier growth and expansion of model capability. Future work is planned to explore longer multi-day scenarios and associated logistical considerations.

To date, ADAM has supported large scale, two-sided, mission level analyses with 1,000s of platforms. All domains are modeled within ADAM and dynamically coordinate threat perception, target engagements, and respond to attrition. The analyst using ADAM has the ability to vary target platform priority, weapon inventories and configurations, platform laydown and quantities, as well as platform tactics. The analysis provided by ADAM has supported a variety of customers and has provided analytical insights into weapons, platforms, and battle management questions.

Location: TH357 Classified
Classification: SECRET NOFORN
Working Group: WG13 Power Projection and Strike Warfare

68505 - Defense Planning Scenario (DPS) Mobility Timing and Force Generation Comparisons

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Katherine Wilson		

Abstract: With the Department of Defense’s release of new Defense Planning Guidance (DPG) in December 2022, there was a significant adjustment to the mobility force generation and indications &

warnings, when compared to the previous 2018 Defense Planning Guidance. The resulting cargo and passenger delivery changes impact the force flow timing and ultimately the campaign's measure of success.
While full campaign scenario development updates are still in work, to better understand the force flow tradeoffs immediately, the Future Projection Analysis Division of the Secretariat, United States Air Force, Studies and Analysis (SAF/SAWP), adjusted only the Time Phased Force Deployment Data (TPFDD) and Force Generation mobility assets for the 2018-based DPS Joint Forces Operating Scenario 2.1 (JFOS) to match the new 2022 DPG. The study results highlighted mobility challenges impacting future joint warfare.

Location: TH357 Classified
Classification: SECRET NOFORN
Working Group: WG13 Power Projection and Strike Warfare

65673 - M&S Powered Wargames for Concepts of Employment Experimentation

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Chris R. Linhardt; Emily Power; Emily Power; Ryan Samuelsen		
Abstract: How a new technology, concept, or system is employed is often as important, or even more important, than the performance or capabilities represented by those new developments. Recognizing this, the High Speed Strike Weapon 2 (HSSW 2) program hosted a M&S Powered Wargame Capstone event in October 2022 at Air Force Research Laboratory (AFRL). This wargame was held to develop Concepts of Employment (CONEMP) for government reference high-speed missile concepts as well as identify analysis questions of interest. The results of the wargame will be used to inform constructive simulation analysis over the coming year. In preparation for the event the HSSW 2 team developed modeling, simulation, and analysis tools to create a simulation environment to meet the objectives for the Capstone event. This presentation will describe those newly developed capabilities, the rationale for those capabilities, and results generated from the wargame. Some of the major new capabilities developed to support this M&S powered wargame included enhancements to the Mission Planning Wizard, automated route generation, a two-sided wargame workflow, automated scenario merge, near-real-time analytics, and mission rehearsal runs. Location: TH357 Classified Classification: SECRET NOFORN Working Group: WG13 Power Projection and Strike Warfare		

WG14 Air Warfare

66139 - Airborne Defense in AFSIM, including Zoned Battle Management

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Stephen Paul Jones		
Abstract: Defending high value assets with an airborne patrol is an important mission; and determining a way to assess various aircraft types, weapon combinations, geographic placements, and orientations to defend those assets from multiple threat types and attack vectors is a difficult challenge. Through the use of flexible zones, custom scripting, and basic constraints; a robust test bed using AFSIM was developed for reviewing effectiveness of each of the airborne patrol selection against different threats. This brief will showcase basic implementation practices, the use of zones to simulate real-world battle management, pitfalls and tradeoffs, and finally suggested updates.		

Location: TH356 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG14 Air Warfare

65202 - Results of Airborne Weapons Layer Analytic Exploration

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Jeffrey Alton Dubois; Dean Baker; Ethan King; Christina Rulon; Ms. Lee Ann Rutledge

Abstract: The assessment of defensive layers utilizing both current and future system-of-systems technologies to defend Air Bases has been a topic of interest for several years. A key component of this assessment is the representation of the Airborne Weapons Layer (AWL). The composition of the air layer as well as the placement relative to the incoming threats and air base being defended will have a substantial impact on the effectiveness. The Advanced Framework for Simulation, Integration and Modeling (AFSIM) was used to model the AWL and statistical analysis was executed to determine promising AWL positions and composition. This presentation is a follow-up to the 90th Symposium's presentation that discussed the technical approach used to assess the AWL. This year's presentation will present a subset of the results, the benefit and some lessons learned related to the analytic approach.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG14 Air Warfare

65672 - M&S Powered Wargames for Concepts of Employment Experimentation

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Chris R. Linhardt; Emily Power; Ryan Samuelsen

Abstract: How a new technology, concept, or system is employed is often as important, or even more important, than the performance or capabilities represented by those new developments. Recognizing this, the High Speed Strike Weapon 2 (HSSW 2) program hosted a M&S Powered Wargame Capstone event in October 2022 at Air Force Research Laboratory (AFRL). This wargame was held to develop Concepts of Employment (CONEMP) for government reference high-speed missile concepts as well as identify analysis questions of interest. The results of the wargame will be used to inform constructive simulation analysis over the coming year. In preparation for the event the HSSW 2 team developed modeling, simulation, and analysis tools to create a simulation environment to meet the objectives for the Capstone event. This presentation will describe those newly developed capabilities, the rationale for those capabilities, and results generated from the wargame. Some of the major new capabilities developed to support this M&S powered wargame included enhancements to the Mission Planning Wizard, automated route generation, a two-sided wargame workflow, automated scenario merge, near-real-time analytics, and mission rehearsal runs.

Location: TH356 Classified
Classification: SECRET NOFORN
Working Group: WG14 Air Warfare

66228 - Boyd: Air Force Doctrine and Fighter Tactics

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Michael W. Garrambone, FS; Mr. Hunter Adam Marks		
Abstract: The statement, “Colonel John “Forty-Second: Boyd maybe the most important officer the Air Force ever produced” is foreign to most modern Airmen. This is because like most Service Mavericks, whose abrasive attitude is not well taken, their ideas have been suppressed from careerist and conformist leadership. This presentation talks about his analytic findings, his generation of modern tactics, his concept of fighter aircraft design, and his unrelentless drive to support winning in combat. Location: TH339 Classification: UNCLASSIFIED Working Group: WG14 Air Warfare		

65968 - Investigating Air Base Resiliency

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 10:00 AM
Authors: MAJ Olin H. Kennedy; Elisha Palm; Dr. Mark A. Gallagher, FS; LtCol Tim Holzmann		
Abstract: Adversaries of the United States have prepared to attack the infrastructure of the air power. …. Our Monte Carlo model confirms the insights of previous research that there is little that can be done if the enemy decides to conduct an overwhelming missile attack. However, interesting insights are available if the missiles are considered scarce and the quantity of missiles used to attack aircraft on an airbase is roughly equal to the enemy’s assessment of the number of aircraft present. Desired outcomes such as getting the enemy to waste the maximum number of missiles (i.e., missiles that don’t hit targets) and maximizing the amount of aircraft available for retaliation sorties afterwards are able to affected by either inducing the enemy to overestimate the number of aircraft at the airbase, or underestimate the number of aircraft at an airbase, respectively. Additionally, we find that the cost of decoy aircraft dominates the solution space given that they are an order of magnitude cheaper than hardened shelters or even non-protective sunshade-type shelters. Recommendations based upon the findings of this study conclude that the Air Force should heavily consider the procurement of high-quality decoy aircraft and develop a concept of deceptive operations with the decoy aircraft that nests within the agile combat employment construct. Location: TH339 Classification: UNCLASSIFIED Working Group: WG14 Air Warfare		

65978 - Evaluating Military Strategies with BEAM

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Mark A. Gallagher, FS; Connor Shaw		
Abstract: The Bilateral Enterprise Analysis Model (BEAM) is a military simulation at the operational level of war. We classify BEAM as an enterprise because it is more aggregate than campaign models. The main modeling entities within BEAM are missions, which constitute a collection of offensive assets, encountering defense assets to affect targets. This aggregation enables BEAM to evaluate different military strategies, force mixes, and basing. BEAM represents strategy by campaign phase objectives specifying ends, ways, means, risk, and a priority. In this presentation, we present a systematic approach to search for improved military strategies using BEAM. Our demonstration is notional predominantly air campaign.		

Location: TH339
Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

65661 - Sensor-Capabilities Visualization Techniques Using an AFSIM Sensor Coverage Diagram Tool

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Christopher Huffman; J. Scott Thompson

Abstract: Visualization techniques to capture important aspects of sensor performance are essential to understanding sensor-model capabilities and mission-simulation results interpretation. A Sensor Coverage Diagram tool was developed as a diagnostic testbed to determine the capabilities of a sensor using Vertical Coverage Diagrams (VCDs), Horizontal Coverage Diagrams (HCDs). These outputs provide the user with diagnostic information regarding the elevation and azimuthal limits of the sensor against a particular signature. The plots may also be used to provide information on the effects of beam steering on sensing capability. When VCDs are paired with a threat altitude, speed, and signature information, they may be useful in helping interpret the results of a mission-level simulation. This briefing focuses on visualization techniques for understanding a sensor's capability and diagnosing simulation environment results.

Location: TH339
Classification: UNCLASSIFIED // FOUO
Working Group: WG14 Air Warfare

66249 - End-to-End Kill Chains for Mission Analysis – A Complete Approach to Evaluation for Technology Development

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ryan Samuelsen

Abstract: End-to-End Kill Chains for Mission Analysis – A Complete Approach to Evaluation for Technology Development

Submitted by: AFRL/RQSA
2180 8th St. Bldg. 145, WPAFB 45433
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ABSTRACT: A prioritization on complete end-to-end kill chain analysis directed by the Deputy Secretary of Defense has been the catalyst for redesigning traditional modeling, simulation, and analysis (MS&A) approaches. Often during MS&A for technology assessment there are broad assumptions made in attempts to isolate targeted analysis objectives. Broadly applied assumptions are frequently driven by but not limited to lack of data, insufficient subject matter expertise (SME), and scope limitations imposed by schedule or funding constraints. An incomplete or even insufficient representation of a multi-domain scenario can lead to mission analysis products that are biased and uninformed. Decision authorities of technology investors rely on accurate, well informed, and wholly

represented studies that are derived from classified intelligence sources, and which require an extensive end-to-end representation for all involved domains in a kill chain. The development effort to support end-to-end mission analyses requires an increased scope and objective over traditional approaches. The simulation environment to support the kill chain analysis must be constructed from a multi-domain system of systems perspective where SMEs from partnering services identify and bring forth technology concepts of interest to the specific kill chain. This presentation will describe how the AFRL Corporate Model Analyze (CMA) team of cross-directorate and partner service MS&A analysts, developers, and technical SMEs are developing and executing these digital experiments to support rapid technology assessment. This approach also includes a process for continuous improvement and collaboration designed to enable sustainable, efficient, and iterative analysis efforts that are capable of quickly incorporating emerging red and blue capabilities.

Location: TH357 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG14 Air Warfare

65648 - AFSIM Kill-Chain Research

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: David Collins; Christopher Huffman		
Abstract: ABSTRACT: An end-to-end understanding of the kill-chain and how it performs allows us to make better informed decisions on the constituent building blocks that make it up. To this end a twelve step kill-chain was conceived and implemented in AFSIM to observe the effects of each step in the overall goal and lower-level metrics unique to each step. Through a series of hooks developed in the AFSIM scenario each step of the kill-chain can be modeled at variable levels of fidelity or with entirely different models performing the same function. Each step can be turned on or off to be replaced by a better representation of that step in the kill-chain. These provide the capability for each model, and more importantly its effect on the kill-chain, to be investigated in degrees of isolation or integration with other fleshed out steps. The kill-chain is tested using a simple vignette with variable levels of red intervention available. This briefing focuses on the processes of creating the kill-chain in AFSIM at different levels of fidelity and proving analytic capability all using native AFSIM. Location: TH357 Classified Classification: SECRET NOFORN Working Group: WG14 Air Warfare		

66354 - Fighter and Drone Ratios

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Bradford Lott; Dr. Mark A. Gallagher, FS		
Abstract: This study considers a future where the Air Force is going to have some expensive, possibly manned systems, deployed with a squad of low-cost drones. We examine the question: How should the Air Force determine the balance between the limited high-cost control system and the low-cost drones? Previously, during the 2022 MORS symposium, we provided an example of how to decompose this and other complex issues into analytic tasks. Extending this study, we implement a set based design modeling three sets of autonomous drones. In addition to examining cost to capability tradeoffs, we provide recommended force mixture ratios for fighters and drones as a function of fighter survivability. The recommended ratios are those that are expected to best mitigate		

fighter losses assuming a fixed budget such that the drones must be purchased from the existing fighter budget. A closed form solution is provided to calculate these ratios as a function of expected fighter survivability. Additionally, we demonstrate a probability model which may be used to calculate fighter survivability and thus may also be used to calculate the recommended fighter to drone force ratio. This is achieved through a closed form population dynamics model which is adapted to fit this military force mixture use case.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

67964 - The Modeling of Operation Corkscrew in World War II

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Ms. Tara A. Garrambone; Mr. Mark L Axtell; Mr. Jeffrey Alton Dubois; Mr. Michael W. Garrambone, FS

Abstract: Described is the analytical planning and combat results of one of the most famous operations research analysts of World War II, Dr. Solly Zuckerman. Professor Zuckerman, an anatomist, was Winston Churchill's scientific chief going from the study of apes to supporting the planning of warlords. Dr. Zuckerman, assigned by Air Marshal of the Royal Air Force to support General Carl A. (Tooey) Spaatz, was his operations analyst in the Mediterranean Theater. Spaatz, preparing for the invasion of Europe through Sicily had to negotiate the "Italian Gibraltar," Pantelleria, a small island fortress between Africa and Sicily. Pantelleria was well defended with units of Italian and German forces. The island was a regional airbase for attack aircraft and a submarine base to control the air and water routes between North Africa and Europe. Zuckerman's task was to eliminate Pantelleria's defenses, preparing it for naval invasion. The operational planning and results of this most successful air operation are the subject of this discussion. We describe "Solly's" use of operations research, his control and analysis of combat data, and the results of his planned sorties. Described is the modeling of "Operation Corkscrew" using the SEAS (System Effectiveness Analysis Simulation) computer model based on the historical reports and archived aerial photos.

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

67982 - Polar Operations: Table Top Exercise

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:30 AM

Authors: Ms. Tara A. Garrambone; Mr. Michael W. Garrambone, FS; Mr. Chris R. Linhardt

Abstract: Backed by popular demand, we will look at the highly dangerous and time sensitive mission of Search and Rescue (SAR) in the harsh climates of the Polar Arctic. We created a scenario of downed pilots in polar night with characteristic weather, complete with vast distances, solar storms, frozen terrain, and the threat of bears and arctic wolves. The mission was of international importance pulling limited resources from diverse rescue centers with unique and varied assets, jurisdictions, and operating procedures. Six novel system concepts were provided to the blue and maple planning cells who had minutes to plan and move air, land, and maritime teams into harm's

way. The hotwash discussions and material assessments are both interesting and priceless—get the bigger picture, but don't let the bears get you!

Location: TH330
Classification: UNCLASSIFIED
Working Group: WG14 Air Warfare

WG15 Health Service Support, Force Health Protection, and Casualty Estimation

68155 - RealOpt-Contingency – A Computational Platform for All Hazard and Disaster Response

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Dr. Eva K. Lee

Abstract: Catastrophic calamities such as an earthquake, nuclear or pandemic disasters, or deliberate terrorist attacks could cause tens or hundreds of thousands of casualties, destroy the physical and social livelihoods of the displaced, paralyze the economy, and trigger cascading effects across critical infrastructures and national security. Rapid decisive actions and mobilization of limited resources must be carried out for mass casualty mitigation and population protection.

This work aims to advance applied scientific knowledge, and in-service training in national and public health emergency response and logistic operations by developing a computational platform, RealOpt-Contingency, that enables logistics analysis, inventory management, and computational modeling technologies to support all hazard and disaster response during a contingency. RealOpt-Contingency enables users to 1) establish camps and medical facilities for the affected population; 2) design facility layouts for optimal usage and safety; 3) optimize the distribution of relief supplies; 4) determine rations, water, fuel, and other supplies required per camp and medical facilities; 5) calculate transportation labor and resource requirements, and determine/optimize routes; 6) develop distribution plans from the incident LSA to LSA hubs and to camps and medical facilities; 7) design decontamination and dispensing sites; 8) perform epidemiological disease/contamination plume modeling; and 9) track movement of displaced personnel for rapid on-the-ground reconfiguration.

The front-end graphical interface allows users to outline the affected region, design the layout of facilities, input inventory level, demand requests, estimated population size, etc. The backend translates this information automatically into appropriate mathematical formulations and simulation parameters.

RealOpt-Contingency includes powerful computational-optimization engines including multiple resource allocation, transportation and routing algorithms, simulation and ODE disease spread modeling, facility layout design heuristics, inventory control stochastic processes, and machine learning and prediction of influence networks. The modular design allows continued technological advances and adaptation using on-the-ground knowledge.

RealOpt-Contingency facilitates experimentation, operations analysis, and decision support for preparedness, planning, and response, enabling decision/policymakers to understand tradeoffs, competing goals, and interdependencies during disaster emergency response.

We will discuss the actual usage of RealOpt-Contingency for a) COVID-19 mass diagnostic tests, mass vaccination, and clinical redesign; b) radiological emergency response for sheltering, resupply,

decontamination, and population health registry; and c) earthquake emergency response, rescue and treatment.

This work was carried out in collaboration with the NGB and was partially supported by the CDC and the DHS.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65888 - Surveillance of Multidrug-Resistant Organisms in Military Treatment Facilities using Whole Genome Sequencing

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Melissa Martin

Abstract: Active surveillance is critical for detecting and preventing the transmission of multidrug-resistant organisms (MDRO) in health care facilities and for supporting Force Health Protection. The Multidrug-Resistant Organism Repository and Surveillance Network (MRSN) is the primary surveillance organization for the DoD and collects MDROs from an extensive network of military treatment facilities (MTFs) across the Military Health System (MHS). Traditionally, investigations by the MRSN were requested by infectious disease physicians or infection control staff upon the suspicion of nosocomial transmission. Recently the MRSN developed an approach for the routine detection, in near real-time, of possible MDRO outbreaks. This new service, originally deployed to five MTFs (Brooke Army Medical Center, Naval Medical Center San Diego, Tripler Army Medical Center, William Beaumont Medical Center, Camp Lejeune) no longer depends on human pattern detection but employs systematic genomic comparison and data analysis of newly received MDROs to a repository of >100,000 isolates. Upon detection of highly genetically related isolates, epidemiological analyses are initiated and the MTF is immediately alerted.
During 2019-2020, for a single MTF and tracking only infections due to MDROs A. baumannii, K. pneumoniae, and P. aeruginosa, this effort resulted in the detection of 28 clusters of potential transmission involving 74 patients. Among the successful outcomes, a multi-ward outbreak involving six patients caused by a carbapenem-resistant A. baumannii was detected early, tracked, and successfully eradicated. After a successful pilot roll out, the MRSN has now expanded this real time genomic surveillance effort to 15 MTFs and 2 VA hospitals, and additional species, making the MHS the largest health system in the world benefiting from an extensive MDRO collection and routine, genome-based surveillance of bacterial outbreaks resulting in rapid notification to physicians and infection prevention teams that an outbreak may be occurring among their patients.
The MRSN is a named organization within the President's National Action Plan (NAP) for Combatting Antimicrobial Resistant Bacteria (CARB) 2020-2025 and serves as a centerpiece organization enabling the DoD to meet its responsibilities as outlined in the DOD-I 6025.26, DHA-PI 6025.09. The MRSN's high throughput labs and cutting-edge use of whole genome sequencing and rapid bioinformatics pipeline analysis ensures the most comprehensive and accurate global tracking of "superbugs" across all Geographic Combatant Commands. The advancement of real-time surveillance technology and dedicated staff that make up the MRSN guarantee that the DoD leads the way combatting MDRO infections and improving patient care now and in future.

Location: TH340

Classification: UNCLASSIFIED Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65418 - Best Practices for Evaluating the Readiness of Technology Could Benefit DHS Efforts to Pursue Innovative Approach to Biodetection

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Paul Bauer		
Abstract: Working Group(s): WG 15 Health Service Support, Force Health Protection, and Casualty Estimation. Working Group Chair: Ranny Maurer, Teledyne Brown Engineering Abstract Title: Best Practices for Evaluating the Readiness of Technology Could Benefit DHS Efforts to Pursue Innovative Approach to Biodetection Abstract Text: In response to the 2001 anthrax attack, the Department of Homeland Security (DHS) started the BioWatch program—designed to provide early indication of an aerosolized biological weapon attack to prevent casualties on a mass scale. The Countering Weapons of Mass Destruction (CWMD) was established within DHS to protect against the dangers posed by hostile state and non-state actors who seek to acquire and use nuclear, chemical, radiological or biological materials in the form of weapons of mass destruction to harm Americans or U.S. interests. Since BioWatch's inception, DHS has pursued enhancements and replacements but without much success. Having a robust biodetection capability is a critical component of the National Biodefense Strategy. However, essential technologies needed to provide early detection have inherent limitations. DHS has proposed the use of a new and novel capability through artificial intelligence / machine learning technology that, if successfully developed, could be an improvement over the existing system. The Government Accountability Office (GAO) evaluated BD-21 technology readiness approach and made several recommendations to improve technology readiness assessments across the agency and for the BD-21 acquisition. GAO is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. To this end, GAO has developed a Technology Readiness Assessment Guide (GAO-20-48G) to provide a better understanding of technology maturity and a framework for conducting high-quality TRAs. GAO's TRA guide establishes a methodology for evaluating critical technologies, such as those being proposed by DHS, based on best practices that can be used across the federal government to determine a project's readiness to move past key decision points that typically coincide with major commitments of resources. Presentation Classification: Unclassified for Public Distribution Presentation Distribution Statement: For Public Distribution Additional Authors names and email addresses: John Ortiz ortizj@gao.gov Paul Bauer bauerp@gao.gov Location: TH340 Classification: UNCLASSIFIED Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation		

65781 - Re-Evaluation of Percutaneous Liquid Toxicity Estimates for G-Agents and VX

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Douglas R. Sommerville		

Abstract: Current G-agents & VX percutaneous (PC) liquid mild effect estimates were reviewed in support of establishing decontamination standards for personel hand-held equipment. Such estimates are also used in other applications: casualty & contact hazard assessment and various system evaluations (personal protective equipment & detection). Two important findings came out of this review. First, mild effect estimates have never been developed for the G-agents and only recently proposed for VX. Second, existing severe effects & lethality estimates have differing implied assumptions between the G-agents & VX: dermal conditions--room temperature/dry (G-agents) and not stated (VX); and dermal location-- forearm (G-agents) & cheek (VX). The current estimates understate the PC liquid potency of the G-agents relative to VX due to the differing standards.
New PC liquid mild effects estimates were developed for the G-agents as a function of the two main factors—dermal conditions (normal-dry versus hot-sweaty) & location (cheek—most sensitive versus forearm—near median). Human G-agent PC liquid data exists for normal/dry/forearm exposures only. However, human sub-lethal VX PC liquid data exists for a variety of dermal conditions & locations. Previous ordinal regression analysis (with probit link function) of the VX dataset has established probit slopes & the ratios of effective median doses (ED50) between the various factor levels, and it was assumed that the slopes & ratios for the G-agents would be approximately the same as VX. The % inhibition of blood acetylcholinesterase (AChE) levels was used as a proxy mild effect—with ED50 & probit slope estimates being provided for both 20 & 50% AChE inhibition (as was previously done with VX). Other reseachers have demonstrated (based on human nerve agent data) that humans having AChE inhibition below 50% have a low probability (<1%) of developing severe clinical effects.
New proposed toxicity values were also calculated for G-agent PC liquid severe effects & lethality to reflect the known impact of dermal conditions & location on toxicity—expanding on the current values which implicitly assume normal/dry dermal conditions & forearm exposures. Severe effects & lethality estimates for VX were also calculated for conditions beyond the currently implied assumptions of hot/sweaty dermal conditions & cheek exposures. The new estimates (mild to lethal) make more sense overall, with common comparison basis established for differing dermal conditions & location.
An unexpected finding from this exercise is that G-agents have a greater PC liquid toxicity than previously appreciated—relative to VX and when previously neglected adjustments for dermal conditions & location are considered. Past hazard risk assessments for G-agent PC liquid exposure scenarios should be re-examined—particularly for GD & GF.

Location: TH340
Classification: UNCLASSIFIED // FOUO
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65783 - Medical Planners' Toolkit Demonstration

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mrs. Alexandra Nicole Weaver; Tracy Negus		

Abstract: Effective military medical planning relies on four interrelated capabilities: (1) generating daily casualty estimates for a scenario, (2) estimating the distribution of specific illnesses and injuries that comprise a casualty population, (3) estimating the medical resources necessary to support the theater hospitalization requirements of an operation, and (4) estimating required Class VIII medical supplies to treat the patient stream. The Medical Planners' Toolkit (MPTk) is an accredited Department of Defense medical planning and programming tool developed by the Naval Health

Research Center that enables medical planners to perform each of these functions in an integrated environment.
The presentation will feature a live demonstration of the MPTk software to showcase its capabilities in support of military medical planning and analysis. It will highlight a typical workflow, perform each of the above functions for a single notional operation, and generate outputs compatible with other planning and analysis tools. Current software limitations and planned future enhancements will also be discussed.

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Location: TH340
Classification: UNCLASSIFIED // FOUO
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65818 - Joint Medical Planning Tool Demonstration

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Christopher Guida		

Abstract: The Joint Medical Planning Tool (JMPT) was accredited for Department of Defense (DoD) medical planning, operational risk assessments, and theater medical course of action assessments by the Force Health Protection Integration Council in 2012. Since that initial accreditation, JMPT has been the primary modeling and simulation tool supporting medical planning in a variety of DoD settings. The model is operational at Combatant Commands to facilitate the development of medical requirements. JMPT output has augmented wargaming efforts conducted by the Marine Corps Warfighting Laboratory and the Navy Warfare Development Command, and it regularly supports ongoing studies and analyses for various DoD organizations.
This presentation will feature a live model demonstration to facilitate awareness among the medical analysis community and solicit feedback from other analysts. The demonstration will briefly cover basic software operations, high-level model features, key assumptions and limitations, and model output. Recently added features and planned future enhancements will also be discussed.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65651 - Medical Resource Capabilities and Logistics (MRCL) Model: Web-Deployed Results Analysis R Shiny Dashboard

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Michael Zachary Smith; Dr. Gregory Reed; Tracy Negus		

Abstract: The Medical Resource Capabilities and Logistics (MRCL) model, which is being developed by the Naval Health Research Center, utilizes a commercial off-the-shelf simulation software, Simio, (Simio LLC, Sewickley, PA) to develop high-resolution representations of deployable military medical treatment facilities. This effort's objective is to provide a model of sufficient resolution to assess how staffing, facility capacity, and medical allowance lists affect patient care events.

Simio is a powerful, discrete event simulation tool, but understanding and visualizing the output with Simio can be challenging. The MRCL Analytic Capability Tool (MRCL ACT) simplifies model scenario analysis using a standardized export file that includes key model output parameters to produce a dashboard with custom visualizations that simplify the analysis and decision-making process.

MRCL ACT is built in R, a free, open-source tool for data analysis, machine learning, and visualization. The app was built to rapidly analyze specific model parameter sensitivities and allow analysts to further optimize the number of beds, workers, equipment, supplies, and worker task capabilities. The presentation will review model development, discuss application utility, and include a brief demonstration of the application.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65444 - The Medical Resource Capability and Logistics (MRCL) Model: A High-Resolution Model of Patient Care with Role-of-Care Flexibility

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Ranny Maurer; Tracy Negus; Dr. Gregory Reed; David Beckley; Robert Hunt		

Abstract: The Medical Resource Capabilities and Logistics (MRCL) Model is a high-resolution representation of a military medical treatment facility (MTF) built in a commercial off-the-shelf simulation package by the Naval Health Research Center (NHRC). MRCL is designed to provide an accurate representation of an MTF capability and lend insight into how staffing, facility capacity, and authorized medical allowance lists (AMALs) impact patient care timelines and events.
MRCL is a data-driven model that accepts a custom patient stream from the Joint Medical Planning Tool (JMPT) and follows each patient from arrival to departure while cataloging the role-of-care-specific tasks performed; providers, equipment, supplies employed, and care decisions made throughout the simulation. MRCL integrates blood modeling and lab work capabilities with the patient care profiles for a wide angle look at the needs of the patients at the MTF.
This presentation will examine the newest MRCL features, including the ability to model different roles of care and user-defined evacuation capabilities, as well as provide a demonstration of the MRCL model.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66762 - Improving Training Risk Assessment for Heat Related Injuries

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Gregory S. Parnell, FS; Dr. Randy Buchanan; Dr. Edward A. Pohl; Dr. Eric Specking		

Abstract: Heat related injuries are a problem for the United States military. The Pentagon reported a 50% increase in heat exhaustion cases and a 68% increase in permanent damage or death caused by serious heat strokes. Hyperthermia (i.e. abnormally high body temperature) leads to heat injuries due to extreme environmental temperatures, high humidity, medications, or excessive physical work or exercise. Fort Benning has the most heat related injuries in the military since it is home to one of the largest U. S. Army training posts with most training involving intensive outdoor activity in high heat and humidity. Currently, they assess risk using a WetBulb Globe Temperature (WBGT) Index, which measures the heat stress in direct sunlight. This presentation will 1) provide insights on how temperature impacts soldiers and current risk assessment methods, 2) describe our approach, which uses a data-driven weather-informed process, and 3) discuss future work of the project, which includes migrating our tool to the U.S. Army's Virtual Testbed for Installation Mission Effectiveness (VTIME) cloud environment.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66508 - Analysis and Approach for Gathering End-User and Commercially Available Information to Inform Medical Technology Gaps and Capabilities

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Casey Hanley; Jan Rizzuto

Abstract: The Johns Hopkins University Applied Physics Laboratory, on behalf of U.S. Army Medical Materiel Development Activity (USAMMDA), Warfighter Expeditionary Medicine and Treatment Project Management Office, applied analytical and systems engineering approaches to gather data on Joint Service capabilities for selected medical technologies to support casualty care. The overarching intent of this work is to identify joint capabilities that meet the Services' documented capability gap. There were two complementary approaches used to gather data: tabletop exercises (TTX) and market research analysis (MRA).

Each TTX was designed to bring together subject matter experts (SMEs) and stakeholders to discuss the current and future concept of operations in the respective domain. A key objective in identifying TTX participants was to have representation spanning the Services, as well as the different functional areas of expertise. To prepare for the TTX, the team collaborated closely with SMEs to develop a set of representative clinical scenarios to provide a framework for the exercise. During the exercise, moderators described the clinical scenario and used a series of questions to guide the discussion among participants. An online chat capability supplemented the real-time discussion, and online surveys quantitatively captured user preferences and feedback. After the TTX, the team analyzed the gathered data to identify and document recurring themes and specific needs.

In contrast to the TTX focus on identifying the desired capabilities based on user inputs, the MRA focused on identifying the current capabilities of commercially available (or near-available) products. Identification of products, and data regarding their capabilities, was gathered through a scoping literature search followed by investigation to identify publicly available documentation, outreach to manufacturers to seek information not available through the online search, and review of specific data sources of relevance (FDA, DTIC, SBIR). For each product, data was gathered on an extensive set of parameters to facilitate grouping of like products. Investigators used analysis techniques to

interpret the collected data and gain insight into the products that could potentially meet the user needs.
The TTX and MRA complement each other by gathering data on capability needs from the perspective of the end user and the current state of available and near-available technologies.

This material is based upon work supported by the U.S. Army Medical Materiel Development Activity (USAMMDA), a subordinate command of the U.S. Army Medical Research and Development Command, through a contract with the Naval Sea Systems Command, funded through the Defense Health Agency.

The views, opinions and/or findings contained in this paper are those of the authors and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66244 - Communications Requirements and Metrics for Telemedicine

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Arnab Das; Paul Fritschen

Abstract: Telemedicine is emerging and evolving as a key capability in the commercial and civilian world given the COVID-19 pandemic. It is anticipated to continue functioning as a medical care option for patients beyond the pandemic, where it will need to evolve in its capabilities to deliver care, remotely monitor patients for chronic care management, and augment patient care through interactive video calls for hospitalized patients or those in an outpatient clinic. Accessibility and feasibility of specific telemedicine services is heavily dependent on the underlying communication networks available to a person/household.
In a tactical battlefield environment, communications capabilities are often limited and constrained. The ability for tactical communications networks to support telemedicine services may be questionable and requires further examination. A major area in which there is interest in incorporating telemedicine services in the battlefield is as an enabler of prolonged field care. The "golden hour" concept refers to the idea that in emergency medicine scenarios, some patients' lives can be saved if the properly trained personnel with the right medical equipment are able to provide care. In the battlefield environment of the early 21st century, the military was able to achieve many gains in providing golden hour care. However, in the future battlefield, golden hour care cannot be assumed. This requires a new approach involving prolonged field care (including telemedicine capabilities), where medical care may need to be administered to military personnel deployed in remote, austere, or contested environments where rapid evacuation is not possible.
Communications and network resource planning in the military does not provide dedicated resources for medical use. Moreover, military missions typically already require more communications resources than are available, making it more difficult to receive resources that may be planned for medical missions. Therefore, network traffic for medical purposes such as telemedicine requires strategic use of limited network resources.
Tailored provisioning of network resources to meet traffic type needs is referred to as Quality of Service (QoS). Although QoS mechanisms have been available for decades, telemedicine services at the level they are currently provided is a relatively new phenomenon. Since telemedicine end-users

are care specialists providing medical services to patients, user experience and outcomes are of critical importance. This research connects the military health domain and the communications domain by exploring communications requirements and metrics for telemedicine services in battlefield scenarios. The focus is on developing a systematic process by which a military health scenario can be mapped to communications technologies, requirements, and metrics and then studied. Lastly, tradeoffs between medical communications and mission operations communications are explored.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66085 - Modeling Casualty Morbidity in Prolonged Care Scenarios with Data and M&S Integration

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: CDR Kevin Patrick McMullen; Andrew Olson; Jamie Yannayon; Thomas Metzger; Eric Cawi

Abstract: Casualty morbidity (CM) modeling and simulation (M&S) is designed to estimate how in-theater casualties progress to outcomes of return to duty (RTD), survival with complications, and mortality. This capability enables analysis of various scenarios to understand the likelihood that casualties will survive and RTD based on medical resource investment in the battlespace. Military medicine has a critical need to more accurately understand how limited patient movement in anticipated combat casualty care environments affects patient outcomes. By incorporating the effects of morbidity over time, greater insight will be gained on casualty survival and in-theater RTD outcomes in simulated scenarios leveraged by military medical and combat planners, especially involving prolonged care.

A key innovation in the enhanced CM model prototype is use of data about real prolonged-care-type patients captured in the Department of Defense Trauma Registry (DoDTR) to define a continuous "morbidity curve" relationship between injury severity score (ISS) and mortality risk as patient status changes over time. This enhancement improves the CM model's scalability, applicability, and data-driven approach as compared to the initial prototype, which relied heavily on qualitative SME inputs. In this dynamic data-driven model, simulated treatment delays increase the ISS value and mortality risk along the defined morbidity curve, while simulated medical treatments decrease along that curve. Using the same quantitative data inputs from DoDTR, the CM model is enhanced to simulate morbidity of polytrauma patients who require multiple treatment types. While the DoDTR data has limitations relative to quality and representativeness of far-forward care, the enhancements to the CM model demonstrate the value of leveraging quantitative data.

The CM model can function as a "standalone" model and has been demonstrated as a federate in an integrated M&S system of multiple models with synchronized run-time. This new application of the CM model demonstrated how morbidity analysis can provide valuable data to inform trade-off analysis for medical resource investment in the battlespace compared to alternative resourcing options. In the future, the CM model could be integrated with authoritative tools such as the Joint Medical Planning Tool (JMPT) as an internal logic module or as a federate in a centralized, integrated M&S system with defined data exchange between key M&S tools and data sources. For example, integrating the CM model with medical logistics and campaign models allows for the CM model to receive a casualty stream characterized by injury types and severities from a simulated combat scenario. It can then match needed treatments with preplanned medical logistics and resource constraints to simulate the time progression of health degradation with scenario-driven treatment delays and medical resources, which can inform planning and force development analysis.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66188 - Modeling the Navy's En Route Care System

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr. Michael Obringer

Abstract: The projected battlefield looks far different than past conflicts - war without air superiority, degraded communications, and vast distances between forces, each impacting care provision from the point of injury to definitive care. The En Route Care System (ERCS) provides an operational medicine capability to maximize combat lethality and survivability of expeditionary Naval forces during transport. Specifically, this force multiplier enables uninterrupted continuation of patient care in preparation for and during patient movement and prolonged periods of time in remote, austere, and contested maritime and littoral environments. This is to be accomplished with a two-person team and the necessary portable medical equipment to provide life support capability. In preparation for the use of the system in this environment, PMS-408 Expeditionary Medicine (ExMed) and the Johns Hopkins University Applied Physics Laboratory have developed an integrated framework using model-based systems engineering (MBSE) approaches. This analytical framework provides ExMed a rapid decision-making tool for system management based on alignment of ERCS staff, equipment, and the policies which govern the use of the medical capability with external requirements, such as the casualty needs and transport platform interfaces. The team developed this framework using Systems Modeling Language (SysML) in Cameo Enterprise Architect, linking together the main pillars of the system which include Needs, Context, Functions, Constraints, and System Requirements across multiple stakeholder groups. Initial analysis efforts focused on integrating ERCS staff and their casualty care operations into the MBSE system of interest, integrating staff activities and data needs per activity with equipment selections, and establishing traceability between staff and equipment requirements. Continuing analytical efforts include optimization of the ERCS components based on factors such as volume, weight, and power that may constrain use in an operational environment. There are several benefits to this modeling & analysis effort that include, but are not limited to: 1) verification of the system design; 2) improving standardization and traceability across all system elements; 3) enabling trade-space decision-making; 4) supporting requirements definition and gap analysis; and 5) accommodating operational change with time. Additionally, this model-based approach aims to digitally transform development and sustainment activities associated with the acquisition of expeditionary medical capabilities. The ERCS framework can be applied to other ExMed systems and integrated across the PMS-408 family, enabling the repeatable optimization of enterprise operations. The ERCS model is a critical enabler, providing an authoritative source of truth, incorporating operational and technological innovation, and establishing an infrastructure and environment to collaborate across the many stakeholders involved.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

65495 - Unit Fill Optimizer (UFO): An Optimization Tool for Manpower and Capability Alignment

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Coleman Strickland; Andrew Phillips

Abstract: Introduction

Navy Medicine's (NAVMED) ability to assess personnel readiness, identify future manpower risks, and construct mission capable units for emerging requirements are dependent on models that analyze the full scope of available personnel and efficiently align the personnel across the force structure. While some solutions can be calculated by hand, a computational approach provides an objective, repeatable, and expedited process to solving these problems simultaneously. The Unit Fill Optimizer (UFO) is introduced as a decision support tool to address these concerns by assigning personnel to jobs in an optimal and timely manner. Feedback from the UFO tool provides NAVMED leadership the answers they need to identify and address unit capability gaps, forecast manpower deficiencies, and understand readiness concerns across the enterprise.

Materials and Methods

The implementation of a linear optimization model serves as the foundation of the UFO tool and seeks to identify optimal force alignment to satisfy user-defined needs. Input data for the model contains personnel readiness, training, and education metrics in addition to billet requirement information for each NAVMED platform considered. In addition, the tool has the capability to incorporate not only Program of Record (POR) platforms, or legacy platforms, but also user-defined platforms based on emerging requirements, which ensures tool implementation across a variety of billet requirements to meet mission demands. A graphical user interface (GUI) is integrated as a user-friendly interaction tool for defining inputs and outputs to tailor each unique run of the model. The tool output features the quantity of billets the model was able to fill based on the matching criteria, and what billets are empty due to lack of suitable personnel.

Results

The results of the UFO model provide decision makers the ability to not only optimize force alignment but also project future personnel gaps throughout the organization. The model's outputs can be used to restructure training plans, simulate manpower readiness across time horizons, and enhance recruiting efforts to ensure the future force maintains a ready posture to address any conflict.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

66180 - Assessing Service Member Deployability using Machine Learning Algorithms

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. John de Geus

Abstract: Title: Assessing Service Member Deployability using Machine Learning Algorithms

Navy Medicine is responsible for maintaining medical deployability of Sailors and Marines to support medical readiness and lethality of operational forces. To that aim, Navy Bureau of Medicine and Surgery (BUMED) launched the Health Readiness Common Unfitting Evaluation System (HERCULES) project to ensure Service members (SM) with potentially deployment limiting medical conditions (DLMCs) receive prompt diagnosis and medical management to return them to a deployable status as soon as possible. Many SMs with DLMCs are assigned to temporary profile, or limited duty (LIMDU) for Sailors and Marines, to avoid compromising their unit's effectiveness. Today, LIMDU assignment depends on Department of the Navy (DON) SMs being seen within the Military Health System (MHS) by providers proficient in the most up-to-date DoD and Service-specific standards for retention and

deployability. Consequently, potential DLMCs are not identified at a point of care encounter early in the disease process due to a lack of available clinical decision-support (CDS) to identify when SMs fail to meet these standards. HERCULES aims to proactively identify potentially non-deployable SMs and provide CDS for providers' prompt recognition and management of DLMCs, improving readiness and reducing mission risk.
HERCULES is driven by a suite of machine learning (ML) algorithms that support deployability category recommendations for SMs. These algorithms were trained on five years of encounter data to identify a SM's likelihood to be temporarily non-deployable and requiring temporary profile or LIMDU. Multiple ML models were developed and the best performing model, as based on pre-determined evaluation metrics, was selected for further validation and implementation. The best performing model yielded an area under the receiver operating characteristic (AUROC) curve of 91%. 89% sensitivity and 77% specificity were achieved with a set positive predictive value (PPV) of 20%. The PPV was 38% with a set sensitivity threshold of 50%. In a sample of 236 likely non-deployable cases sent for validation by Medical Evaluation Board Approval Authorities, the reviewers indicated 46% of the cases to be truly non-deployable.
Underlying these algorithms is data aggregation across the Comprehensive Ambulatory/Professional Encounter Record (CAPER), Standard Inpatient Data Record (SIDR), TRICARE Encounter Data Institutional (TED-I) and Non-Institutional (TED-NI), Pharmacy Detail Transaction Service (PDTS), Defense Enrollment Eligibility Reporting System (DEERs), electronic Periodic Health Assessment (ePHA), electronic Deployment Health Assessment (eDHA), and LIMDU module in the Sailor and Marine Readiness Tracker (SMART) system.
These analytics will soon be in MHS Information Platform (MIP) for intended integration in MHS GENESIS in the future. More upcoming pilot studies will ensure MHS-wide applicability.

Location: TH340
Classification: UNCLASSIFIED
Working Group: WG15 Health Service Support, Force Health Protection, and Casualty Estimation

WG16 Strategic Deployment and Distribution

65519 - An Analysis of Alternative Logistics Networks for USTRANSCOM Distribution Channel Flights supporting USINDOPACOM

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Sonia Venegas; Dr Brian Joseph Lunday, Ph.D.; Capt Nicholas T. Boardman

Abstract: The 2022 National Security Strategy stresses the importance of promoting and strengthening relationships and alliances, with a focus on the United States Indo-Pacific Command region (USINDOPACOM). The United States Transportation Command and the Air Mobility Command facilitate the transport of personnel and supplies supporting this area of operations via distribution channels that operate on a fixed schedule. This framework is predominately based on a point-to-point distribution system, where cargo is directly routed from desired origin and destination pairs. The introduction of a hub-and-spoke network may help reduce costs and increase the longevity of aircraft. Focusing on shipments within the USINDOPACOM area of responsibility, this study conducts two related analyses. The first analysis applies network measures to historical data from FY18-FY22 to identify potential hub locations. The second analysis develops and applies a mathematical program to (re)route historical shipments from FY20-FY21 to minimize estimated costs, given a user-determined number of hubs and percentage of shipment volume that must transit a hub. Initial analysis over a range of the user-defined parameters identified selected airports as candidate hubs. The identified minimal cost routing suggested up to a 15% price decrease in costs. Subsequent

analysis explored a higher utilization of plane cargo capacity and identified a 48% cost reduction when compared to pricing in the initial analysis. The utilization of hubs can significantly impact aircraft cargo capacity utilization, and therefore may induce a significant decrease in costs while improving efficiencies in aircraft utilization.

Location: TH343
Classification: UNCLASSIFIED // NOFORN
Working Group: WG16 Strategic Deployment and Distribution

65472 - Game-Theoretic Models for Rapid Operational Airlift Network Design in Contested Environments

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Jefferson Huang		

Abstract: Growing global activity from adversarial forces requires a robust air-routing plan to transport personnel and cargo effectively. In developing these plans, the US Air Force's Air Mobility Command (AMC) must account for the dynamic nature of inter-theater operations in a contested environment. Currently, AMC planners predominantly calculate resource allocations manually, which contributes to slower plan implementation and potentially suboptimal solutions. Starting with a proven AMC model, which provides an optimal use of aircraft, cargo allocation, and airfields, we add model features that help determine how to attack this transportation network, optimally delaying the delivery of cargo to operationally relevant locations. The results identify vulnerabilities and provide AMC planners with a prescription of airfield resource allocation that maximizes the movement of cargo. This model delivers a quantitative assessment of an adversary's (whether weather or competitor) ability to delay the mission that can be used to guide policymakers in providing a robust air mobility capability.

Location: TH343
Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

66147 - Joint Light Tactical Vehicle Optimization Fielding Model

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Alexandria Rae Meade		

Abstract: The Joint Light Tactical Vehicle (JLTV) is the Army & Marine Corps' replacement for many of the long-standing HMMWVs in service. The JLTV program follows an acquisition plan which procures thousands of base vehicles, each to be outfitted with a collection of kits, with each vehicle being specifically kitted and configured to satisfy each unit's Modernized Table of Equipment requirements. The JLTV program utilizes an optimization model to generate vehicle assignments and construct a Master Planning File to determine efficient and effective movement, placement, and transportation of military vehicles while minimizing cost. The model is based upon a matrix that considers vehicle mission capability while also balancing protection, performance, and payload, as well as considering funding and programmatic constraints which allows for maximized deployment and distribution for JLTV fielding.

Disclaimer: This is an unclassified topic but is currently in the process of gaining Sponsor approval for Public Release and Distribution Unlimited.

Location: TH343
Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

65582 - Supply Chain Simulations for Logistics Planning and Real-Time Decision Support

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr. Michael Hugos

Abstract: After the skill and bravery of the troops, logistics is perhaps the next most critical component in the success of any campaign. Based on work over the last three years with the U.S. Air Force, and the U.S. Army, I show how combining the use of a commercial-off-the-shelf (COTS) supply chain modeling and simulating (M&S) application with Agile Combat Employment (ACE) methodology enables effective logistics planning and decision making in a fast-paced, unpredictable environment.

The COTS supply chain M&S application employs a map-based, geospatial user interface (UI). People define logistics entities such as warehouses, vehicles, and transportation routes, and their entity icons appear on a digital map. In the same manner as placing game pieces on a game board, people drag and drop these icons to place them on the map. They zoom in on the digital map and turn on the satellite view to place icons in exact and appropriate Locations.

This UI makes the application easy to use by a wide range of military, government, business, and academic people. By defining and placing icons on a digital map, rigorous mathematical models of supply networks are defined that can then be run in simulations. But people do not need advanced math or engineering skills because the computer handles the math. AI algorithms can be applied to the supply chain data generated by simulations to find optimal facility locations, delivery routes, delivery frequencies and amounts. This enables logistics personnel to quickly model and simulate new supply chain configurations to respond to changing situations and support decision making by the mission commander.

My presentation will show work done by logistics officers in the Advanced Study of Air Mobility (ASAM) program at the Air Force Institute of Technology (AFIT). They modeled, simulated, and analyzed supply chains to support four different strategies defined by their professor for the Russian invasion of Ukraine. This work was published in August 2022 by the Modern War Institute at West Point in an article titled, “Logistics Determine Your Destiny”.

I will also present models and simulations of contested supply chain networks in the INDOPACOM AOR developed for presentation at the Air Force Special Operations Command (AFSOC), and work done with professors at West Point to model and simulate the supply chains that supported Operation Iraqi Freedom (OIF).

Key Words:
Agent-based simulation
Decision-support
Logistics
Mission planning
Wargaming

Location: TH343
Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

65911 - Everything, Everywhere, All On Time? Modernizing USTC's Strategic Distribution Database

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Major Rob Froberg

Abstract: U.S. Transportation Command (USTC) conducts globally integrated mobility operations, leads the broader Joint Deployment and Distribution Enterprise (JDDE), and provides enabling capabilities in order to project and sustain the Joint Force in support of U.S. national objectives.

In accordance with DoDM 4140.01-V10, DoD Supply Chain Material Management Procedures: Supply Chain Inventory Reporting Metrics, USTC is responsible for helping capture, analyze, and share distribution performance metrics for optimizing DoD Global Distribution performance. This includes providing ongoing Logistics Response Time (LRT) and Time Definite Delivery (TDD) performance assessments in the form of quarterly distribution performance reviews (DPRs) and monthly reporting. The major JDDE stakeholders (i.e., COCOMS, Military Departments, DLA, and GSA) then use this information to assess and evaluate performance against weapon system support and supply performance agreements, to include performance-based logistics, and then implement procedures and process improvements based on the metrics.

The primary LRT and TDD metrics data source is the USTC-maintained Strategic Distribution Database (SDDB), which processes, transforms, cleanses, and integrates millions of supply and transportation transactions generated/updated, throughout each month, for measuring the velocity of sustainment materials moving through each of the four major segments (and many of the subsegments) within the DoD Global Distribution System.

The more than 20 year-old legacy version of the SDDB application (originally developed by RAND Corp.) is no longer able to meet evolving major JDDE stakeholder requirements because the most current information available within SDDB is 20-to-50 days old, and represents closed-out requisitions only. This existing information velocity no longer meets operational requirements where decision makers now require weekly (and in some cases daily) distribution performance updates. Therefore, USTC is in the process of developing a major SDDB v2.x upgrade for supporting assessing the health of the network on demand, and greatly improving the accuracy and completeness of performance information. In addition, this major upgrade is being designed to provide new features such as the incorporation of open requisition visibility (ORV) and the implementation of advanced dynamic standards (ADS) where updated TDD standards can dynamically be generated by leveraging AI/ML technologies.

Location: TH343
Classification: UNCLASSIFIED
Working Group: WG16 Strategic Deployment and Distribution

65910 - Efficiency and Effectiveness from ChAOS: The Channel Augmentation, Optimization, & Scheduling (ChAOS) Model

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Major Rob Froberg
Abstract: U.S. Transportation Command (USTC) is responsible for resourcing the global Air Channel Network operated by the Air Force component Air Mobility Command which exists in a constant state of tension amid multiple desired outcomes. These include: the requirement to move cargo and passengers through the network in a timely manner, the need to fly aircraft enough to provide training opportunities for Air Force pilots to qualify as aircraft commanders, but not fly the organic fleet so much that readiness is impacted in the event of a contingency, all while being a good steward of the taxpayer's dollar. The Channel Augmentation, Optimization, & Scheduling (ChAOS) Model distills these competing priorities into a mathematical framework with inputs for required workload, the channel network structure, organic aircraft minimum flying hours, and essential flight schedules for austere locations. The primary outputs from ChAOS are the routes covered by organic aircraft and their associated number of flying hours, routes needing commercially contracted augmentation, the projected efficiency of the route schedule, and an estimate of network costs. With rising transportation costs due to inflation and increased competition for commercial conveyances, it is vital that USTC strive to squeeze as much value out of daily operations while not risking capacity that may be called upon at a moment's notice. Location: TH343 Classification: UNCLASSIFIED Working Group: WG16 Strategic Deployment and Distribution

66189 - Agile Basing & Resource Allocation Tool

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Jessica ML Matthews		
Abstract: The Agile Basing and Resource Allocation (ABRA) tool was designed as a force closure model to support expanded maneuver operations across all DoD services. ABRA aids planners in calculating the logistics demands for desired operational basing changes. The desired outcome is the acceleration of logistics planning to support and inform operational planning. Through ABRA, logisticians, operational planners, and operations analysts have a way to quickly develop courses of action, conduct quantitative assessments on those courses of action, and provide detailed analyses on the logistics and supportability of units moving in theater. This, in turn, enables the warfighter to make data-driven recommendations to leadership in a timely manner, so that decisions can be made consistent with the speed of operations. ABRA itself can be used as both a strategic and tactical tool, assessing plans and providing data-driven courses of action in dynamic, contested environments. Approved for Public Release; Distribution Unlimited 23-0594 Location: TH343 Classification: UNCLASSIFIED Working Group: WG16 Strategic Deployment and Distribution		

WG17 Logistics, Reliability and Maintainability

66015 - Using CNNs to detect munition manufacturing defects.

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: MAJ Thomas Frederick Mussmann		
Abstract: We use Convolutional Neural Networks (CNN) to identify defects in military manufacturing processes. We explore the concepts of transfer learning using the munition images the U.S. Armament center has provided for training with a goal of finding a process that can compare the munitions to MILSPEC requirements categorize defect munitions. We start with background subtraction using a recursive algorithm to identify areas that are not of interest. We then use the cleaned data and parameters transferred from a network built to identify welding defects to train the network to identify defects. Location: TH347 Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

66213 - RAMS in the Kill Chain -

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Robert Stukes; Norman Eng; Chris Stecki		
Abstract: Kill Chains are modelled to understand their potential variability in efficacy based on factors ranging including target vulnerability, the speed of signal processing, temporal constraints, geographical limitations and human factors (decision accuracy, proficiency, etc.). However these models typically assume that the various systems and equipment involved in the process will always be functional (Ready) when required to perform, and DoD data suggests that this is not the case. This presentation outlines how the understanding of Kill Chains can be enhanced by introducing an Ao (Operational Availability) factor into the modelling process, to establish probabilistically how likely it is that each of the various weapon systems and supporting equipment involved in the Kill Chain will function effectively, as and when required. A key outcome from this approach is the ability to prioritize Sustainment (maintenance, spares, consumables) in the context of specific Operational Requirements, and the associated Mission Effective Function List (MEFL) necessary to achieve the Kill Chain. Location: TH347 Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

66072 - DISCO: End-to-end simulation model for networked supply chain operations

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Minerva Song		
Abstract: DISCO: End-to-end simulation model for networked supply chain operations One of the challenges in developing a counter-logistics strategy is the need for understanding a supply chain, its strengths and weaknesses as a system. Developed in support of a wargame, the Disruptive Intervention of Supply Chain Operations (DISCO) is a hybrid model utilizing discrete event simulation model in node and edge network framework that allows us to understand the impacts and consequences of disruptions and mitigations to a logistics system. DISCO is currently used to analyze production and distribution of jet fuel for both military and civilian demands. It can be used to model		

any class of supply. This initial version modeled the movement of crude oil via sea, pipeline or rail, to ports and associated refineries, the transformation from crude oil to jet fuel and other refined products; and then tracked the distribution of jet fuel to operating bases, assessing whether supply could meet OPTEMPO requirements.
The user-friendly interface graphically displays the supply chain network and allows users to implement and observe the impact of disruptions and mitigations on the network to evaluate the resilience of the logistics process. The network is adaptive, meaning that in the event of a disruption, the network will attempt to find an optimized mitigation strategy, which may include adjusting its sources of supply, finding new transport routes, or redirecting resources to high priority areas at the expense of others. This allows for the quick comparison of multiple strategies and can provide detailed insight into an otherwise opaque logistics process. If information on the supply chain is lacking, DISCO can be used to infer the supply relationships based on proximity to the demand, and the available transportation system.
DISCO was built to support a Joint Staff J4 wargame looking at Red Logistics. However, the utility for analyzing Blue logistics is obvious, and new work is being conducted to expand the model's capabilities. As DISCO is designed to be industry-agnostic and is built on an Object-Oriented Programming (OOP) structure that provides the flexibility for modeling various materials and information, it has been used to analytically examine U.S. munitions resupply in a specific INDOPACOM scenario, and to look at NATO fuel distribution in support of EUCOM fuel planning. Other applications and analyses are currently taking place.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66083 - Maintenance Operating Periods in Large Scale Combat Operations

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Andrew Bellocchio; Kyle Ditonto; Mr. Daniel C Finch; MAJ Sam Yoo

Abstract: The U.S. Army's new doctrine developed for Multi-Domain Operations and arrival of the next generation of rotorcraft, Future Vertical Lift, creates an opportunity to change the way the Army maintains its aircraft. The presented work explores the use of maintenance operating periods to improve Future Vertical Lift's survivability against near-peer competitors. Operating periods are an attractive sustainment strategy in large scale combat operations because they offer an assurance of flight operations over a given number of operating hours that are undisrupted by maintenance actions and unencumbered by a heavy sustainment tail. Fewer maintainers forward present less risk to personnel while lighter sustainment packages generate the agility needed for frequent survivability moves in the tactical support and close areas, which are within range of enemy air and fires.

An examination of the Army's evolving doctrine, including 2022's Field Manual 3.0 Operations, highlight the need for Army forces to operate dispersed for extended periods without continuous support in Multi-Domain Operations. The authors introduce the conceptual approaches and the analytical techniques needed for maintenance operating periods. Presented works and analysis provide compelling evidence that predictive maintenance and technologies such as health monitoring systems are now ready to enable Army Aviation to implement shorter, limited operating periods. As Future Vertical Lift matures in future increments, operating periods will likely grow to provide even greater capability to extend operations while dispersed.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66055 - Lightweight Torpedo (LWT) Intermediate Maintenance Activity (IMA) Study

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: John Walker; Thomas Karnezos; Deanne McPherson; Jonathan Celaya

Abstract: In order to meet current and future requirements, streamlining the assembly and maintenance of the Lightweight Torpedo (LWT) inventory is critical. Additionally, demands on the Intermediate Maintenance Activity (IMA) are expected to change dramatically over the next decade due to addition of future systems much as the Mk 54 Mod 2, Mod 1 production ramp up, Mod 0 requirement reduction, and the sunset of the Mk 46. This study examined the LWT IMA assembly and sustainment processes and practices to understand what type of resourcing and support would be needed to meet LWT requirements now and into the future. The study approach was based on characterizing the throughput capacity of the IMA by developing a custom-built Throughput Model using Discrete Event Simulation (DES). The DES model structure is based on process flow diagrams representing the approximate 100 individual processes for each of the seven LWT build/turn types. The process flow diagrams and the time to complete each individual process was informed by IMA historical data collection of individual process times. The model utilizes prioritized queuing by build/turn type and incorporates variability by assuming exponential distributions for each individual process time. The model represented expected throughput of the IMA when constrained by the physical capacity of work areas and determined the baseline rate for IMA assembly and sustainment. This provided the foundation for a sensitivity analysis of different courses of action to increase throughput.

Location: TH347
Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

65894 - Lifetime Operations and Sustainment cost comparison for the VTA-903 and Advanced Combat Engines

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: JAE H KIM

Abstract: Title: Lifetime Operations and Sustainment cost comparison for the VTA-903 and Advanced Combat Engines

Author: MAJ Jae Kim

Submission Group: WG 26 – Cost Analysis, WG 17 – Logistics, Reliability and Maintainability

Classification: Unclassified

Distribution Statement: Distribution Statement: Distribution authorized to the Department of Defense and U.S. DoD contractors only

As the current threat environment evolves, the United States Army continues to look forward by examining how to best modernize its ground combat vehicle fleet. As part of this effort, the Ground Vehicle Systems Center (GVSC) and Cummins Inc. have studied and developed a new opposed-piston powertrain technology as part of proposed and upgraded vehicle designs. With the Advanced Combat Engine (ACE) engine currently being tested, this study, on behalf of Program Executive Office Ground Combat Systems, aims to analyze the operations and sustainment costs of the current VTA-903 powerplant compared to the projected operations and sustainment (O&S) costs of the new ACE by focusing on the Army's current medium tracked vehicle fleet. O&S measures being considered include reliability of engine function, fuel consumption, maintenance hour requirements, and the logistical footprint. The model output will help inform us if the ACE will result in O&S cost savings over the engine lifetime. Vehicles considered in the study include the Bradley Fighting Vehicle (BFV), M109A7 Paladin Howitzer, the Armored Multi-Purpose Vehicle (AMPV) and the in-development Optionally Manned Fighting Vehicle (OMFV).

Location: TH347
Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

65844 - Generating Sorties Under Attack (GSUA) Cluster Study Volume 1

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. anthony alvarez dronkers; Andrew Langland		
Abstract: GSUA is a series of studies to address "the fight to get airborne" using SAF/SA's Airbase Damage-Assessment and Resiliency Model (AD-ARM). The Cluster study explores the potential benefits of non-traditional hub-and-spoke operations focused on generating combat sorties from several small operating locations, the spokes, supported by a more traditional base of operations, the hub. Since the cluster concept deviates from traditional operations, this study also explores the feasibility and challenges of operating as a cluster, with a focus on the support elements required to generate combat sorties. While the study focuses on generating sorties under new operating concepts, other mitigating factors, such as air defenses and resiliency measures, are tested as well to provide insights for interacting effects. Due to the broad scope of the study, the results have been split into three volumes: Volume 1 provides the research insights gained while leaning how the cluster concept could be supported from the perspective of munitions production, fuel operations, aircraft maintenance, and recovery after attack. Volumes 2 and 3 cover the analytic insights for traditional basing and cluster basing, respectively. Location: TH357 Classified Classification: SECRET//REL TO FVEY Working Group: WG17 Logistics, Reliability and Maintainability		

66027 - Modeling the FARA Airframe's Design for Supportability

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: MAJ Sam Yoo; Andrew Bellocchio; Kyle Ditonto; Madison Kusano		
Abstract: The US Army Future Attack Reconnaissance Aircraft (FARA) aircraft structure will be composed primarily of advanced composites compared to the current fleet of Army helicopters made largely of sheet metal. Advanced composite maintenance is much more complex and difficult to make		

repairs in comparison to metal structures. This study examines the airframe structure's design for supportability, with a focus on the materials engineering, to provide an objective model for comparison between the two FARA Competitive Prototype (CP) aircraft: Bell's Invictus and Sikorsky's Raider X. Most of a system's lifecycle costs occur during the support and sustainment phase. An early and deliberate analysis of the FARA airframe's design for supportability could help inform senior decision makers understand important distinctions between the two competing designs, which could save the Army billions of dollars in support costs over the life of the program. This study will be comprised of three parts. First, a literature review and stakeholder analysis inform the essential supportability requirements, functions, and objectives for the airframe. Second, a qualitative and quantitative value model is developed in support of multi objective decision analysis. Lastly, the airframe data and relevant assumptions about cost are made to highlight the cost vs. value trade space for decision makers.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66410 - Quantitative War Reserve Requirements for Losses (QWARRL) Methodology

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Emmanuel Tchanqué; Dr. Erika Oshiro

Abstract: QWARRL is the U.S. Army's methodology for estimating wartime equipment losses for major end items (Class VII) and their rate of loss in support of Headquarters, Department of the Army G-4/Combined Arms Support Command (CASCOM). The Center for Army Analysis (CAA) is the data proponent to develop and provide results for modeled and non-modeled systems to CASCOM for use throughout the analytical and logistical planning community.
CAA's Campaign Analysis Division recently improved the QWARRL process, shifting from estimating theater-level loss rates to tactical and operational levels for large-scale combat operations scenarios. CAA bases the analysis on the results from the Joint Integrated Contingency Model, and the Estimate of Wartime Attrition and Replacement for Materiel historical Class VII loss rate data using the latest scenarios from the Total Army Analysis iteration.
The purpose of this briefing is to present QWARRL's new methodology and to discuss how its improvements will be useful at echelons below theater level.

Location: TH357 Classified
Classification: CONFIDENTIAL
Working Group: WG17 Logistics, Reliability and Maintainability

66191 - Responsible AI for Predictive Maintenance: A Case Study in Delivering Trustworthy Component Failure Forecasts

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: CPT John T McCormick

Abstract: Despite the promise of military analytics as a force multiplier, integrating AI/ML solutions at the tactical edge of logistics and maintenance operations remains a significant challenge. In addition to the technical process of developing and deploying performant AI/ML models, an established procedure for implementing these solutions in accordance with the DOD's Responsible AI (RAI) guidelines is sorely needed. We present a case study of building an RAI-based framework for

delivering probabilistic forecasts of rotary-wing aircraft component failures to tactical maintenance managers in Army Aviation units.

The proposed implementation was designed and deployed within a prototype predictive maintenance application, Griffin-Analytics, currently being tested by multiple Army Combat Aviation Brigades. User engagement directed our development away from traditional Reliability-Centered Maintenance tasks and towards predicting the conditional hazard of the next 100 flight hours, informing the selection of aircraft for specific missions and pre-emptive ordering of parts. This application called for deliberate RAI processes and techniques, given the requirement to generate and govern over a thousand survival models for all independent serialized components in the three primary rotary-wing aircraft.

Model reliability was supported through both standard test and evaluation procedures as well as a technical review from outside the development team. Temporal and grouped cross validation was used to assess candidate models across time and military formations with dynamic AUC_ROC as the primary performance metric. The external technical review was primarily performed to validate the model training and selection for appropriate evaluation and correct interpretation, though the process additionally allowed for recommendations regarding modelling techniques

In order to provide traceability, the delivery of predictions was augmented with procedurally generated model cards. These model cards were designed to explain the intended use of the predictions, elaborate on the data used for training, and provide clear descriptions of model performance in domain relevant language. Engagement with aviation maintainers and battalion staff provided additional evidence and feedback on the efficacy of these explanations.

Finally, we explored the organizational mechanisms necessary for promoting equity and governance of AI/ML systems. Specifically we examined the process for an external ethics review, the considerations for assessing and accepting risk associated with the AI deployment, and the application design necessary for effective communication channels with end-users.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66275 - Using Statistical Modeling Techniques to Compare Part Availability Between Traditional and Additive Manufacturing Practices

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Justin LaBranche		
Abstract: Additive manufacturing is an emerging technology that can be utilized within the DoD to optimize repair turnaround times and supply availability. While traditional manufacturing can utilize economies of scale, it requires minimum orders, large contracts, custom tooling, and limits repairs to fixed locations. Conversely, additive manufacturing techniques have the potential to be more versatile for builds that do not benefit from large scale production. Within the defense sector, the time and cost associated with shipping large, controlled parts internationally is also a major consideration. Additive manufacturing allows parts to be produced on location and reduces system downtime due to complex shipping procedures. This study utilizes statistical modeling techniques to track parts through the repair process and compares repair turnaround time between additive and		

traditional manufacturing practices to optimize part availability for any given system. Such analysis can provide much needed relief in the defense industry's overall supply chain structure.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66181 - Predictive Resilience Modeling

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Priscila Silva; Dr. Lance Fiondella		
Abstract: Resilience is the ability of a system to respond, absorb, adapt, and recover from a disruptive event. Dozens of metrics to quantify resilience have been proposed in the literature. However, fewer studies have proposed models to predict these metrics or the time at which a system will be restored to its nominal performance level after experiencing degradation. This talk presents alternative approaches to model and predict performance and resilience metrics with elementary techniques from reliability engineering and statistics. We will also present a free and open source tool developed to apply the models without requiring detailed understanding of the underlying mathematics, enabling users to focus on resilience assessments in their day to day work. Location: TH347 Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

66429 - Practical Applications of Bayesian Analysis in Reliability Testing

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Nathan Herbert		
Abstract: Multiple papers and symposium presentations have highlighted recent advances in applying Bayesian statistical models to reliability. These models can provide a rigorous methodology for combining data from different tests or system variants without requiring overly restrictive assumptions regarding the relationships between the data sources. They can also be easily generalized to handle a wide array of modeling problems, and they form the basis for more complete analysis in support of reliability testing. This paper will cover recent applications in reliability testing that demonstrate the utility of these approaches. Application examples include 1) a reliability growth projection showing the need for a fundamental redesign for reliability, 2) test planning to compare the reliability of a system modification with the baseline, and 3) estimates of consumer and producer risks as a function of follow-on test length as part of test planning. Location: TH347 Classification: UNCLASSIFIED Working Group: WG17 Logistics, Reliability and Maintainability		

66460 - Evaluating Representation of Tactical Logistics in the COMBATXXI Simulation

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Curtis L. Blais; Dr. Imre Balogh		

Abstract: The Marine Corps is undergoing a transition from countering violent extremists to “great power/peer-level competition” and a return to its “historic role in the maritime littoral” (USMC Force Design 2030, March 2020, 2). The USMC recognizes that this transition demands a re-assessment of all aspects of its operations and in so doing has identified several shortfalls in current capabilities. New warfighting concepts, such as Expeditionary Advanced Base Operations (EABO) and Stand-In Forces (SIF) (USMC, A Concept for Stand-In Forces, December 2021), require new capabilities, tactics, techniques, and procedures. In turn, the Marine Corps needs analytical tools and techniques to understand implications of the new concepts and to explore alternative force structures and tactical operations. A key tool in the conduct of such studies is the Combined Arms Analysis Tool for the 21st Century (COMBATXXI), a combat simulation jointly developed by the U.S. Army and the USMC. To fully understand the operational planning considerations needed to implement EABO and SIF concepts, it is expected that the Marine Corps needs better logistical representation in COMBATXXI. The objective of this study is to perform detailed research to evaluate the efficacy of COMBATXXI as a tool for modeling logistics operations relevant to the new concepts, to identify gaps, and to make recommendations on possible solutions. This presentation describes the study objectives and approach, findings-to-date, and remaining work to be performed.

Location: TH347
Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

66056 - Leveraging Simulation, Artificial Intelligence, and Multi-Attribute Tradespace Exploration to discover enterprise solutions: F-35 Aircraft Engine Exemplar

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Zachary Shannon; Ms. Kelly Bush

Abstract: The United States Air Force (USAF) relies on logistics networks to support its mission at bases and other operating locations during both peacetime and contingencies. Because of its global mission, the USAF needs to accurately predict future combat readiness resulting from the incremental investment in spare inventory and repair capability. This accurate prediction is essential for holistically capturing the impact of a robust supply chain on sortie generation capabilities. Current efforts, such as traditional Readiness Based Sparing (RBS) models , derive sortie generation insights from solvable mathematical formulas which determine the sparing levels from a given set of demand parameters. Traditional RBS models have limited stochastic functionality which enables some statistical analysis; however, performance predictions are not precise and offer little insight regarding the wide range of possible outcomes given specific input parameters. This research effort developed an innovative proof of concept that utilizes SimPy, a discrete-event simulation library in Python, to simulate an aircraft spares servicing network in support of the Pratt & Whitney (P&W) F-135 engine to formulate network resource requirements. The simulation is combined with a machine learning application called Harness for Adaptive Learning (HAL) and Making Robust Lifecycle Decisions (MRLD) software. HAL employs numerous machine learning methods to efficiently sample and explore the vast trade space that is applicable to any problem set. MRLD is an analytic tool that enables the Multi-Attribute Trade Space Exploration (MATE) methodology and provides insight into the compromised solutions across various stakeholder needs. Specifically, this novel solution is intended to support optimal strategic level decision making, identify and isolate inherent cost-performance relationships, and to forecast resulting performance from the incremental investment in network resources.

Location: TH347

Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66013 - Modeling Contested Logistics in Distributed Operations

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Michael P Huck; Tristen Leinbach

Abstract: In response to challenges posed by a return to strategic global competition, Navy and Marine Corps developed Distributed Maritime Operations (DMO) and Expeditionary Advanced Base Operations (EABO) concepts for conducting far forward combat operations in contested environments. Systems Planning and Analysis (SPA) has developed a logistics force level model accounting for refuel, resupply, and rearming of maritime combat forces supporting these concepts in a future-year, campaign-level, Pacific theater warfighting scenario.

The maturation of this logistic analysis has been ongoing since 2018, supporting Navy force design efforts for the surface combatant and future fleet afloat logistics elements. Initially, this work examined fleet ship and aviation fuel demand and the relationship between survivability of the combat logistics force against the overall combat effectiveness of the surface force in a campaign-level warfight. This NAVSEA supported logistics analysis, required development of fuel burn curves for new surface combatants operating through an intense limited duration wartime scheme of maneuver. NAVAIR also provided the projected fuel demand from the integration of the F-35 into carrier air wings, to calculate JP-5 fuel requirements.

In 2020, the analysis expanded in scope, examining all logistics elements in order to support ICD development capturing afloat logistics requirements necessary to meet a theatre level wartime scenario - from the warehouse to the front line. In response to the expanded scope, SPA developed a nodal analysis for fuel, supplies, ordnance, rescue, and repair demand across the force using a theater-level warfighting campaign scenario. This broader treatment of operational logistics was applied to future force level analysis in a series of Navy AoA's. The AoA's showed changes in campaign-level combat produced by Navy ships as a function of the degree of interruption of the logistics flow relative to enemy attacks on logistics units.

SPA continues to support the Navy analysis utilizing the JFOS 2.2040 scenario, which includes logistically supporting the entire afloat force as well as Marine Corps Expeditionary Advance Base Operations. This longer scenario has required a better understanding of how to logistically model a force that dynamically maneuvers from one phase of operations to another and has explored different concept of operations that would ensure the success of the force by more efficiently protecting the logistic force.

Location: TH347
Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

66432 - Combined Scorecard for Assessing Program Reliability

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Adam Hull

Abstract: Previously, the US Army Materiel Systems Analysis Activity (AMSAA) developed individual scorecards for both hardware and software reliability to evaluate a program's planned and completed reliability activities, ensure reliability best practices are implemented and identify areas that may need improvement. The U.S. Army Combat Capabilities Development Command (DEVCOM) Analysis

Center developed the new combined scorecard at the behest of the DEVCOM Ground Vehicles Systems Center to address the fact that modern systems tend to be both hardware and software intensive, and hardware reliability and software reliability are often interrelated. The updated and combined scorecard consolidates the previous scorecards into a smaller number of total elements and allows a more in-depth analysis through supplemental criteria scoring. The combined scorecard presents a clearer overall picture of the current status of reliability for a program or vendor. This presentation examines a reliability scorecard analysis to demonstrate how the scorecard can provide significant insights and how a program can use these insights to improve reliability outcomes. The new scorecard advances a capability that has been requested hundreds of times by Department of Defense and contractor organizations.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

66154 - Agile Basing & Resource Allocation Tool

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Jessica ML Matthews

Abstract: The Agile Basing and Resource Allocation (ABRA) tool was designed as a force closure model to support expanded maneuver operations across all DoD services. ABRA aids planners in calculating the logistics demands for desired operational basing changes. The desired outcome is the acceleration of logistics planning to support and inform operational planning. Through ABRA, logisticians, operational planners, and operations analysts have a way to quickly develop courses of action, conduct quantitative assessments on those courses of action, and provide detailed analyses on the logistics and supportability of units moving in theater. This, in turn, enables the warfighter to make data-driven recommendations to leadership in a timely manner, so that decisions can be made consistent with the speed of operations. ABRA itself can be used as both a strategic and tactical tool, assessing plans and providing data-driven courses of action in dynamic, contested environments.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

65670 - Logistics Sustainment Modeling and Analysis for Agile Combat Employment

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Richard K. Null; Jacob Locker

Abstract: Agile Combat Employment (ACE) shifts Air Force operations from centralized physical infrastructures to a network of smaller, dispersed locations or cluster bases. Flight operations from dispersed operating locations drives a need for robust, responsive logistics sustainment support. This presentation will introduce a discrete event simulation developed to assess ACE logistics sustainment and sample analysis of air mobility assets needed to support combat sortie generation from dispersed operating locations. Airlifter force composition and performance metrics including payload, range and speed are examined.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

65808 - Future Logistics in a Dispersed and Contested Environment

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Nick Ulmer

Abstract: This presentation covers a capstone study with expected completion in March 2022, that attempts to use simulation and an analysis of alternatives (AoA) to recommend a procurement strategy for aircraft or airships that perform logistics in a distributed and contested environment. In addition to legacy assets the study will consider five new craft concepts. Status-quo as well as contested scenarios will be included to help simulate anticipated future conflicts. The overall goal is to provide a strategy that procures a logistics solution that is more flexible, rapidly fielded, sustainable, adaptable, and less vulnerable.

Location: TH347
Classification: UNCLASSIFIED
Working Group: WG17 Logistics, Reliability and Maintainability

65814 - Air Force Supply Chain Part Gap Analysis

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Jeorge Fulk Atherton

Abstract: Air Force supply chain management requires comparison of part level requirements, scheduled shipments from procurement and repair actions, as well as knowledge of stock availability, lead times, and other supply chain data. This information generates insights of serviceability or backorders years into the future. All the beforementioned elements are typically available to responsible parties but have previously been difficult to aggregate due to the number of legacy systems and datasets required. The deployment of the Enterprise Supply Chain Analysis, Planning, and Execution (ESCAPE) system has integrated these legacy sources onto a single platform with modern analytical tools. Consequently, a dashboard connected directly to the source data enables visualization into active items within the requirements system. The connected modules deliver a set of filters, charts, and tables enabling easy analysis of item subsets and their projected supply health over the next 5 years. Relevant supply chain stakeholders now can view all their items in aggregate, drill down to those with the largest supply chain gaps between requirements and due-ins and take preemptive corrective action. These actions can potentially lead to improvements in Air Force aircraft availability rates and minimize excess inventory costs.

Keywords: Supply Chain Management, requirements, backorders, ESCAPE

Location: TH347
Classification: UNCLASSIFIED // FOUO
Working Group: WG17 Logistics, Reliability and Maintainability

WG18 Manpower and Personnel

65677 - Automated Scoring of Army Officer Evaluation Reports

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Thomas Malejko		

Abstract: In late 2021, Army senior leaders inquired as to the feasibility of using natural language processing and machine learning to reduce the manpower burden associated with the Army's Centralized Selection List Board. This time-consuming, annual process consists of a series of boards—which combined with the outputs from the Command Assessment Program—select high-quality individuals for command and key developmental positions at, or above, the battalion-level (organizations consisting of at least 500 soldiers, noncommissioned officers, and officers). While members of the Centralized Selection List Board consider a variety of information about each officer when generating the total board score, officer evaluation reports explain a large portion of final board scores. Consequently, developing an algorithm that effectively scores officer evaluation reports is fundamental to the creation of a broader algorithm that scores an officer's entire board file. This paper explores the development of a machine learning model that uses the officer evaluation report's rater block check, senior rater block check, and senior rater narrative to generate a score for each individual officer evaluation report. The most effective model developed uses a random forest algorithm, combined with bag-of-words featurization for the free text field, to score 96.0% of combat arms officer evaluation reports to within a half-point of the human-generated (career-manager-assigned) score and 99.5% to within a full point of that value.

Keywords: Machine learning (ML/AI), natural language processing (NLP), officer evaluation report (OER), centralized selection list (CSL), human resource management, Shapley values

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

67857 - An Evaluation of Cadet Reviews Using Natural Language Processing

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Andrew Lee; John Scudder		

Abstract: The objective of this research was to provide an alternate perspective of the US Military Academy Periodic Developmental Review (PDR) system by using statistical and natural language processing (NLP) based approaches to find whether certain dimensions of PDR data were predictive of a cadet's overall rating. We implemented multiple NLP tasks and techniques, including sentiment analysis, named entity recognition, part-of-speech tagging, and word2vec embeddings. Several statistical models were applied, including linear regression and ordinal logistic regression. The ordinal logistic regression model concluded PDRs with optional written summary statements had more predictable overall scores than those without summary statements. Our findings also indicate that writer demographics have a significant impact on overall rating. We recommend that the Academy implements a forced distribution or provides a clearer explanation of the numerical ratings. Furthermore, we recommend that the Academy requires the summary statements field be filled in for all PDRs.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

65613 - From Reactive to Proactive in Ready & Resilient Initiatives: How Analytics Drive Actions

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: MAJ Jaison Desai, PhD; Linda Stewart		
Abstract: The U.S. Army has increasingly prioritized all manner of programs related to its people and their individual readiness, both in responding to adverse actions as they occur and in proactively encouraging resilience. While data is routinely presented to leaders at all echelons, it is often limited to aggregated incident numbers and changes from prior periods. Ongoing collaboration between the operations research team and the Ready & Resiliency (R2) team at 7th Army Training Command (7ATC) effectively demonstrates how simple yet rigorous analytic efforts can produce powerful insights and visualizations. Our analyses and products enabled data-driven decision making by senior leaders and helped turn command conference discussions from reactive to proactive. Of note, we discuss how these analyses drove collaboration with the 7ATC Noncommissioned Officers Academy (NCOA) to inspire and enable junior NCOs to mitigate alcohol-related incidents within their teams. Location: TH363 Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

65494 - Unit Fill Optimizer (UFO): An Optimization Tool for Manpower and Capability Alignment

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Coleman Strickland; Andrew Phillips		
Abstract: Introduction Navy Medicine's (NAVMED) ability to assess personnel readiness, identify future manpower risks, and construct mission capable units for emerging requirements are dependent on models that analyze the full scope of available personnel and efficiently align the personnel across the force structure. While some solutions can be calculated by hand, a computational approach provides an objective, repeatable, and expedited process to solving these problems simultaneously. The Unit Fill Optimizer (UFO) is introduced as a decision support tool to address these concerns by assigning personnel to jobs in an optimal and timely manner. Feedback from the UFO tool provides NAVMED leadership the answers they need to identify and address unit capability gaps, forecast manpower deficiencies, and understand readiness concerns across the enterprise. Materials and Methods The implementation of a linear optimization model serves as the foundation of the UFO tool and seeks to identify optimal force alignment to satisfy user-defined needs. Input data for the model contains personnel readiness, training, and education metrics in addition to billet requirement information for each NAVMED platform considered. In addition, the tool has the capability to incorporate not only Program of Record (POR) platforms, or legacy platforms, but also user-defined platforms based on emerging requirements, which ensures tool implementation across a variety of billet requirements to meet mission demands. A graphical user interface (GUI) is integrated as a user-friendly interaction tool for defining inputs and outputs to tailor each unique run of the model. The tool output features the quantity of billets the model was able to fill based on the matching criteria, and what billets are empty due to lack of suitable personnel. Results		

The results of the UFO model provide decision makers the ability to not only optimize force alignment but also project future personnel gaps throughout the organization. The model's outputs can be used to restructure training plans, simulate manpower readiness across time horizons, and enhance recruiting efforts to ensure the future force maintains a ready posture to address any conflict.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

66185 - The Efficacy of Machine Learning Models to Predict Retention of Mid-Career Managers: Evidence from the U.S. Army

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Brandon Michael Podojil; Luke Gallagher; Alexander Saul

Abstract: Modern Human Resources (HR) organizations seek to maximize workforce performance by providing employees with tailored experiences to meet their professional and personal goals. As HR organizations adopt modern practices, they face exponentially increasing complexity with infinite career paths, compensation profiles, professional development, and work-life balance considerations. To operate in this environment, executives demand data-driven insights capitalizing on increasingly rich internal and external data. By exploiting high dimensional data, AI capabilities such as Machine Learning (ML) complement and improve human decision-making. Despite progress, significant uncertainty remains. HR applications of ML inherently involve human behavior, for which prediction often proves more elusive than other domains. This effort is further complicated by the desire to predict not just in the short-term, but behaviors many years into the future which involves more uncertainty. Finally, concerns for ethical and equitable AI employment accompany any modeling of human systems. This paper explores how ML models can improve HR decision-making regarding retention of mid-career managers. Specifically, we explore U.S. Army commissioned officer retention through eight years of service. The U.S. Army is an ideal setting for several reasons. First, the officer corps has limited lateral entry; therefore, only officers continuing through eight years of service are available for promotion to field grade ranks. Additionally, eight-year retention is a driver for both monetary and non-monetary incentives and increased commissioning contract lengths. Lastly, the U.S. Army administrative data systems provide detailed information on employee demographics, pre-commission attributes, occupation, military training, job assignments, military decorations and awards, professional development, and advanced education. We predict U.S. Army commissioned officer eight-year retention using supervised learning classification algorithms. We evaluate 16 supervised learning models measuring improvement in test sample prediction across several metrics from both a baseline of cohort and occupation and naïve mean, achieving model performance six to eight percentage points above baseline accuracy. Furthermore, limited lateral entry allows us to understand how information gained over time impacts the accuracy of predicted eight-year retention by fitting models on five subsamples, based on time-invariant features and features corresponding to two, three, four, five, or six years of service, respectively. Finally, we address several model application topics. Areas include alternative performance metrics and classification thresholds to account for trade-offs between types of misclassification errors. As a last evaluation, we consider data subsets that eliminate the use of predictors with potential equity concerns to evaluate the trade-off between model performance and fairness.

Location: TH363

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

66367 - A Crew of Two: A Comparative Analysis of the Optionally Manned Fighting Vehicle (OMFV) and Apache Helicopter

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Arrio Granum

Abstract: Since the inception of modern armored warfare, armed forces have contended with the trades of weight, size, mobility, and survivability. As armament capability increased, armor requirements similarly increased to provide adequate protection. As increases to armor protection are limited by size, space, and weight limitations, one potential solution was reducing the crew required on a platform. Today, these tradeoffs and plans for crew reductions are present in the development of some next generation combat vehicles. In fact, the Army's potential next Infantry Fighting Vehicle (IFV), the Optionally Manned Fighting Vehicle (OMFV), has stratified platform requirements mandating smaller crews than its Bradley Fighting Vehicle (BFV) predecessor. This crew manning attribute is a departure from today's crew of three in the BFV to a crew of two in OMFV.

In 2021, the Commanding General, Army Futures Command (CG, AFC) directed The Research an Analysis Center to conduct an OMFV workload study. The purpose of the study was to consider how OMFV might best be crewed with only two personnel by providing a comparison to the current use of two crew members in the Apache helicopter. The analysis was organized primarily on the personnel, doctrine, organization, and training domains of DOTmLPF-P. Over the course of the study, the team individually interviewed more than 30 subject matter experts (SME), synthesized information, and conducted three collaborative panels with SMEs from multiple Army organizations.

These engagements led to confirmation of major OMFV implementation themes and implications related to reducing an IFV crew from 3 to 2, given OMFV's anticipated technological suite. The study answered the questions of interest and illuminated several interesting implementation considerations that apply specifically to the OMFV program, but also to other new vehicles that are similarly planning on reducing crew manning. The study results included courses of action and recommendations support CG, AFC decisions and provided potential areas for future analytic work: Should the OMFV crew stations be specialized or identical? What knowledge and attributes should an OMFV crewmember possess? Should the OMFV crew and the passengers be the same Military Operational Specialty? How does an OMFV-equipped formation perform priorities of work and handle the loss of a crewmember? What does technological redundancy mean for the OMFV? Should OMFV crews be qualified individually or collectively? What training should be provided by the institution, installation, or unit? How might OMFV technologies (and AI) impact qualification?

The study also explored these additional points of interest: Enterprise-level Culture Change; Trust in Technology; New Equipment Training and Fielding

This presentation will explore how the study team elicited and communicated SME feedback to inform capability development and senior leader decisions.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

66095 - Optimal Leadership Role Assignment

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Jack R Hernon; Thomas Kendall		
Abstract: Throughout the United States Army, there exist many military schools that test the induvial leadership skills of trainees in simulated platoon level operations. To graduate from these schools, trainees are assessed and receive "GOs" for their performance in specific leadership positions. Generally, there is no systematic way of assigning trainees to specific leadership roles during specific missions, as instructors typically complete such assignments by hand. Leadership role assignment can be quite difficult due to real world constraints, which we explore in depth. Thus, the human element of leadership role assignment allows for errors and bias. Additionally, unexpected events, such as injuries or illness, can completely derail a leadership role assessment schedule which, in the worst-case scenario, means some trainees do not receive the required number of opportunities to pass. To address this, we develop a linear programming model that systemically distributes all leadership roles among the trainees during each simulated mission during a school. We create an objective of maximizing flexibility in the later part of the schedule and capture all the complex constraints placed on instructors for scheduling. Our solutions to the leadership role assignment problem are robust to unexpected events, never erroneous, and are unbiased in assignment. Location: TH363 Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

65974 - Army Retention: Not the Cure for Low Accessions

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. William Corson, Jr.; MAJ Matthew J Beigh		
Abstract: The Army experienced a historically bad year of accessions in fiscal year 2022, falling short of its goal by roughly 15,000 recruits. This trend carried over into 2023. Army Senior Leaders have implemented several programs to improve the influx of America's youth into the Army: recruiter bonuses, Future Soldier Preparatory Courses, increased enlistment signing bonuses, and selection of duty station for recruits. In conjunction with increasing accessions, Army Senior Leaders have also focused efforts on keeping Soldiers through retention programs. Despite the attention devoted to retain Soldiers, the retention of Soldiers alone will not solve the Army's strength problems induced by low accessions. The Army should always be looking to keep quality Soldiers within its ranks and increased retention bonuses, choice of next duty assignment, and / or choice of school have all helped. However, retained Soldiers are not additive to Army strength. This brief will provide an overview of HQDA's end strength modelling process and a recent history of Army retention. It will focus on why retention will not be enough to alleviate the strain on the Army's strength created by accessions shortfalls. Included will be analysis to determine maximum feasible annual retention and further reductions in attrition necessary to optimize strength targets for mid-grade NCOs. In conclusion, this brief will provide our results, recommendation, and a way forward. Location: TH363		

Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

65612 - Sick and Tired: Leveraging Local National Manpower Analysis to Enable Organizational Change

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: MAJ Jaison Desai, PhD; Matthew Eidt

Abstract: The U.S. Army operates thousands of training ranges worldwide to support the readiness requirements of both U.S. and partner forces. The most realistic versions of these ranges utilize dynamic targets to assess firing reflexes and the ability to hit moving objects. Behind the computers and sensors is a precious commodity, critical to ensuring the success of the mission – range operators trained in the safe and effective operation and maintenance of these target systems. This presentation discusses a collaborative assessment of the unique constraints of German local national manpower in support of the largest U.S. range complex in Europe, the Grafenwoehr Training Area. We describe how Training Support Activity Europe (TSAE) effectively leveraged the operations research team at 7th Army Training Command (7ATC) to help frame the problem, gather relevant data, and present compelling analytics to illuminate potential solutions. This produced an objective analysis that enabled data-driven decision making by senior leaders within the organization. The study highlighted how current Army-level manning models underestimate necessary manpower in a European setting. By highlighting gaps in coverage plans we enabled the director to make timely and relevant policy changes in the near-term and consider longer-term changes to the organizational structure.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

64890 - The Social Return on Investment of Workplace Diversity, Equity, Inclusion, and Accessibility

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Matthew Griesbach

Abstract: Government workplace Diversity, Equity, Inclusion, and Accessibility (DEIA) initiatives promote diversity as a national strategic imperative and greater opportunities for historically underserved communities. While Executive Order 14035 seeks to innovate the government through increased employee engagement, more capabilities are needed to analyze, prioitize, and justify workforce investments. Monetizing government investment costs and benefits is a perrenial focus, but what about investment implications that cannot be readily translated into dollars? MITRE applies Social Return on Investment (SROI) principles to inform government workplace DEIA investment decisions. An Investment Value Management Framework (IVMF) compares DEIA solutions and identifies optimal solutions. The extensible framework offers performance management guidelines and includes an SROI model to estimate cost, benefit, uncertainty, and risk. The model translates metrics to benefits, and an early warning system manages lifecycle DEIA investment performance, comparing projected to actual SROI. IVMF calculations leverage historical DEIA costs from such sources as USASpending.gov and correlations of employee satisfaction and DEIA initiatives drawn from recent Office of Personnel Management (OPM) Federal Employee Viewpoint Survey (FEVS) data. Our presentation includes an IVMF demonstration, and a descriptive technical report is available upon request. The IVMF was built by economist, social-behavioral scientists, and data analysts.

Workforce diversity involves modifications in recruiting and hiring to ensure that the workforce composition more accurately reflects the variety of race, gender, and sexual orientation that exists within the population. Workplace inclusion involves actions to embrace the unique strengths and facets of identity for all individuals so that they feel welcomed, valued, and supported. Workplace equity refers to fairness of access, opportunity, and resources available to all employees. Agencies now seek ways to assess DEIA investment value and inform decisions regarding allocation planning, regulatory compliance, employee engagement, customer experience, and mission outcomes. While expected benefits of DEIA investment are significant, so too are the costs, risks, and uncertainties. While the White House indicates that costs of implementing President Biden's Executive Orders 13985 and 14035 will be too minimal for consideration, the list of on-going requirements for technology, process, and people would suggest otherwise.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

66843 - Sufficiency Analysis and the Application to Force Structure Validation

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Robert A Kirgan		

Abstract: Every year, commands across the Army must defend their force structure requirements during the Program Objective Memorandum (POM) process. Informing these resourcing decision and planning efforts requires the creation of a rigorous and repeatable analytic approach. Sufficiency analysis provides the approach to identify right-sized requests, while estimating the risk to the command's mission when the allocation of units is insufficient. Fundamentally, sufficiency analysis answers: Is there a sufficient supply (force structure) to meet a set of projected mission demands using ordered, study-specific business rules?

Three main inputs are required for sufficiency analysis that include a plausible mission demand (typically 5 to 10 years out), a sustainable unit of action supply, and business rules. The demand signal is derived and projected from current and future planning documents along with SME expertise within the command. The supply represents the current force structure and remains constant throughout the demand signal time frame. Business rules represent how the command allocates the supply to the demand signal and provides the model a sequence of rules to follow.

This presentation will discuss the key factors of sufficiency analysis, the methods used for modeling and analysis outcomes. Also, demonstrate how the results inform force structure requirement decisions.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

66046 - Future Force Structure Analysis

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Adwoa Gyekye; Dr. Suzanne Marie DeLong		

Abstract: As the Army Futures Command shifts its focus to designing the Army of 2040, the Army must now identify what the Army future force structure should look like to carry out its mission. The purpose of this study is to conduct analysis on the Army's potential future force structure through simulation experimentation with the Next Generation Threat System (NGTS). This study will identify possible Army future force structure course of actions (COAs), define metrics and conduct analysis to compare, contrast and identify the strengths and weaknesses of the developed Army future force structure COAs as well as identify areas of additional research and analysis needed.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

65635 - Managing Manpower Risk Using VFT and Portfolio Analysis

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Susan Lynch

Abstract: The Air Force Lifecycle Management Center Operations Research and Analysis division (AFLCMC/OZA) in partnership with the Manpower and Organization division (AFLCMC/DPB) has developed an Enabling Organizations (EO) Risk Based Tiering (RBT) model to manage program risk during manpower realignments. This model was developed because each project and task performed by the supporting functional organizations across AFLCMC has different required levels of expertise, staffing, support, costs, and schedules. The purpose of this model is to compare these disparate projects and tasks and use a common means of comparison to reallocate manpower resources as required. AFLMC developed a similar RBT model for the Mission Execution Directorate (MED) and then validated it within those directorates. The EO RBT uses Value Focused Thinking (VFT) to create a tailored model to support organizations by asking questions about the project's workforce and workload. The RBT models (MED & EO) each have five tiers based on the project's relative execution risk tolerance score. Projects are scored using the respective VFT model. Based on the scores, the projects are grouped into tiers applying a normal distribution. While the two types of organizations are scored and tiered by separate models, both are used by leadership for manpower decisions. The model provides a data driven baseline for manpower realignments, but additional criteria are added such as funding stream, classification level, with a healthy dose of professional military judgement on top (ex. new projects or those not funded in future years).

Because there are two separate RBT models in use for MED and EO, additional criteria are used to consider the overall health of AFLCMC. The next step of this project is to provide a portfolio analysis capability, to evaluate the overall risk/health and balance of resource needs across the center or within a specific Directorate. This updated model will enable leadership to explore various changes to personnel and measure the overall changes to AFLCMC program and organizational risk and health. The results will be aggregated to the directorate level allowing directors to determine where risk can be assumed and the model would provide a data driven guide for potential manpower realignments to support and streamline the current manual process.

Location: TH363
Classification: UNCLASSIFIED
Working Group: WG18 Manpower and Personnel

65897 - Investigating Coast Guard Investigators: A Discrete-Event Simulation Approach

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Jack B. Smith; Margaret Harward; Craig Nilson		
Abstract: There is a reason that simulation is taught late in any robust operations research curriculum: it presents the ultimate capstone to the full body of academic work across mathematics and computer science disciplines, and tests the analyst's mettle in properly employing the correct tools to address the problem at hand. Our discrete-event simulation combines elements of queueing theory, network graphs, systems theory, and uses Monte Carlo methods to understand the stochasticity of these models. We will discuss our approach to modeling the behavior of a segment of the U.S. Coast Guard officer corps: the marine investigators. Our project sponsor sought to ensure that the current workforce structure is a feasible system, and to build out "what-if" capabilities to address current bottlenecks and workforce shortages. We will take our audience from framing the business problem to the implementation of our discrete-event simulation in Python and present our findings. We will then discuss next steps for the Coast Guard's use of simulation as a key component of workforce analytics. Location: TH363 Classification: UNCLASSIFIED Working Group: WG18 Manpower and Personnel		

65893 - Can we Leverage Transformer Models to Efficiently Code Complex Task Data for Army Job Analysis? Streamlining Army Qualitative Research with Automated Qualitative Assistants (AQA)

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Naiqing Lin		
Abstract: Individual critical task lists (ICTLs; published in the Central Army Registry [CAR], 2023) are short summaries of the mission critical tasks Soldiers in various positions must be able to perform. ICTLs are often leveraged for a variety of personnel-related purposes, such as helping to identify Soldier career development and pathing needs, as well as crafting job descriptions and requisitions more attractive to potential applicants (ATMTF, 2022; CASCOM, 2023). Specialized branches like those within AMEDD (covering multiple specialized medicine-related branches) often cover a complex, wide range of requirements, leading to challenges in obtaining complete and accurate evaluations of proficiency (Hertz et al., 2020). Therefore, identifying methods to efficiently summarize and code these task lists is an important area of research. Typically, analyzing this type of data would involve traditional qualitative research methods – for example, having subject matter experts (SMEs) review, analyze, and annotate the information, followed by collectively discussing (dis)agreements and reaching synthesis. However, such methods can be prohibitively expensive in terms of time and labor, and so they remain underused, despite the value of qualitative analysis. Despite these challenges, we suggest leveraging the BART model (Bidirectional and Auto-Regressive Transformer) as an automated qualitative assistant (AQA) to facilitate the coding of lengthy, complex text data to advance traditional computer-assisted qualitative data analysis (CAQDA; Richards, 1999; Devlin et al., 2019; Joshi et al., 2019). Previously validated criterion-driven competency frameworks (e.g., "the Great Eight"; Bartram, 2005) can be leveraged to categorize tasks into broader competency domains. Such an approach holds promise in replacing human-facilitated coding procedures with transformer-based label prediction. As a result, the proposed approach may help ease the labor-		

intensive and time-consuming aspects of qualitative research and circumvent certain issues that may arise with human coders, increasing inter-rater reliability and reducing training requirements for SMEs.

The ability to quickly summarize and label task statements and similar data would have direct implications for Army branches and functional areas (FAs), enabling organizations to quickly evaluate, summarize, and compare ICTLs for use in personnel management and training. In this presentation, we will show how modern transformer-based NLP models like BART can be used to quickly code and categorize personnel tasks and make qualitative analysis of such data more feasible.

Disclaimer: The views expressed in this presentation are those of the author and do not reflect the official policy position of the Department of the Army, DOD, or US government.

Location: TH363
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG18 Manpower and Personnel

WG19 Readiness

66373 - Total Army Analysis (TAA) Component Rebalance Analysis

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: LTC John Ferguson; Craig Flewelling		
Abstract: Each year, the Center for Army Analysis' Force Strategy Division has the responsibility to support Headquarters, Department of the Army (HQDA) G-3/7 Force Management Directorate (FM) during completion of Total Army Analysis (TAA). Our analysis helps HQDA determine the unit composition of the Army's total force. TAA 26-30 focused on balancing the Regular Army (RA) and the Reserve Component (RC) force mix required to meet future National Defense Strategy demands. This presentation will include a brief overview of the methodology we used to support FM in TAA 26-30. We examined how changing the future RA and RC force mix impacts the Army's ability to meet operational demands outlined in the National Defense Strategy and in time-phased force and deployment data for operation plans. Since unit readiness varies over time, we modeled how the Army transitions from Campaigning to Conflict and back to Campaigning over an 8-year period using a discrete event simulation. We hope to inform and solicit feedback from those interested in force generation analysis and simulation. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

66704 - Future Force Structure Analysis

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Adwoa Gyekye; Dr. Suzanne Marie DeLong		
Abstract: As the Army Futures Command shifts its focus to designing the Army of 2040, the Army must now identify what the Army future force structure should look like to carry out its mission. The purpose of this study is to conduct analysis on the Army's potential future force structure through simulation experimentation with the Next Generation Threat System (NGTS). This study will identify possible Army future force structure course of actions (COAs), define metrics and conduct analysis to		

compare, contrast and identify the strengths and weaknesses of the developed Army future force structure COAs as well as identify areas of additional research and analysis needed.

Location: TH365
Classification: UNCLASSIFIED
Working Group: WG19 Readiness

66694 - Sustainment Data Education in Support of a More Data Centric Army

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Brian Thomas Johnson; Dr. William Smith

Abstract: The Multi-Domain environment demands and requires Sustainers to quickly organize and present data from multiple sources to describe the current sustainment situation and make data-informed decisions. Sustainers must rapidly describe what happened, diagnose why it happened, and apply the analytical competencies and skills enabling them to prescribe optimal actions. These actions account for interrelated effects across the industrial base, the global distribution system, and the complex, multi-domain battlefield. Army Sustainment leaders must adopt a culture of rigorous data-driven decision-making, and it starts by providing the workforce the analytic competences required to develop sound recommendations through effectively using increasingly available data. Army Logistics University (ALU) is implementing a program comprised of sequential and progressive levels of data education embedded in professional military education for officers, non-commissioned officers, and civilians throughout their careers. This approach will include expanding existing professional military education and functional courses, developing exportable interactive multimedia instruction and programs of instruction, assessing civilian academic programs for equivalency, and increasing access to advanced academic degrees. Talent management will identify exceptional sustainers and connect them with the right educational and broadening assignment opportunities to create sustainment data specialists. Additionally, senior decision makers attend a Senior Leader Data Course to better utilize the skills being developed in Sustainers. This will blend both math and computer skills with Army Sustainment Warfighting Function (SWfF) requirements.

To change the culture and develop data analytic skills and proficiency across the Army, ALU proposes a multi-tier approach to establishing, delivering, and sustaining data education. ALU will embed sequential and progressive data education into current ALU courses. This will be practical rather than theoretical in nature, blending both math and computer skills with SWfF requirements. For exceptional sustainers, talent management identifies those personnel to enhance their data education external to ALU. These personnel complete data analysis related graduate degree programs or training with industry.

The Army's technical capabilities in collecting, storing, and disseminating data has increased dramatically over the last two decades. The capabilities of Sustainment Soldiers and civilians to effectively use that data has not developed at the same rate, giving rise to a gap between analytic competencies and technical capabilities which will only widen if not addressed. Sustainers must be capable of exploiting and understanding relationships of data from the tactical to strategic level. The Army's investment in materiel modernization must be matched by an investment in its people.

Location: TH365
Classification: UNCLASSIFIED
Working Group: WG19 Readiness

65979 - Data Science: What is it? How is DoD educating for it?

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr. Mark A. Gallagher, FS; Prof. Bradley A. Warner; Lt Col Bruce A Cox, PhD; Col Judson Dressler; Col Tucker Hamilton		
Abstract: Data Science is the latest rage! Whereas data science (DS) mostly overlaps the fields of operations research (OR), statistics, and computer science (CS), we contend that it is an emerging new field. Along with a unique blend of expertise, data scientists are developing a new and distinctive approach to addressing challenges with an approach of data-first, then modeling. The Department of Defense (DoD) wants to exploit the military advantages of the information age brought on by inexpensive sensors and computer storage; however, the competition with industry for data scientists is very challenging for the government and the DoD, in particular. Hence, the DoD needs to grow more of our own data scientists. As educators at the United States Air Force Academy (USAFA) and Air Force Institute of Technology (AFIT), we present mostly an Air Force perspective. After identifying the necessary DS knowledge and skills, we have developed and continue to refine appropriate courses for our degree programs along with associated research. In this presentation, we define DS, its role in the military, and how our new degree programs support developing the data scientists needed within the DoD. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

65753 - Chance-Informed Contract Management

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Maximillion Disla; Dr. Sam Savage		
Abstract: Many government agencies manage both civilian and defense contracts. These agencies manage thousands of contracts per year and must contend with an ever-growing range of uncertainties such as as labor rates, material costs and supply chain delays. In spite of significant data on past contracts, and ranges of future conditions, it is nonetheless difficult to estimate the chances of delays and cost overruns. The discipline of probability management allows the creation of stochastic libraries from both historical data and expert opinion to monitor the chances that contracts will be ready when needed and come in within budget. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

66255 - Machine Learning-based Prediction of Aircraft Maintenance Likelihood

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Yan Glina; Cynthia Engholm		
Abstract: Unscheduled aircraft maintenance significantly affects operational readiness, repair crew and supply-chain scheduling, and fleet operations costs. Recent advances have shifted many operations from run-to-failure into the domain of intelligent scheduling or conditions-based predictions, perhaps enhanced by the use of specialty sensors. These advances have improved maintenance operations, yet a large number of unscheduled maintenance types and events remain unpredictable. Sensor deployment may not be practical in all systems, and the availability of truth,		

often requiring a labelled dataset, is frequently beyond reach. For some activities, the complex interplay between the possible signals containing information about components and the absence of a good characterization of a potentially failing system, has prevented development of a successful prediction model.

An alternative approach to either run-to-failure or sensor-drive maintenance, is assessing the health of the aircraft by fusing historical maintenance data and recorded flight data. It is possible to perform post-flight assessment of the impacts of both continued in-flight equipment wear and maintenance activity on aircraft health. The fused data can be used with survival modeling machine learning techniques to improve prediction accuracy. A proof-of-concept predictive system architecture utilizing this approach was developed at MIT Lincoln Laboratory to investigate maintenance predictions for the KC-135 Stratotanker, a military airframe with a primary mission of aerial refueling. The system architecture was divided into three parts: establishing predictive scope, generating and choosing predictive features, and making the predictions. This talk will focus on the latter two parts, the obstacles faced, and capabilities built to yield a successful result.

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Location: TH365
Classification: UNCLASSIFIED
Working Group: WG19 Readiness

65496 - Readiness Predictions for the MH-60 SeaHawk with the Digital Aviation Readiness Technology Engine

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr Jamal Tildon Rorie		
Abstract: The Digital Aviation Readiness Technology Engine (DARTE) paradigm, proven highly successful with fixed-wing aircraft such as the F/A-18 Super Hornet and E-2 Hawkeye, has had the MC model expanded to rotary wing aircraft for the first time with predictions for the MH-60 Seahawk. Readiness datasets for the MH-60 are explored and AI/ML models are created to predict future Mission Capable (MC) aircraft in squadrons. New challenges, including different squadron structures and deployment profiles, are addressed. Additionally, new insights are accessible with the addition of new readiness datasets and interrogation of model predictions with explainable AI (XAI). Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

66700 - Quantifying the Marine Littoral Regiment's Contribution to Deterrence

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: LtCol Roy L. Miner		

Abstract: This presentation attempts to examine the MLR's effect on deterrence using a modification to the risk construct model Risk = Threat*Vulnerabilities*Consequences (TVC) where we modify the Risk equation to be Risk = (Threat*Consequences)/Defensibility and incorporate Dr. Michael Armstrong's Stochastic Salvo Model into the Risk equation.

In the modified risk construct model, we can define force A's threat value from adversary force B as: Threat = (B Offensive #SSMs)*P(Hit)*Target in Range*Target Acquired where "P(Hit)" is the probability of an unimpeded hit on the targeted ship by an SSM. "Target in Range" and "Target Acquired" are binary variable (yes = 1, no = 0). The notation can be expressed as nB* pB * rB* tB.

We define force A's consequences value with respect to adversary force B as: Consequences = ((Lethality of B Offensive SSM)*(# B Offensive SSMs))/(# A Ships at Risk) where lethality is the number of SSMs required to put an adversaries ship out of action. For example, an SSM that requires 5 hits to put a ship out of action would have a lethality of 0.2. The notation can be expressed as (lB*nB)/A.

We define force A's defendability value with respect to adversary force B as: Defensibility = (Defensive #SAMs)*P(Intercept) where the notation can be expressed as nY* pY and "Y" represents force A's defensive SAM capability.

This yields the risk to Force A as: RA = (nB^2pBlBrBtB)/(A(nYpY))

Essentially, we have the product of two ratios to determine a risk value. The first ratio is between the product of the # of offensive SSMs and their probability of hitting the target to the product of the number of defensive SAMs and their probability of intercept. (nB * pB * rB * tB) / (nY * pY). The second ratio is between the product of number of offensive SSMs and their associated lethality to the number of ships being placed at risk. (lB*nB)/A.

To determine the true risk value, we need to examine the risk between a unit's salvo capability to their adversary's salvo capability as they engage in offensive and defensive actions. This can be done through a ratio to determine the scalable deterrent effect the MLR may have in an area of operations. We can compare the offensive and defensive risk ratios (Ro/Rd) and their respective deltas for a force without the MLR and a force with the MLR.

With the risk equations established we can begin to analyze some fundamental effects of changes in the various parameters used in the stochastic salvo model. We can also show the effects to the risk equation across a range of values for an adversary and examine the results using a heat map to further understand the MLR's contributions to deterrence

Location: TH365
Classification: UNCLASSIFIED
Working Group: WG19 Readiness

66672 - Informing Readiness through the Visualization of Inspection Data

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Stafford R. Maheu; Ms. Emma Shumway		
Abstract: In 2022, the Air Force Inspections Agency (AFIA) undertook an initiative to generate value for leaders and Inspectors General by capturing descriptive data collected during inspections and		

presenting it to stakeholders through a simple to operate and widely accessible visualization. Since 2009, AFIA has used the Inspector General Evaluation Management System (IGEMS) to collect inspection results, generate inspection reports and serve as a report repository. While IGEMS performs these functions well, it lacked the functionality to readily organize, assess and present data in a meaningful way to inform decision makers. Analysts encountered gigabyte sized, spreadsheet data files which, when downloaded, proved difficult to manipulate and required time consuming data cleaning at each user location. Further, IGEMS requires registration for creation of individual accounts to access the SQL based application.
The AFIA solution, referred to colloquially as the "IG Dashboard" leverages Microsoft Power BI for data processing and provides access to inspection deficiency and completion data through a user-friendly interface, tailored to stakeholder needs, and readily accessible by any Airman or Guardian via their Common Access Card. Power BI ingests and cleans data which allows IG Dashboard users to jump straight into analysis from one or more user echelons or mission sets. Following its fielding in October 2022, stakeholders quickly adopted the use of IG Dashboard to where it currently ranks among the Top 10 of over 1600 Department of the Air Force (DAF) hosted Power BI projects as measured by unique users.
This presentation will provide a brief overview of the IG Dashboard capability, discuss AFIA's related uses of Power BI, lessons learned, and plans for expanded use of the visualization capability across the DAF IG Enterprise.

Location: TH365
Classification: UNCLASSIFIED
Working Group: WG19 Readiness

65607 - IDA's Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM)

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Ms. Eleanor L Schwartz		
Abstract: This presentation describes the Institute for Defense Analyses' Risk Assessment and Mitigation Framework for Strategic Materials (RAMF-SM). RAMF-SM is a set of models, procedures, and databases that can be used to identify shortfalls of strategic and critical materials in a national emergency and to develop and assess strategies for mitigation of such shortfalls. Its primary use has been to provide analytic support for DOD's National Defense Stockpile (NDS) of Strategic and Critical Non-fuel Materials. RAMF-SM results appear in the legally-mandated biennial reports to Congress on NDS requirements. This talk includes discussion of some recently-developed linear programming models that can be used to establish priorities for new acquisitions for the NDS. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

65805 - Capturing Space Effects in a Joint Campaign Analysis Effort

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Michael Edward Terry, N/A		
Abstract: The U.S. Space Force (USSF) was established on 20 Dec 2019. As the newest Service, USSF does not have a long history of warfare, lessoned learned, and evolving warfighting doctrine, as do the other Services. So, the continual challenge is using common, campaign-level tools to articulate		

the value of “enabler-focused” capabilities like space. The Joint Space Warfighting Forum (JSWF) effort worked from 2016-2021 documenting warfighting effects using analysis of Joint Mission Threads (JMT) to capture space touchpoints. Once identified, a Delphi method amongst a group of mission experts was used to assess how to model effects in a Synthetic Theater Operations Research Model (STORM). So, for missile warning (MW); positioning, navigation, and timing (PNT); satellite communications (SATCOM) a mission analysis was conducted to capture order-of-battle, satellites/orbits, and expected effects. These inputs were used to develop a roadmap for space development within STORM based on considerations of leadership priorities and low hanging fruit – start with an early victory. Many engagements with experts were required to understand the space mission capabilities. Subsequently, warfighter vignettes or real-world scenarios were used to assess space mission area contributions to a selected warfighting tactical operation. Additionally, various space studies were leveraged. These space contributions were used to further inform space effects to the warfighting campaign. SpOC DCG-T S9’s analytical benchmarking contributed to identifying space insights to the Joint Force Operating Scenarios (JFOS) modeling & simulation effort which was briefed up to the Deputies Management Action Group (Vice Service Chiefs). Low-hanging fruit was how space contributes to the Command, Control, Communications, Computers, Intelligence, Surveillance, Reconnaissance, and Targeting (C4ISRT) in an anti-access/area denial (A2AD) environment against a near peer. An orbitology model called Integrated Space Situational Awareness (ISSA) captured the National Reconnaissance Office architecture. Target grids were developed and the enemy laydown of forces was superimposed. Overflights were conducted to show probability of detection (Pd) and informed the target system analysis (find, fix, track, target, engage). This model shows various architectures including attrition to show the effect of Pd. Moving forward USSF will engage with other Services to capture space effects in models. A TTX captures a specific tactical operations. Vignettes are developed to discuss with tactical planners/experts the detailed key tasks and political, military, economic, social, information, infrastructure, physical environment and time (PMESII-PT) analysis. Space touchpoints are identified for the mission. Then a risk management analysis is conducted to determine impact of not having space capabilities against primary, alternate, contingency, and emergency options. This methodology will be briefed.

Location: TH358 Classified
Classification: SECRET NOFORN
Working Group: WG19 Readiness

65442 - Using Finite Source Queueing and Simulation to Optimally Determine the Number of Maintenance Repair Workstations for a Fleet

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Dr. Greg H. Gehret; gordon m. (mike) mcclure		
Abstract: If the number of repair workstations is too large, excess maintenance capacity will exist and taxpayer money will not have been spent wisely. If the number of repair workstations is too small, excessive maintenance delays will occur and the fleets operational availability will degrade. In this presentation we will show how the finite source queueing model can be used and highlight its underlying assumptions. We’ll also show how simulation can be used to challenge some of the underlying assumptions of the finite source queue. We’ll cover both models within an Air Force application, the number of landing gear stations needed at a depot for the KC-46 fleet. Location: TH365		

Classification: UNCLASSIFIED Working Group: WG19 Readiness

66678 - LCS Wolfpack Lethality & Survivability

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr John Gibson		
Abstract: Operations Analysis of US Naval Tactics Using LCS & LUSVs in a Wolfpack Scenario: This presentation will state the results of a modeling and simulation study to determine if the use of Littoral Combat Ship (LCS) Wolfpacks improve fleet survivability and effectiveness, and if so, if the inclusion of Large Unmanned Surface Vehicles (LUSV) enhance the Wolfpack's performance. A Wolfpack is a small contingent of ships designed to operate separately from a Surface Action Group (SAG). The Wolfpack moves at high speed, conducts its mission by attacking predetermined targets, and quickly departs. This allows the remaining SAGs / Carrier Strike Groups to remain out of range of enemy weapon systems until completion of the Wolfpack's mission. This study showed how the use of a smaller "Wolfpack" grouping of LCS increased the survivability of the US Navy fleet. Additionally, the second portion of the study incorporated the use of LUSV in place of some of the LCS. The incorporation of LUSV greatly reduces the number of US Navy personnel required to participate in the conflict, thereby reducing the number of sailors "in harm's way", while increasing firepower and effectiveness. The study used ExtendSim to model a SAG vs SAG conflict. Four different US-ship configurations were modeled – a Baseline based on current Naval tactics; a Wolfpack comprised of LCS; a Wolfpack where two LCS were replaced with two LUSVs who escorted the LCS to the target location; a Wolfpack where two LCS were replaced with two LUSVs, where the LUSVs loitered in a predetermined location (LUSVs are currently designed to travel at a slower speed than LCS, so having them wait reduces the time the LCS spend within range of adversary weapon systems). Two metrics were used to assess if a difference existed between the four configurations: number of adversary targets destroyed and number of US targets destroyed. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

65617 - MK48 Heavyweight Torpedo Lifecycle Simulation

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: John Walker		
Abstract: During past assessments of Navy budgets, discussions with senior leaders and subsequent analysis revealed the potential benefit of a modeling tool to aid in determining the optimal mix of new heavyweight torpedoes (HWT), HWT repair parts, and exercise torpedo (EXTORP) to warshot conversion hardware. As a result, N81 examined the HWT lifecycle and developed a simulation model to assist planners and decision makers in evaluating options to meet inventory objectives as early as possible. N81 collaborated extensively with Undersea Weapons Program Office (PMS-404), Naval Undersea Weapons Center (NUWC), OPNAV N97, and COMSUBFOR to develop a thorough understanding of the HWT lifecycle and associated requirements. This information was used to develop a discrete event simulation model using SIMIO. Underpinning the model was five years of historical data used to empirically model various processing, transit, and torpedo dwell times throughout the lifecycle to		

develop an accurate picture of how many EXTORPs and warshots are required to meet fleet training and inventory requirements now and into the future.
Based on the results of early data analysis, this initial study focused on the potential near to mid-term inventory impacts of a reduction in torpedo Intermediate Maintenance Activity (IMA) processing time. This type of improvement creates immediate opportunity for conversion of EXTORPs to warshots, improving fleet inventory without sacrificing EXTORP requirements. Notably, the model was developed in-house by N81 and is available to HWT stakeholders for further development and future decision support. The model is enduring and input parameters can be updated as real world conditions change (e.g. changes to transportation networks, improvements in IMA processing time).

Location: TH358 Classified
Classification: SECRET NOFORN
Working Group: WG19 Readiness

65752 - Lockheed Martin Fellow

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Mr. Philip Alan Fahringer		
Abstract: Dynamic, stochastic weekly sortie completion model – chances of success and magnitudes of failure Across the aviation community worldwide, weather it's peacetime or war, weather it's on a deployment or home station, training or proficiency, each squadron is faced with the same question – will we complete our desired sorties this week? And unfortunately the answer is very simplified, unscientific, founded on rules of thumb, and averages and historical success or failure rates and is usually in the form of a phrase – such as "we should be able to" or "as long as we aren't unlucky", etc. Today in the Age of Chancification, this simplification is no longer necessary and can immediately be replaced by responses such as – "We have and 85% chance of meeting all sorties this week, and a 5% chance of falling short by 5 or greater sorties". Further, we can instantaneously and interactively explore which factors are driving the 85% success rate – is it parts, pilots, maintenance? Too many sorties, too few jets? Also, what if we increased the requirement? Lastly, what if the first day we had higher than average aborts and breaks, now how do our chances look? Should we adjust the schedule or press on? Is it training or mission operations? Should we alert someone? This presentation and demo model will introduce the audience to a tangible example of exactly how the discipline of Probability Management can be employed in the Age of Chancification to answer all of these questions and explore many others and it's all ready to be implemented and exploited. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

66371 - Readiness and Risk under ReARMM

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Raymond Vetter		
Abstract: The Regionally Aligned Readiness and Modernization Model (ReARMM) is the Army's current force generation model, which commenced in October 2021. This model is meant to support modernization of Army equipment and formations at a scale not seen in the past 40 years, while simultaneously maintaining a global campaigning presence. Grounded in three core tenets, ReARMM		

seeks to provide predictability, stability, and synchronization for the Total Army. The Army established “mission lines,” which group like units in alignment against regional demands (e.g., United States Indo-Pacific Command) or functional demands (e.g., Immediate Response Force). At any given time, a unit within a mission line can fulfill a “campaigning” mission or a “prepare to deploy” mission. Simultaneously, other units in the mission line are modernizing or training for upcoming missions. This structure provides predictability and stability since unit life cycles are set for at least 5 years into the future. It also allows for synchronization across the training, equipping, and manning communities within the Army. ReARMM ensures that the Army meets the current demand for campaigning requirements; however, analysis for the transition to conflict against a near-peer is sparse.

This presentation will highlight how the Army can forecast force capacity when informed by ReARMM unit life cycles. These forecasts then enable the assessment of Army’s ability to meet conflict requirements based on time-phased force and deployment data. Forecasts include training, personnel, and overall unit readiness matched against the latest war plans and the continuous campaigning demands. Overlaying supply and demand considerations allows for the identification of potential risk areas. Visualizations allow senior leaders to identify when the Army may incur the most risk, and for which unit type. Given recent trends in Army recruiting and retention, the personnel readiness analysis is especially relevant in helping leaders understand the risk to overall unit readiness. This presentation will discuss how the Center for Army Analysis provides timely analysis of how ReARMM generates readiness capacity to meet current and future campaigning and conflict demands.

Location: TH358 Classified
Classification: SECRET NOFORN
Working Group: WG19 Readiness

65601 - Facilitating Procurement and Investment Decisions for Medical Items using the Defense Industrial Base Optimization Model (DIBOpt)

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Quentin Robinson

Abstract: The COVID-19 pandemic disrupted global supply chains, exacerbating previously existing challenges related to the procurement and inventory management of medical items for civilian and military uses. This presentation describes IDA’s Defense Industrial Base Optimization Model (DIBOpt), which is currently being used by the military to prepare budget and procurement plans for medical countermeasures. Such planning needs to consider a variety of factors, including price increases, sole-source manufacturers, product modernization, changes in required quantities, distribution into medical equipment sets, forward storage/stockpiling in different combatant commands, constrained budgets, expiration of items currently in inventory, and costs of and planning for shelf-life extension programs. The complexity and evolving nature of managing these stockpiles calls for a modeling solution to efficiently collect relevant input data and generate quick-turn analyses.

Originally developed as a model to assess munitions readiness, DIBOpt was designed to capture important dynamics of the industrial base and supporting supply chains for any item or consumable. Features like supply chain interdependencies, investments, shared production lines, lower tier constraints, production lead times, facility production rates, demand profiles, and substitution were already part of the DIBOpt structure. To model medical items, DIBOpt was enhanced to allow tracking

of individual items by unique lots to account for lot expirations, and to allow consideration of extended shelf-life through a government-run shelf life extension program.

The next phase of this research will exercise additional DIBOpt capabilities as IDA explores the supply chains that support key items to determine where bottlenecks exist, the effect of those chokepoints on the ability to build inventories, and the mitigation strategies necessary to reduce risk associated with inventory deficits.

Location: TH365
Classification: UNCLASSIFIED // FOUO
Working Group: WG19 Readiness

65746 - Calculating Unit-Level Operational Effectiveness Following CBRN Insults

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr. Sarah (Schmitt) Eaton; James Tyler Dant; Mr. Jason Rodriguez; Dr. Gene McClellan; Greg Schwarz

Abstract: Military commanders and planners lack a time-dependent model that effectively simulates unit-level operational effectiveness following exposures to chemical/biological/radiological/nuclear (CBRN) insults. Modeling CBRN insults is incredibly complex, as models need to account for individual severity of injury or illness over time, incorporate mitigating factors (i.e. individual/collective protection, medical countermeasures), and simulate which aspects of mission-essential tasks are impacted by even low-level exposures. Understanding the impacts of complex CBRN environments on a single warfighter and modeling those impacts across a unit is critical to estimating unit-level readiness as a function of time, mission, and resources following such insults. The models that we will present are designed to address these complexities by: 1) assessing each soldier's task-specific performance degradation based on dose- and time-dependent physiological presentation of illness or injury, and 2) rolling up individual performance degradation as a function of time into unit-level measures of operational effectiveness. These unit-level roll-ups are critical in assessing medical planning and recovery, identifying mitigation techniques to improve survivability and sustainment, and determining a unit's readiness to complete a given mission.

This presentation will provide (1) an overview of the complex operational planning needs specific to CBRN insults, (2) an overview of potential tabular outputs summarizing unit-level operational effectiveness in both the CB and RN spaces and (3) proof-of-concept of both the CB and RN methods using demonstrative use cases.

This work is funded by two Defense Threat Reduction Agency (DTRA) departments within the Research and Development Directorate (RD): Chemical and Biological Technologies (CB) (HDTRA1-22-C-007) and Nuclear Technologies (NT) (HDTRA1-14-D-0003).

Location: TH365
Classification: UNCLASSIFIED // FOUO
Working Group: WG19 Readiness

66060 - Characterizing Production Capacity of Lightweight Torpedo Intermediate Maintenance Activity

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: John Walker; Thomas Karnezos; Deanne McPherson; Jonathan Celaya		
Abstract: In order to meet current and future requirements, streamlining the assembly and maintenance of the Lightweight Torpedo (LWT) inventory is critical. Additionally, demands on the Intermediate Maintenance Activity (IMA) are expected to change dramatically over the next decade due to addition of future systems much as the Mk 54 Mod 2, Mod 1 production ramp up, Mod 0 requirement reduction, and the sunset of the Mk 46. This study examined the LWT IMA assembly and sustainment processes and practices to understand what type of resourcing and support would be needed to meet LWT requirements now and into the future. The study approach was based on characterizing the throughput capacity of the IMA by developing a custom-built Throughput Model using Discrete Event Simulation (DES). The DES model structure is based on process flow diagrams representing the approximate 100 individual processes for each of the seven LWT build/turn types. The process flow diagrams and the time to complete each individual process was informed by IMA historical data collection of individual process times. The model utilizes prioritized queuing by build/turn type and incorporates variability by assuming exponential distributions for each individual process time. The model represented expected throughput of the IMA when constrained by the physical capacity of work areas and determined the baseline rate for IMA assembly and sustainment. This provided the foundation for a sensitivity analysis of different courses of action to increase throughput. Location: TH365 Classification: UNCLASSIFIED // FOUO Working Group: WG19 Readiness		

66196 - Future Force Assessment Results

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Wayne O. Nitzschner		
Abstract: The Army requires operational assessments of planned transformation efforts to inform planning and programming decisions. To design Army 2040, Army Futures Command (AFC) must first understand the effectiveness of Army 2030 formations and capabilities. The Future Force Assessment (FFA) is an analytically underpinned program of annual assessments designed to evaluate the operational effectiveness of future Army formations. The FFA is a multi-dimensional assessment that qualitatively and quantitatively examines force effectiveness. This study's area of focus features the contributions of key organizations within units, organizational interdependencies, associated operational risks, and the impacts of anticipated signature modernization capabilities. To do this, the recent iteration of the FFA leveraged an assessment workshop with operational subject matter experts (SMEs), employed combat models informed by workshop results, and executed a sustainment assessment to confirm operational feasibility. FFA results provided Army senior leaders comprehensive assessments that enabled informed force design and resourcing decisions. The presentation will provide an overview of the FFA focusing on the study methodology, the measures used to assess force effectiveness, the analytical efforts, and the way ahead for future assessments. Location: TH365 Classification: UNCLASSIFIED // FOUO Working Group: WG19 Readiness		

66434 - Dynamic RF Signature Prediction for Helicopter Development

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Ms. Andrea S. Morris		
Abstract: The DEVCOM Analysis Center (DAC) predicts the susceptibility of targets to radar detection with computer simulation tools, like the Air Force's Xpatch, that produce estimates of radio frequency (RF) reflective signature. A static signature in Radar Cross Section (RCS) has single values for each needed view, and a dynamic signature has a set of time-stepped values for each view, based on the expected sampling rate of the radar. The sizable, relatively dynamic rotors of helicopters are highly visible to modern, fast sampling radar capable of Moving Target Indication (MTI). However, developing helicopter designs are typically compared with static rather than dynamic signature because of the additional time it can take to generate the thousands of additional time-step predictions necessary to capture flash, brief but detectable high reflection values. DAC conducted a proof-of-concept effort to explore techniques to reduce the time to adequately estimate dynamic signatures. First, a legacy helicopter target's CAD geometry model was systematically hand simplified, to get each prediction run's time down to minutes. Based on threat analysis, the number of needed views were then pared down and distributed into sections that would run for a given frequency in two weeks, producing sufficient dynamic signature results in a couple months on a single available computer system, or quicker with multiple systems. Post processing is expected to result in both I&Q type files that can be compared with existing test data, and RCS files that can be averaged for comparison to existing averaged static predictions, or further processed to capture flash sustained long enough to be seen at the expected radar sampling rate. With this approach of CAD model simplification and relevant threat analysis to focus on frequencies and views of interest, we have the tools and processes to perform adequate dynamic RF signature predictions in time to inform developing helicopter designs concurrent with input from other Technologies. Specific threat analysis will not be discussed. Location: TH365 Classification: UNCLASSIFIED Working Group: WG19 Readiness		

WG20 Analytic Support to Training and Education

68517 - Natural Language Processing Analysis Using Text Data from Soldier Training Observations

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Sargis Karavardanyan		
Abstract: Observational information is an integral component of warfighter training. Yet, there are limited approaches in applying modern analytical techniques to extract useful insights from such data. This project presents a framework for analyzing text format data on Soldier trainings. The framework incorporates Natural Language Processing (NLP) analysis to train various classification models. The models use textual data collected on Soldiers training which includes observations, discussions and recommendations. The objective of the project is to learn how the sentiment scores (positive or negative) in each Soldier training observation and discussion impact the sentiment scores in corresponding recommendations. More specifically, after calculating the sentiment in each collected observation, discussion and recommendation using Machine Learning methods, the ratings of sentiments are inserted in ordinary least squares (OLS) and Logit regression models to derive		

predicted probabilities. The predictions inform about the size of the effect that sentiments scores in observations and discussions produce on the sentiments of recommendations.

The results showed that while at the base level neither the continuous nor the binary measurements of Observations' sentiment scores had any meaningful statistical impact on the Recommendations variable, yet, the effect produced by Discussions variable on Recommendations in the OLS and Logit models was positive and statistically significant. Finally, we trained Random Forest, Neural network and Extreme Gradient Boosted Machines models to analyze the predictive accuracy of sentiment scores in the Recommendations variable given the set of Observations and Discussions sentiment scores, and word counts. The results demonstrated that the most accurate predictions with lowest false positive and negative outcomes were produced by XGBoost model when the main explanatory variable was Observations sentiment scores, and Random Forest model when the main explanatory variable was Discussions sentiment scores.

Important implications of this modeling approach include 1) providing holistic view in understanding the text based training information, 2) refining observation collection practices to provide most productive insights, and 3) verifying the validity of aggregate and specific sentiments in observations collected by the analyst when comparing it to the feedback received from the community of interest.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

66200 - Campaign Level Training with Simulation-Supported Wargames

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Mr. Charles D Burdick, CAP

Abstract: In reviewing our options for training in large-scale command post exercises and wargames, it was proposed to go back and look at how the Joint Forces Command (JFCOM) J9, their experimentation and exercise Directorate conducted simulation supported wargames and exercises with the Joint Warfare System (JWARS), a then new constructive model.
In 2006, when JWARS successful simulated an entire Strategic Theater scenario in a single model, JFCOM asked if it could also be used as a simulation-supported wargaming at large scale. When the answer was yes. JFCOM then assumed sponsorship of JWARS, renamed it the Joint Analysis System (JAS), and proceeded to take advantage of its capabilities.
First, JWARS is an event-stepped model rather than a time-stepped model. The model can be therefore paused at any point and subsequent events would be held in a queue. Modifications were made to the pause function to allow new inputs and then resume the simulation mode.
Second, JWARS has over 150 types of computer agents commanding or managing multi-domain operations and their supporting logistics, transportation, and C4ISR. They generate status reports and sensor reports in the form of a map-based Common Operational Picture or COP.
Third, in JWARS, information is transferred by simulated networks carrying English readable messages. The loss or delay of these messages causes uncertainty in the situational awareness and can lead to faulty decisions.
Placing wargamers into the roles of selected agents allows them to review the same status reports and the COP, make potentially decisions, and resume the model at high speed until the next pause. And because every event in JWARS is automatically recorded, the recorded wargame can then be rerun as either the same wargame with pauses to review the previous actions or as the same

wargame with new wargamers. Thus, training could be continued and expanded using the recording as a basis and changing orders, parameters, etc. to improve the outcome.
This presentation addresses the opportunity for even individuals to improve their capabilities to perceive the situation when it is not provided as ground truth. How far the COP differed from reality can be determined the ground truth, which is also collected, but only available to the White Force. And it's not just commanding agents being replaced, you could replace logisticians or transportation experts. The opportunities are extensive because rerunning the wargame costs virtually nothing.
JAS was archived by OSD/CAPE in 2011 following JFCOM's disestablishment and CAPE's decision to leave Campaign analysis up to the Services. But it could be rapidly restored to operational capability. Given the increasing possibility of near-peer conflict, the opportunity for rerunning large scale wargames without all the necessary support either by teams seeking better outcomes or individuals learning their responsibilities would be an excellent addition to our training capabilities.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

65510 - Developing an Undergraduate Program in Navy Engineering Analytics

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Cameron MacKenzie

Abstract: The Department of Defense (DoD) requires personnel with engineering and analytic capabilities. The design of better educational programs in science, technology, engineering, and mathematics with defense applications and relevance will help DoD recruit personnel with technical and engineering expertise. Military systems are increasingly becoming more complex. Designing complex systems requires an understanding of how humans interact with these systems and how these systems should be designed in order for military personnel to operate these systems safely and efficiently.

The era of big data has arrived in defense. DoD needs people with data analytic skills who can discover patterns in that data, apply machine learning techniques, and make informed decisions based on that data. Good decision making requires sound analytical thinking with the ability to identify objectives for the decision and identify key uncertainties that impact the quality of the decision. DoD needs a workforce educated in decision making and risk mitigation who can apply those principles while interpreting and relying on the best data and information available.

Thanks to funding from the Office of Naval Research, Iowa State University (ISU) is launching a Navy Engineering Analytics Program (NEAP) for undergraduate students. The objective of NEAP is to develop an innovative education and training program that teaches analytical skills in:

* Complex system design analysis
* Designing and evaluating human-computer interaction (HCI) systems
* Crisis decision making with uncertainty and multiple objectives
* Risk assessment and mitigation
* Modeling and forecasting an uncertain future
* Data science and machine learning

NEAP is teaching students how to apply this knowledge and these diverse set of tools to solve Navy problems. The goal of NEAP is to provide undergraduate engineering students at ISU with the necessary analytical skills so that they can enter into exciting professions in the Navy, the broader defense community, and industry that directly supports the Navy and DoD.

NEAP is currently composed of four courses: (i) crisis decision making and risk management, (ii) design and evaluation of HCI, (iii) problem solving using R, and (iv) a project-based course in which students work on DoD-sponsored projects.

NEAP is designed to attract undergraduate engineering students at ISU. Engineering students have little room for additional electives, and there is a trade-off between designing courses that go in-depth and require prerequisites and making the classes broader without prerequisites. Although several students have expressed interest in the program, it has been challenging to get students enrolled in all the courses. NEAP did award 10 students with scholarships in Spring 2023 and will be awarding an additional 10 students with scholarships in Fall 2023.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

66145 - Improving Training Risk Assessment for Heat Related Injuries

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Gregory S. Parnell, FS; Dr. Randy Buchanan; Dr. Edward A. Pohl		
Abstract: Heat related injuries are a problem for the United States military. The Pentagon reported a 50% increase in heat exhaustion cases and a 68% increase in permanent damage or death caused by serious heat strokes. Hyperthermia (i.e. abnormally high body temperature) leads to heat injuries due to extreme environmental temperatures, high humidity, medications, or excessive physical work or exercise. Fort Benning has the most heat related injuries in the military since it is home to one of the largest U. S. Army training posts with most training involving intensive outdoor activity in high heat and humidity. Currently, they assess risk using a WetBulb Globe Temperature (WBGT) Index, which measures the heat stress in direct sunlight. This presentation will 1) provide insights on how temperature impacts soldiers and current risk assessment methods, 2) describe our approach, which uses a data-driven weather-informed process, and 3) discuss future work of the project, which includes migrating our tool to the U.S. Army's Virtual Testbed for Installation Mission Effectiveness (VTIME) cloud environment. Location: TH312 Classification: UNCLASSIFIED // FOUO Working Group: WG20 Analytic Support to Training and Education		

66096 - Optimal Leadership Role Assignment

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Jack R Hernon; Thomas Kendall		
Abstract: Throughout the United States Army, there exist many military schools that test the induvial leadership skills of trainees in simulated platoon level operations. To graduate from these schools, trainees are assessed and receive "GOs" for their performance in specific leadership positions.		

Generally, there is no systematic way of assigning trainees to specific leadership roles during specific missions, as instructors typically complete such assignments by hand. Leadership role assignment can be quite difficult due to real world constraints, which we explore in depth. Thus, the human element of leadership role assignment allows for errors and bias. Additionally, unexpected events, such as injuries or illness, can completely derail a leadership role assessment schedule which, in the worst-case scenario, means some trainees do not receive the required number of opportunities to pass. To address this, we develop a linear programming model that systemically distributes all leadership roles among the trainees during each simulated mission during a school. We create an objective of maximizing flexibility in the later part of the schedule and capture all the complex constraints placed on instructors for scheduling. Our solutions to the leadership role assignment problem are robust to unexpected events, never erroneous, and are unbiased in assignment.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

65929 - Professional Development and Wargaming at the United States Naval Academy

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: CDR Kenneth Maroon; Franklin Kenter

Abstract: We present an overview of the current and future state of wargaming efforts at the United States Naval Academy. This is a multidisiplinary effort among many disciplines including professional development, operations research, and history, among others.

We hope the wargaming initiative at USNA will become a larger and enduring component of the midshipmen experience and curriculum with the ultimate goal of developing leaders to synthesize the combination of their professional knowledge, analytical expertise and their personal experience to make decisions.

There are many challenges of introducing wargaming at the pre-commissioning/undergraduate level and how to integrate wargaming within the current training schedule and tight requirements on midshipmen time.

We discuss past, current, and future projects at USNA, including the following:

* Developing STEM-focused wargaming courses and modules for implementation at service academies and even universities at-large.

* Implementing wargaming into past courses within operations research, core science, and history.

* Establishing programs to train and equip facilitators at USNA for more common, yet complex, wargames. Among these facilitators would be midshipmen, officers and civilians.

* Building the foundations of digital wargaming capabilities at USNA via equipment and software.

* Expanding programs and collaboration for wargaming across the Navy-education enterprise and with other service academies.

We hope to spawn discussion of this endeavor.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

65676 - The Impacts on Air Force Pilot Production of Divesting Reserve T-38C Aircraft During the T-38C to T-7A Transition

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Mark D Hatch; Christopher R Caldwell; Dr. Stephen E Wright; Mr. Ryne M Spears

Abstract: The United States Air Force Air Education and Training Command (AETC) is responsible for producing pilots for the Air Force through the Undergraduate Pilot Training (UPT) program. Student pilots entering UPT begin their training on the T-6A Texan. After completing this phase of training and earning their wings, students proceed to one of three tracks: future rotary wing pilots train on the TH-1H, future airlift and tanker pilots train on the T-1A Jayhawk, and future fighter and bomber pilots train on the T-38C Talon.

The Air Force will soon be replacing the T-38C with the T-7A Red Hawk. This transition will take place in a phased approach. As T-7A aircraft are delivered over time the T-38C aircraft will be divested at a similar rate. AETC Studies and Analysis Squadron (SAS) and AETC/A5 have performed several analyses to understand the impacts to pilot production relative to the uncertainty in the T-7A delivery schedule, limitations on the structural life of the T-38C, and several other factors related to this transition.

Attrition Reserve (AR) aircraft are aircraft used to replace expected losses due to aircraft exceeding their useful life. AR aircraft can also be used provide parts that are difficult or expensive to procure. Fifty-one AR T-38C aircraft were scheduled for divestiture as part of the original T-7A delivery schedule. One of the many studies performed for the T-38 to T-7 transition sought to determine whether AETC should proceed with the divestiture of these 51 aircraft. Several “what if” analyses were conducted to predict mission capable and utilization requirements to support production. After many iterations, and the fact that many aircraft marked as attrition reserve could be used for parts in support of the operational fleet, AETC leadership determined this request would have unresolved negative impacts on the future of pilot training.

AETC SAS conducted these analyses using a Monte Carlo simulation tool, the Executive Decision Model (EDM). EDM models the Air Force’s UPT pipeline. EDM calculates the impacts that several variables (i.e., weather, number of available aircraft and simulators, number of instructor pilots and civilian simulation instructors, aircraft utilization rate, maintenance, etc.) have on the production and capacity of the flying training pipeline.

AETC SAS and AETC/A5/8 used EDM to forecast up to 17 years of pilot production impacts during this analysis. We present results of these simulations that predict unacceptable negative impacts to future pilot production. This analysis supported AETC's decision to delay the divestiture of the 51 AR aircraft.

Location: TH312

Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

65693 - The Application of Machine Learning Data Analytics to Optimize After-action Review (AAR) Sessions.

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Michael King, Ph.D.; Joseph Filipek; Meghan O'Donovan; Clifford Hancock; Gregory Goodwin, Ph.D.

Abstract: Effective communication is vital to optimal team performance, especially under high-stress conditions. Communication breakdowns on the battlefield can have catastrophic consequences, such as friendly fire and fratricide. Communication is a key leadership competency indicator and the U.S. Army has made significant investments in developing its leaders to be effective communicators. An essential element of leadership training is the availability of valid and timely assessments of leadership competencies. However, Army instructors and unit leadership rarely have access to rich natural language data for their competency assessments because recording, analyzing, and interpreting communications is arduous and time-consuming. The exclusion of these verbal communications in leadership competency assessments constitutes a missed opportunity to capitalize on a valuable and abundant data source to assess and optimize leader performance. Currently, individual instructors responsible for training and assessing leadership competencies through live training events must rely solely on what was directly heard in real-time. These observations are subject to the limits of human perception and memory. Consequently, team leadership communication assessments and after-action reviews (AARs) in live training events tend to be subjective and based on incomplete information. This can lead to unreliable, improper diagnoses resulting in ineffective training, wasted resources, and potentially adverse impacts on squad and team morale.

As part of the US Army DEVCOM Soldier Center's Small Unit Performance Analytics program, we developed communications-based measures of teamwork and leadership competencies for infantry squads executing Battle Drill 2A (BD2A: Conduct a Squad Assault). We collected audio of verbal communications from 153 Soldiers from N = 33 squads executing more than 62 iterations of BD2A. To analyze this data, we developed an automated communication classification model using machine learning (ML) techniques. This model took transcriptions from Soldiers completing BD2A and classified them based on the pre-identified communications-based measures. The communication scores extracted using the ML model were associated with, and predicted, key indicators of NCO leadership competencies with statistical significance.

The presentation will discuss the application of ML data analytic techniques to process natural language data during squad battle drill completion and produce prototype visualizations for Army instructors conducting squad evaluations in AAR sessions. We will present the methodology used to create visualizations from natural language data and sample data visualizations from actual BD2A live training events. The objective is for the audience to think about the vital role of communications in team performance and how that training data can more effectively and efficiently optimize instruction.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

66101 - Quantifying Offensive Security Expertise and Target Vulnerability with Item Response Theory Models

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Richard Callahan		

Abstract: Quantifying attacker efficacy and target vulnerability to exploitation is an important problem in cyber security. This research uses statistical models from educational assessment (Bayesian multidimensional IRT models) for the first time in the cyber-security domain, in order to identify the number of distinct skill dimensions required for success in two cyber-security competitions, and then to interpret what those dimensions are. IRT models benefit decision makers by transparently relating generalizable characteristics of the attackers and defenders to estimates of the probability that an attack would succeed. As a result, practitioners can use them to evaluate the performance of both human operators and algorithms and predict their performance in a hypothetical scenario, train human teams and AI-enabled systems, and empirically evaluate the contribution of new technologies to risk mitigation. Metrics for assessing model fit indicate how many distinct categories of attacker skill the models can identify. One competition tracked solutions submitted at the team level, and the second at the individual level. The research identifies two dimensions of ability at the team level: one most associated with web exploitation and forensics challenges and the other more strongly reflected by cryptography, binary exploitation, and reverse engineering challenges. The analysis at the individual level identified five dimensions of ability from four categories of questions: a dimension each for web exploitation, cryptography, and reverse engineering, and two separate dimensions for the binary exploitation category. As a theory-building exercise, we discuss the relationship between the challenge content and how well each question is measured by the corresponding dimension of expertise. The research plausibly leads to connecting the skills of attackers with their preferred methods of exploitation.

Location: TH312
Classification: UNCLASSIFIED // FOUO
Working Group: WG20 Analytic Support to Training and Education

66146 - A Digital Engineering Technology to Provide Advanced Network and Cyber Training

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Charles D Burdick, CAP; Dr. Deepinder Sidhu		

Abstract: The Persistent Cyber Training Environment (PCTE) is designed for excellent introductory and certification training but has little time available for the more advanced student. The Network Digital Twin technology was originally built for high fidelity testing of digital networks and the equipment and protocols on them, but also offers opportunities for realistic advanced training on clones of actual networks with minimum effort.

Network Digital Clones or NDCs passively collect information from available network and commercial reports, automatically map that collected data, and then produce a 3D visualization of the data map as a fully interrogatable 3D clone of the mapped physical network. The visualization allows access to all the mapped data with just a few clicks. The passive collection can continue for days or longer depending on the size of the network being cloned, but once sufficient data is available, the rest of the process completes in a matter of minutes to hours, again dependent on the size of the network.

Then, by taking the cloned data, adding millions of lines of public internet software including protocols, digital artifacts such as virtual network hardware, and adding some proprietary code, a

Network Digital Twin (NDT) is produced. That NDT is capable of emulating the operations of the cloned network including predicting its responses to disruptions and outages including cyberattacks.

This capability runs on commercial computers and requires no access to the internet. Not only can active-duty soldiers train on it, but reservists can now have access to an emulation of the network they must defend. And by training on this capability they can gain the experience necessary to "take the cyber high terrain" and better fend off all attackers. Also, malware attack on a virtual network cannot destroy any physical computer hardware.

The NDT uses only standard network commands and no simulation commands. Network test personnel have thus found it easy to learn and use NDTs. We believe that the benefits to network and cyber training to moving beyond the PCTE and cyber ranges with their notional networks offers network and cyber defenders truly advanced training on their assigned networks. And this can occur at their home station or Reserve Center with virtually unlimited access to the NDT. This should increase our network reliability, and maintainability, thwart a high percentage of attacks, and speed network recovery.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

64808 - Structured Analytic Techniques (SATs) improves Essential Elements of Information (EEI) Detection resulting in Improved Performance: An ISR Assessment

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr Justin Nelson

Abstract: Introduction: Intelligence, surveillance, and reconnaissance (ISR) operations collect critical information across Joint All-Domain Command and Control (JADC2) with respect to our near-peer adversaries' ground movement patterns, threat-level capabilities, and future military actions. However, intel analysts are rapidly becoming overwhelmed and overtasked as the quantity of incoming information exponentially increases with the advancements in emerging technologies. To combat this issue, ISR enterprise tools are being developed to support the comprehension of collected intelligence and enhance the decision-making process. Structured analytic techniques (SATs) coupled with information workflow methodologies have been shown to activate critical thinking and logical reasoning when confronted with unstructured, ill-defined content. Therefore, the objective of this research study was to evaluate the efficacy of SATs as a decision-support tool by correlating identified EEIs with solution accuracy through visual network text analysis when vague intelligence information is provided in both, incremental and complete sections.
Methods: Six groups of 25 participants each (N = 150) completed data collection for this study. Each participant was randomly assigned to one of two SATs (MDAQ, scaffolding) or a control condition and provided unstructured information in either incremental or complete sections with the objective of correctly identifying EEIs leading to improved solution accuracy.
Results: The findings provided underlying evidence that implementing the method for defining analytical questions (MDAQ) in an incremental fashion significantly enhanced EEI detection compared to scaffolding and control ($p < 0.01$). As a result, there was a significant improvement in solution accuracy for MDAQ compared to scaffolding and control ($p < 0.05$).
Conclusion: The results from the study provided new evidence that structured analytic techniques (SATs) can improve detection of essential elements of information (EEI) leading to greater solution

accuracy when confronted with unstructured intelligence similar to ISR collection datasets. Specifically incorporated the MDAQ approach, an in-house ISR SME developed SAT, improved detection of subtle EEIs embedded within the content that maybe overlooked otherwise. The results are promising that imposing MDAQ as a decision-support tool could enhance comprehension and processing effectiveness for unstructured datasets. Future research needs to be conducted in order to optimize the workflow structure and determine how SATs can be transitioned into currently existing and new ISR tools to support our warfighters.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG20 Analytic Support to Training and Education

WG21 Operational Energy

65688 - Project Pele Status and Industry Perspective

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Christa Reed		

Abstract: In 2016 the Defense Science Board(DSB) identified energy as a critical enabler of future military operations. The DSB found that the intermittent characteristics of many alternative energy sources do not appear able to keep pace with the growth of the Department of Defense's(DoD) energy needs, concluding that "the U.S. military could become the beneficiaries of reliable, abundant, and continuous energy through the deployment of nuclear energy power systems." Consequently, the DoD's Strategic Capabilities Office(SCO) launched Project Pele. The project aims to design, build and demonstrate a prototype transportable nuclear power plant. This effort will leverage state-of-the-art technologies and recent advances in nuclear engineering to deliver a nuclear reactor. The design will provide reliable and resilient power while minimizing the risk of nuclear proliferation, environmental damage or harm to nearby personnel/populations.*

SCO leads Project Pele in close collaboration with the DOE, Idaho National Laboratory(INL), Nuclear Regulatory Commission, U.S. Army Corps of Engineers and BWX Technologies, Inc.(BWXT).

The transportable power plant will produce 1-5 MWe, operate for at least three years at full power, and can be set up in 3-days and torn down in 7 using standard Armed Forces equipment. The reactor will be powered by TRISO uranium fuel, described by the Department of Energy (DOE) as the most robust nuclear fuel on earth. TRISO is walk-away safe, meaning the reactor will shut itself down if operating conditions exceed design parameters, thereby ensuring the system safety. Additionally, the power plant is expected to offset more than one million gallons of diesel fuel annually.

BWXT is contracted to build the power plant, complete integration testing at BWXT and ship the reactor to INL by 2025. The reactor will then be fueled with TRISO and initial operational testing will be performed.

The prototype is vital to demonstrate desirability and viability to the Armed Forces. Throughout the project, BWXT focused on ensuring that the design is easy to use, safe, affordable and can be used in real-world applications. Once the prototype is demonstrated, the Armed Forces will decide whether to pursue additional production units. Current first-case uses are for island and arctic U.S. bases.

The last details of the design are being finalized, and we have ordered initial pieces of long-lead materials and hardware.

Manufacturing the first advanced reactor in 50 years has its challenges. These include supply chain, regulatory, cost and schedule challenges, and BWXT is using its manufacturing and industry experience to address these. The presentation will focus on the challenges and BWXT's industry perspective on Armed Forces uses and also the unique set of problems for which nuclear power is the

best solution, including domestic emergency energy needs, climate change and space propulsion and exploration.
*DoD Research & Engineering, OUSD

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

66119 - Current US Army Developments of Micro-Mobile Nuclear Power Plants for Ground Operations

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Kenneth S. Allen

Abstract: The original US Army Corps of Engineers Army Reactor Operators Course ended in the 1970s when the Corps of Engineers concluded the Army Reactor Program which included several fixed-base and mobile nuclear reactors. In 2018 in response to high costs and casualties associated with POL use to produce electricity, the Strategic Capabilities Office (SCO) designated the US Army as the lead to investigate the use of Micro Mobile Nuclear Power (MMNP) reactors for ground operations. In 2019, the SCO created Project PELE to develop a prototype MMNP reactor designed to create 10 MW electricity, be air-deployable, and use high-assay low enriched TRISO fuel. As of October 2022, the SCO project PELE down selected to one corporate developer (BWXT) for the MMNP prototype with a criticality target of 2024. In 2021, the Office of the Chief of the Corps of Engineers (OCE) established the Nuclear Power Branch with responsibilities that include developing the training and curriculum for both enlisted reactor operators (RO) and officers who will serve as reactor leads (RL) and senior reactor operators (SRO). Currently, the Nuclear Power Branch is working with the Department of Physics and Nuclear Engineering at West Point to help develop the program of instruction and move forward to meet strategic milestones and requirements set by Army Reactor Office for licensed operators as the MMNP prototype is developed. In spring of 2022, Dr. Allen conducted a virtual course for six weeks to over 65 members of the Army and DoD titled “Nuclear 101”. This course was sponsored by OCE to help educate and train various members across the Army to include Army Testing Command members about the basics of radiation, nuclear reactors, radiobiology, and safety. This was the first step in the education and training of the Army’s personnel to introduce nuclear power capability safely and effectively to the service. For the future Reactor Operators, the current ideation for training has initial concepts such as the basics of math, physics, heat transfer, and electrical systems provided by the OCE. Following the basics, the students would receive training from members of the West Point Nuclear Engineering program on nuclear theory, reactor operations, radiological control, health physics and safety. This partnership leverages the intellectual capital of the trained Army officers and civilian faculty at the Academy in support of the future of ground nuclear power plants. Following the academic phase, the students would move to the hands-on simulator and then eventually move to the actual reactor prototype for final licensing and eventually providing safe, reliable power to DoD installations worldwide.

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

65735 - Energy Intensity of Operations and the Impact to the Warfighter

Start Date: 6/14/2023	Start Time: 10:00 AM	End Time: 10:30 AM
Authors: Dr Jordan Eccles; Troy Warshel		
Abstract: Operational Energy investments in the Air Force may increase the efficiency of the platform, increase the effectiveness of the mission, or both. Air Force Operational Energy combines these metrics into a unified "energy intensity" of operations, with a mission of increasing "lethality per gallon." The metrics framework is deployed into a platform that detects the performance of initiatives and provides inputs to operational simulations and models. These models allow us to assess the value to the warfighter, providing a unique mission-based project tracking system and overall strategic guidance framework. Air Force Operational Energy's first deployment of this system successfully detects a significant fuel efficiency improvement in a behavioral incentive program and provides a direct link to the benefit to the warfighter in effectiveness in airlift and aerial refueling. Location: TH367 Classification: UNCLASSIFIED Working Group: WG21 Operational Energy		

65833 - Simulating Future Battlefield Hybridized Power

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Gail Vaucher; Dr Robert Scott Jane; Mr. Morris Berman; Dr. Michael Lee; Micheal 'Sean' D'Arcy		
Abstract: Reducing battery requirements, power grid signatures and energy vulnerability can be done through the integration and optimization of fielded hybridized power. While battle-ready alternative resources are still limited, the future integration of this heterogeneous energy is just over the horizon. Supported by the Army Climate Strategy, versatile power is another means for the Army to help mitigate and adapt to the dynamic nature of our climate, while also strengthening the reliability of the future solder's electric energy supply. Optimizing the performance of these multiple power resources requires an informed strategic plan. Simulating battlefield requirements so that the power distribution is efficiently and effectively conducted is a centerpiece in the authors' presentation of the various analytics used to evolve a single hybrid testbed into multiple testbeds that simulate battlefield combat loads and other mobile re-charging station requirements. Location: TH367 Classification: UNCLASSIFIED Working Group: WG21 Operational Energy		

66421 - A framework for modeling of battlefield & platform electrification within combat simulations

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Greg Dogum		
Abstract: Ground vehicle electrification is going to dramatically change the future battlefield environment, and yet the Army lacks a sufficient approach to suitably represent electrified platforms in combat simulations. An electrified battlefield will have wide reaching affects including potential changes to tactics, techniques, and procedures. These complex interactions will require a refined approach to Modeling & Simulation (M&S) for power and energy in support of combat simulations and the representation of sustainment & logistics within those simulations to adequately capture the benefits and considerations of electrification.		

This effort describes an approach for electrified vehicle Physical model Knowledge Acquisition Document (PKAD) algorithms which includes a description of the development of a simplified (system-level) framework and illustrates an example application. While more detailed component level models exist, they do not match the fidelity required of combat simulations. A holistic approach is employed to characterize steady-state power rates in a consistent manner such that it can describe a range of future powertrain combinations and topologies at all levels of hybridization (mild, full, plug-in, or fully electric), to include various technology layout compositions (series hybrid, parallel hybrid, auxiliary power units (APUs), etc.), complex battery management systems, and advanced battery chemistries or energy sources (lithium-based batteries, supercapacitors, hydrogen fuel cells, flow batteries, solid state batteries, flywheels, etc.).
While future vehicles will employ unique energy management strategies, the objective of the PKAD approach is to focus on modeling the tactical advantages (e.g., silent mobility, silent watch) of advanced powertrains in military vehicles using a rule-based strategy focusing on battery state of charge, mobility, and non-mobility power demands. The framework would support assessment of new vehicle capabilities and the advantages that they offer. The goal is to provide tailored sustainment-centric energy estimations to align with modern and future vehicle capabilities and to support mission scenario-driven decisions or requirements in Multi-Domain Operations (MDO) and Large-Scale Combat Operations (LSCO).
The methodology provides a more refined point-to-point energy estimation and improves accounting of energy at the operational level. It can be applied across military platforms to include a range of charging technologies, methods, and fuel sources by using system-level attributes to characterize electrification of the future battlefield.

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

66049 - Uncertain Waters: Integrated Modeling of Fuel-Constrained Operations in Contested Environments

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Lucas McCabe; Stephanie Brown; Simon Whittle; Nathan Danneman; Brian Cheng; Michael Anderson

Abstract: The evolving battlespace has underscored a critical need for de-risked energy supply lines, which warrant innovation in energy demand, fuel production, and contested logistics. Toward the latter end, we introduce COLOGEN (COntested LOGistics ENgine), a library for synthesizing information about the global contestedness landscape and solving constrained routing problems using graph algorithms, and FuelSim, an agent-based simulation application for analyzing fuel-constrained operations and alternative fuel paradigms. Our integration of these software components provides a robust framework for modeling and simulation of contested maritime logistics, where increased attention has been paid to the operational feasibility of sustainable fuels. We illustrate the coherence of our framework via example, focusing on naval exercises in the Pacific.

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

66252 - Cost Engineering a MVDC Power & Energy Design for Navy Surface Combatants

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Richard Shea; Ms. Ann Hawpe; Mr. Henry Jones, III; Victor Sorrentino		

Abstract: Since maritime MVDC systems do not exist, a statistically significant cost estimating relationship is not easily determined. The components required for a MVDC system do exist at some scale and technical level of maturity. However, there is nothing in production meeting all the same requirements of a Navy surface combatant ship installation. Therefore, this paper follows an approach to compare the theoretical costs of a MVDC to a MVAC architecture in a US Navy Ship.
As the Navy transitions to a new era of electronic warfare, ship power system becomes the critical foundation to support the future. I recent years, combat systems and mission loads grew significantly and consumed the power margin that was inherent in traditional power generation and distribution designs. Future combat capabilities will not only increase power demand and increased power transients on the system.
While qualitative and heuristic arguments have been made for why MVDC systems should be more affordable and energy efficient than MVAC systems, a comprehensive feasibility and cost analysis has not been performed to date that provides quantitative rationale. The challenge with completing a comprehensive feasibility and cost analysis is that MVDC technology still requires significant investment in research, design, development, and production.
The purpose the study is to present a quantitative cost comparison of MVDC and MVAC architectures based on an independent cost engineering approach. This study will identify the parameters that will impact the cost of MVDC components, along with the uncertainty, associated with those parameters. Also identify relative cost comparison to MVAC components; industry investments in MVDC to support development of Navy components; and factors that will impact producibility of MVDC components and producibility risks.

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

65541 - Determining Biogas Potential for U.S. Army Installations

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Phillip D Schmedeman		

Abstract: Sustainability challenges are particularly complex on military installations, where security and environmental objectives are often in tension. Currently, wastewater treatment facilities on Department of Defense (DoD) installations are a source of greenhouse gas emissions (GHG) and contribute waste to landfills at the installations' expense. The beneficial use of biogas through anaerobic digestion offers a means to reduce emissions and landfill contributions, decrease energy costs and reliance on fossil fuels, and improve energy security. Nevertheless, the economic feasibility of biogas applications on DoD installations remains unknown. This study models the economic and environmental implications of utilizing anaerobic co-digestion to produce electricity from wastewater and food waste across U.S. Army installations. Given infrastructure and population characteristics for each installation, we calculate biogas production, energy and GHG savings, waste excluded from landfills, and the additional infrastructure costs. Following model validation, we incorporate decision variables that control which installations upgrade their facilities for biogas production over a 10-year period. We optimize this integer program to maximize energy savings. We conclude with sensitivity analysis that quantifies the financial and environmental benefits over a range of uncertain

parameters, thereby illuminating installation-specific characteristics that are the most appropriate for the beneficial use of biogas.

Location: TH367
Classification: UNCLASSIFIED
Working Group: WG21 Operational Energy

WG22 Military Assessments

65380 - The Case for a Model-Based Assessment Framework

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: LTC Cardy Moten, III; Jason Mazariegos		

Abstract: Most campaign assessment frameworks primarily use the systems engineering methods of developing measures of performance (MOPs) and measures of effectiveness (MOEs) to drive their data collection efforts. While this is a necessary function of an assessment framework, there tends to be a missing association of a guiding context of how these measures correlate to resources and activities military organizations are conducting in that environment. At SOCAFRICA, we developed a method that integrates logic models, futures networks, and strategic questions, along with MOPs and MOEs, that result in a more nuanced understanding of what resources and activities are either effective or ineffective in the African theater of operations.

Location: TH368
Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

65797 - Measuring Joint Performance - A Case of a DHS Operations Coordination Plan Modernization Effort

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr. Yukari K Hughes		

Abstract: Effectively measuring operational performance is integral to achieving an organization's goals. The traditional way of measuring performance is through quantitative data measures; however, qualitative measures via observations, interviews, and narrative input from questionnaires also allow analysts to probe the extent of the effectiveness of plans and programs. In addition, readily available textual analysis tools would make qualitative (thematic) analysis effortless and save time.

In this presentation, the author focuses on qualitative measures used to assess the effectiveness of the DHS Maritime Operations Contingency Plan (MOC-P, 2011). The MOC-P established DHS' cross-component plan for maritime operational coordination, planning, information-sharing, intelligence integration, and response activities for an efficient, effective, and coordinated departmental response to threats (i.e., unlawful exploitation of the maritime domain). The plan was implemented by the operational execution arms (Regional Coordinating Mechanisms - ReCoMs) in the Coast Guard Sector geographic areas of responsibility (AORs).

The author presents how a questionnaire was used to determine the strengths and shortfalls of the joint plan and the maturity of ReCoMs to modernize the decade-old plan for greater success where joint performance data are scarce.

Location: TH368 Classification: UNCLASSIFIED Working Group: WG22 Military Assessments

66193 - Future Force Assessment Results

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:30 AM
Authors: Wayne O. Nitzschner		
Abstract: The Army requires operational assessments of planned transformation efforts to inform planning and programming decisions. To design Army 2040, Army Futures Command (AFC) must first understand the effectiveness of Army 2030 formations and capabilities. The Future Force Assessment (FFA) is an analytically underpinned program of annual assessments designed to evaluate the operational effectiveness of future Army formations. The FFA is a multi-dimensional assessment that qualitatively and quantitatively examines force effectiveness. This study's area of focus features the contributions of key organizations within units, organizational interdependencies, associated operational risks, and the impacts of anticipated signature modernization capabilities. To do this, the recent iteration of the FFA leveraged an assessment workshop with operational subject matter experts (SMEs), employed combat models informed by workshop results, and executed a sustainment assessment to confirm operational feasibility. FFA results provided Army senior leaders comprehensive assessments that enabled informed force design and resourcing decisions. The presentation will provide an overview of the FFA focusing on the study methodology, the measures used to assess force effectiveness, the analytical efforts, and the way ahead for future assessments. Location: TH368 Classification: UNCLASSIFIED // FOUO Working Group: WG22 Military Assessments		

65736 - Operation Assessment & Analysis at United States Cyber Command (USCYBERCOM)

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: MAJ Galen Cipperly; SHELLY TINGLER; Dr. Francine Nelson; E. Thomas Powers; Keith Rulison; Michael Lind		
Abstract: (U) USCYBERCOM Operation Assessment & Analysis Branch produces operation assessments for the USCYBERCOM Annual Campaign Operation Order (OPORD) (ACO) and priority operations, and conducts Cyber Mission Force readiness analysis. This presentation will include a summary of the USCYBERCOM operation assessment methodology and products used to present findings on achievement of ACO objectives and recommendations for improvement, as well as initiatives to improve readiness and tie readiness to operation outcomes. Finally, this presentation will describe how the USCYBERCOM Operations Directorate (J3) is working to standardize operational metrics and automate data collection to provide assessment information at all levels of USCYBERCOM. Location: TH358 Classified Classification: SECRET//REL TO FVEY Working Group: WG22 Military Assessments		

66036 - USSTRATCOM J73 Assessment Enterprise (J73AE) – A Continuum of Assessment

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Martin Robert Apprich		

Abstract: USSTRATCOM J73 Assessment Enterprise (J73AE) – A Continuum of Assessment

The USSTRATCOM Assessments Division/J73 directs and employs a wide range of data-driven assessments across a Continuum of Assessment. These assessments inform strategy development, operational planning, resource prioritization, operations execution and advocacy across all of USSTRATCOM's assigned Unified Command Plan Mission Areas.

This Continuum of Assessment helps the command better understand the strategic and operational impacts of USSTRATCOM's Operations, Activities, and Investments (OAI's) on the strategic and operational environments.

Our Continuum of Assessment is comprised of the Campaign Assessment, the Risk of Strategic Deterrence Failure (RoSDF) Assessment in the Current and Future temporal domain. The Campaign Assessment Methodology employs the traditional elements of assessment structure (Objectives-based, Measures of Effectiveness (MOE) and Performance (MOP)). The Campaign Assessment is a data-driven, discussion-based process that involves a multi-level, Subject Matter Expertise-enabled vetting process. The RoSDF assessment process originated in 2020 as a Secretary of Defense directed focused assessment designed to inform Globally Integrated Deterrence Operations. The core venue for these processes is the Command Assessment Cell (CAC). The CAC convenes weekly or as needed during Steady-State, Crisis, or Contingency. Members consist of Action Officers from across the Headquarters Directorates as well as Components.

J73's assessments are supported with a suite of infrastructure and software to input (Microsoft Access), process (R, Python….) and visualize data (Tableau Desktop Professional, Server). USSTRATCOM J73 is participating in novel AI and ML development, bringing advanced analytical capabilities to the assessment process.

We provide this overview of the USSTRATCOM J73 Assessment Enterprise (J73AE) and insight into how advanced data analytics support USSTRATCOM Campaign and RoSDF Assessment in an effort to share methods and encourage collaboration among the assessment community. [269 Words]

Location: TH358 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG22 Military Assessments

66457 - Interoperability Challenges of the Combined Joint Force: Technologies, People, Processes, Permissions, and Authorities.

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Arrio Granum		

Abstract: The Army's Project Convergence is a campaign of Combined Joint Experimentation with core emphasis on interoperability. Project Convergence 2022 (PC22) was an attempt to understand how the data from various domains aggregate across a command and control architecture, available on demand to the Combined Joint Force (CJF) to make decisions at machine speed. PC22 was targeting-focused, designed to determine data-to-shooter linkages required for an interoperable CJF. Combined

Joint All-Domain Situational Awareness (CJADSA) was one of the main threads for enabling the CJF during experimentation. The focus of establishing a CJF, a mission partner environment (MPE), or any combined environment is to leverage data across all domains at scale. Accomplishing this complicated capability is the very definition of interoperability and is paramount for a CJF to get correct across all domains. CJADSA for a CJF increases the cost of adversary escalation of hostilities.

Technology: PC22 highlighted several technological challenges primarily in integrating message format types from a technical (and sometimes doctrinal terminology prospective) across a system of experimentally linked network nodes. Additional technological challenges highlighted the need for enterprise-wide change towards data-centric zero trust architecture over network centric and stovepipe data flows.

People and Process: Interoperability agreements exist to help define roles and processes. American, British, Canadian, Australian, and New Zealand (ABCANZ) standards are one of the main Army agreements among the Five Eyes (FVEY) partners. PC22 demonstrated the importance of partner interoperability standards such as ABCANZ and how they can apply in a Combined Joint experimentation environment. Joint and multidomain interoperability standards enable a CJF. Enabling CJF requires interoperable network capabilities, and PC22 demonstrated the importance of having the right personnel with the relevant network expertise to adequately provide network capabilities at the scale of combined joint experimentation and for an operational CJF.

Authorities Policies Permissions: PC22 demonstrated the wide range of necessary considerations of Partner laws, doctrine, organization, weapons, equipment, capabilities, terminology, culture, politics, religion, language, and objectives to shape an interoperable CJF. Several mission threads, while technically achievable, were often hindered by policies and authorities predicated along national stovepipe protection of data flows with no easy way to operationalize sharing of data across the CJF at the speed of machine learning. Examples include sharing of communication security information for Australian-U.S. feeds to go directly across the enterprise network into a U.S. TOC; artificial intelligence (AI) database sharing for combined AI target recognition data labeling program; sharing information relating to targeting data within the CJF AOR.

Location: TH358 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG22 Military Assessments

65623 - Natural Language Processing (NLP) and Computational Linguistics (CL) Supporting a Continuum of Assessment in the USSTRATCOM J73 Assessment Enterprise

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Reginald Henry Rice		
Abstract: The Assessments Division (J73) at USSTRATCOM employs a wide range of data-driven assessments across a Continuum of Assessment. The Continuum of Assessment is comprised of the following: Campaign Assessments and Risk of Strategic Deterrence Failure (RoSDF) Assessments. RoSDF assessments are further split into two temporal domains (Current and Future). The Continuum of Assessment supports the command's comprehension of the effects USSTRATCOM's Operations, Activities, and Investments (OAI's) have on the strategic and operational environments.		

A large majority of the data supporting the Continuum of Assessment is text-based reports. J73 currently utilizes a manual processes to gather and mass distribute reports to analysts. In addition, analysts collect reports from preferred sources. Due to individual subject matter experts reviewing reports, this process is highly effective to assemble reports relevant to the Continuum of Assessment but inefficient at adding data points.

To address this inefficiency, J73 is investigating 1) use of automated collection of reports and 2) utilizing NLP and CL to process, classify, prioritize and distribute reports for use in assessments. J73's assessments are currently supported with a suite of infrastructure and software to input (Microsoft Access) and visualize data (Tableau Desktop Professional, Server). This effort will add to those tools and focus on the second part of J73's investigation: the utilization of NLP and CL to improve Continuum of Assessment data input efficiency. J73 is currently exploring the use of Python with the spaCy package and a modified freeware English language model to process and classify (recommended team and sentiment analysis) manually collected reports. With this initial effort and model performance feedback from analysts we believe the amount of data supporting the Continuum of Assessment should increase.

We present this overview of USSTRATCOM J73's efforts to utilize Natural Language Processing and Computational Linguistics to increase assessment efficiency to share techniques with, collaborate among, and demonstrate the utility of Natural Language Processing and Computational Linguistics to the assessment community.

Location: TH368
Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

66375 - Total Army Analysis (TAA) Component Rebalance Analysis

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:30 AM

Authors: LTC John Ferguson; Craig Flewelling

Abstract: Each year, the Center for Army Analysis' Force Strategy Division has the responsibility to support Headquarters, Department of the Army (HQDA) G-3/7 Force Management Directorate (FM) during completion of Total Army Analysis (TAA). Our analysis helps HQDA determine the unit composition of the Army's total force. TAA 26-30 focused on balancing the Regular Army (RA) and the Reserve Component (RC) force mix required to meet future National Defense Strategy demands. This presentation will include a brief overview of the methodology we used to support FM in TAA 26-30. We examined how changing the future RA and RC force mix impacts the Army's ability to meet operational demands outlined in the National Defense Strategy and in time-phased force and deployment data for operation plans. Since unit readiness varies over time, we modeled how the Army transitions from Campaigning to Conflict and back to Campaigning over an 8-year period using a discrete event simulation. We hope to inform and solicit feedback from those interested in force generation analysis and simulation.

Location: TH368
Classification: UNCLASSIFIED
Working Group: WG22 Military Assessments

64920 - Using IG Data to improve the Air Force

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr Geoffrey Fischer		
Abstract: The Inspector General's office looks at data in a unique way…you're compliant or you're not. This presentation will cover all the different ways I've learned how to present inspection data in a way that is meaningful for Airmen and Commanders to make decisions—from the lowest levels through potentially AF-level change. How building data as it relates to guidance is meaningful for decision makers and helps ensure a smooth program with fewer compliance-related problems. How tracking issues over time provides valuable insight to commanders and allows them to take data from static information and reinforces their decisions while also guiding them toward their next steps. A real-life example of how Sampling accurately predicted the results of self-inspections based on a Wing Commander who conducted mutual inspections: a full 100% inspection of all compliance-based questions and a random sample team examining the same information. And finally, how a thoughtful review of Inspector General inspection data by policy makers can identify programs that need attention, and (by embracing the red) may also address that a problem that plagues every governmental organization: "We don't have enough manpower." Location: TH368 Classification: UNCLASSIFIED Working Group: WG22 Military Assessments		

WG24 Test and Evaluation (T&E) and Experimentation

65940 - Planning, Execution, and Analysis of Soldier Operational Experiments

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Avery Nevling		
Abstract: The Research and Analysis Center (TRAC) was the evaluation lead for the Next Generation Combat Vehicle (NGCV) Phase I Soldier Operational Experiment (SOE) conducted at Fort Carson, CO, in 2020, and the Human Machine Teaming (HMT) Phase II SOE held at Fort Hood, TX, in 2022. TRAC worked in conjunction with stakeholders of the Robotic Combat Vehicle (RCV) community (Ground Vehicle Systems Center, Army Test and Evaluation Command, Army Research Laboratory, Combat Capabilities Development Command (DEVCOM) Analysis Center, and NGCV Cross-Functional Team) to develop and implement plans associated with data collection, experiment execution, and analysis to inform operational and technical learning objectives. Data was collected through event observations, facilitation of after action reports (AAR), and digital data collection. The knowledge gained during these experiments has refined the Army's understanding of the HMT concept and how it could be applied within a reconnaissance and surveillance mission set. Soldier feedback captured during the events provided information on required capabilities, technical improvements, and possible tactics, techniques, and procedures (TTP) for use of HMT in accomplishing missions. This presentation will cover specific data collection methods used during the experiment; processes and tools developed to capture and analyze the data; and general lessons learned from a data collection perspective. Additionally, the presentation will highlight the overall data collection methodology to include discussion of data sources and their associated limitations. A follow-on effort that aims to refine speech-to-text and natural language processing of AAR recordings so that these analysis techniques can be more efficiently leveraged in future events will also be discussed. Location: TH310		

Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation

65209 - Non-parametric Statistics for Operational Test and Evaluation: How do we analyze survey ratings and unbalanced data?

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Bradford Lott; Kyndreshia Stroman		
Abstract: Operational Test and Evaluation (OT) requirements often lead to un-balanced and non-normally distributed datasets. Most OT training programs exclusively cover parametric statistical methods. These parametric methods are subject to assumptions which are violated by many OT datasets. In this study we examine five non-parametric methods which span all combinations of continuous and categorical dependent and independent variables. Additionally, we identify a non-parametric method which may be used for performing pairwise and post-hoc analysis as well as building confidence intervals around the median for ordinal datasets. Our pairwise approach offers a formal statistical test which may be used to support two heuristics commonly used in reports published by the Office of the Director for Operational Test and Evaluation (DOT&E). Utilizing nominal datasets, we examine the Kruskal-Wallis, Chi-Square, and Wilcoxon tests along with Generalized Linear Models and Kernel Regression. Implementing these methods, we maintain statistical integrity when analyzing ordinal and non-normally distributed datasets. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

65471 - A Comparison of Bayesian Methods for Integrating Information from Developmental and Operational Test and Evaluation

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Justin Krometis		
Abstract: A strategic goal of the test and evaluation community is to “shift left” to accelerate the acquisition of new capabilities. Increasing operational realism in earlier phases of testing provides an opportunity to improve the quality of information available for decision-making. However new methods are needed to integrate information from across multiple phases of test, levels of systems maturity, and varying operating conditions. One approach to modeling knowledge accumulation is via a Bayesian approach, using data gained from early tests to inform understanding later in the acquisition process. In this work we compare two Bayesian approaches - one using hierarchical models and one using informative priors - to develop probabilistic estimates of system behavior under various conditions applied to data from a real defense program. Data from the Stryker Family of Vehicles developmental and operational testing are used to make a comparison between the methods. The comparison illuminates best practices for Bayesian modeling and illustrates how modeling assumptions affect understanding of the system. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

65490 - Utilizing Bayesian Inference and Techniques in Operational Test

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Capt Chloe Thurman; Mr Shane Melancon; Elizabeth Rinehart; Victoria Rose Carrillo Sieck		
Abstract: Bayesian statistical methods provide an approach to applying probability to statistical problems by utilizing past information to characterize the current understanding of a system under test (SUT) and provide a mechanism to update the understanding of a SUT during test execution. By using past information and Subject Matter Expertise (SME) combined with updated understanding of the SUT during test, the potential exists to develop efficiencies in Operational Test (OT) through the development of prior distributions and the use of Bayes' Theorem. Bayesian methods may be helpful in cases where there are non-repeatable scenarios and can be more effective than frequentist methods to quantify uncertainty across the test space. The Air Force Operational Test and Evaluation Center (AFOTEC) is developing a process to incorporate Bayesian methods throughout all phases of the OT Lifecycle. This process incorporates SME judgement and existing system information to identify and develop priors; provides a focus for data collection during test; and allows analysis of data collected to increase understanding of the SUT. This presentation focuses on the development of this process and the application of Bayesian methods in the AFOTEC OT Lifecycle. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

65993 - A Timeline to Execute Defensible Operational Effectiveness Analysis

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Mr. Evan Bradshaw		
Abstract: Beginning in fiscal year 2022, The Research and Analysis Center executed analysis focused on identifying the operational impacts of adding Vehicle Protection Systems (VPS) capabilities at the platform and formation levels to inform future science and technology investments for Product Manager VPS. The study analyzed operational effectiveness impacts of eight technology trades: Soft Kill (Electronic Warfare), Hard Kill (Kinetic Energy/Chemical Energy), Obscurants, Armor, Top Attack Protection, Pre-Shot, Hostile Fire Detection, and Mobile Camouflage. To address stakeholder questions, three analytic vignettes were explored: a battalion attack, a company deliberate breach, and a brigade hasty defense. The analysis was conducted using Combined Arms Analysis Tool for the 21st Century and a novel model developed in Python specifically for this study. This presentation will cover the design of experiments used, with a focus on the individual technology trades, as well as looking at combinations of VPS technologies to provide layered-defense effects. Additionally, the presentation will highlight the post-processing techniques and interactions with warfighters and other subject matter experts utilized for operational effectiveness analysis to directly address study questions. Finally, the presentation will address how the study team created both defensible visualizations and summarized output data that clearly and efficiently conveyed key information to stakeholders to enable informed decisions and follow-on cost-benefit analyses, with a discussion on lessons learned. Location: TH310		

Classification: UNCLASSIFIED // FOUO
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

65185 - Survey of Soldier Acceptable Uses of Biosignals for Assessment of Readiness

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Ms. Florence Bautista Chua, MS; Alexis Cady; Erica R Nahin, PhD; Dominic T Cheng, PhD; Jessika L Decker; John Shkëmbi; Nikola Jovanovic; Charles Sheridan; Dr. Elizabeth Mezzacappa

Abstract: Wearable sensors (e.g., Fitbit) that record physiological measures (e.g., heart rate, blood pressure) are now ubiquitous. These biosignal recordings are thought to reflect clinical, physiological, and psychological states. For example, elevated temperature may indicate a medical condition, increased heart rate may relate to fear, and EEG patterns may indicate fatigue. For these reasons, Army researchers have proposed wearable sensors as a way to monitor health, performance, and Soldiers' state of readiness.

Subject matter experts were invited to discuss these possibilities and usage offered by physiological monitoring. Surprisingly, some responses suggested an uneasiness with devices that could interpret internal states being read by others. In essence, physiological monitoring lays bare private internal states; and thus, engenders a privacy concern.

This observation led to the present study as a preliminary investigation of Soldiers' attitude toward physiological monitoring. 36 Active Duty service members, aged 18-50, participated in one or two studies where several tasks were used to test a novel in-ear biosensor. Following the study tasks, Soldiers were asked to complete a survey regarding what uses they would find acceptable if the device were to be deployed. All procedures were approved by Armaments Center Human Research Protections Program as exempt protocols (#19-021, #21-004).

A 16-item questionnaire was created based on the current thoughts about near future uses of physiological signals for Soldier monitoring for health, performance, and readiness. Examples include: "Your biosignals are used by health care workers to diagnose and treat an illness you might have.", "Your biosignals are read by your peers in your unit to understand how you are feeling.", and "Your biosignals are read by your team leader in order to monitor fatigue and stress in order to make battlefield decisions.". Soldiers were asked to indicate their approval level on a 5-point scale of Strongly Disapprove to Strongly Approve.

Descriptive statistics were calculated. Analyses revealed that Soldiers generally expressed approval to diagnose medical-related issues and to improve their own performance. In situations where their biosignals could be read by peers or first-line leaders to understand how they are feeling emotionally or read by those in leadership position to evaluate performance or to help leadership make battlefield decisions, Soldiers expressed more neutral responses. These results suggest that Soldiers' compliance on the use of their biosignal data may be more selective and not fully comprehensive. These findings should be taken into consideration in the development of wearable sensors and documentation of their purposes.

Location: TH310
Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

67883 - Model Validation Levels in Digital Engineering

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Ms. Corinne Weeks		
Abstract: Digital engineering uses an integrated, model-based approach in order to speed up the acquisition process and provide capabilities to the warfighter as quickly as possible. As the Department of Defense shifts toward the digital engineering approach, it is critical that modeling and simulation results can be trusted in order to minimize the risk introduced by using models in place of physical articles. Trust is assigned to a model through validation, which determines the degree to which a model is an accurate representation of the real world from the perspective of the intended use. However, validation is often a one-time, subjective process resulting in a binary indicator of whether or not a model is valid. Digital engineering requires a new paradigm of model validation, where model validity can be continually reassessed as models change and improve over the course of the system lifecycle. Model Validation Levels (MVLs) aim to meet this need by redefining validation in terms of fidelity, referent authority, and scope, and providing an objective, rigorous validation metric which can be automated to continually assess model validity. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

65608 - Quantifying the Operational Resilience of Systems Operating in Cyberspace

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Aaron Madewell		
Abstract: This presentation contributes to the body of knowledge on the quantification of cybersecurity risks for military systems and networks. It is based on the paper of the same name published in the MORS Journal in 2022: V27 N23. In this paper is an approach that adapts frameworks and mathematical methods from cybersecurity, actuarial sciences, and reliability theory. What results is a quantification and graphical representation of aggregate cybersecurity risks that can be used by acquisition and operational decision makers to assess the resilience of a system in a cyber-contested environment. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

66527 - Exploring the Use of Predictive Analytics and Design of Experiments in Cyber Testing

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr Charles Unkrich, III		
Abstract: Current operational cyber tests evaluate mission critical systems utilizing a checklist approach to find vulnerabilities and then prioritize vulnerabilities according to severity, and ease of securing the vulnerability. Motivated by the DoD Cybersecurity T&E Guidebook, this research will assimilate predictive analytics and design of experiment techniques to promote “data-driven mission impact-based analysis and assessment methods for cybersecurity test and evaluation.” The implementation of design of experiments and predictive analytics may improve the cyber test community’s ability to report system deficiencies and empirically assess their impact on the confidentiality, integrity, and availability of systems to decision-makers.		

Location: TH310
Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

66437 - Analytics, the Cyber Cognates of Anything, Everywhere, All at Once

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Thomas Tenorio; Dr. Laura Freeman; Ricardo Valerdi

Abstract: This presentation now considers the cognitive dynamics discussed in "The Logistics of Data in the Future G Fitness Landscape". Multidomain operations sets the stage for extreme competition involving cohorts of MASS (Men-Agents-Smart Systems). Analytics is the orchestration mechanism for collective intelligence and collaborative action. This framework considers knowledge curation and enrichment; learning and adaptation: mission and system space; system life cycles; future operating environments; and discovery in the real-world of collaborative and competitive action.

Analytics are integral to the sustainment of planetary scale systems advancing generationally every 18 months with a heavy focus on profit driven viability. The analytics of Silicon Valley exploit cognition enabling exponentially expanding monetization. Learning and adaptation as exemplified by Blackbox systems on Commercial Airplanes enabling an evolutionary model for knowledge by continuously refining measures of cognition, information and physical. Artificial Intelligence and Autonomy address the dynamic and integrity limits of the human collectives. The Analytics of Doctrine, Operations, Training, Materiel, Leadership, Personnel, Facilities and Policy (DOTMLPF-Po) must identify where DOTL-Po is over constraining MPF dooming acquisition to 10-year Industrial Era fielding cycles.

The Joint Operational Environment defines the Cyber Domain as Cognitive, Informational, and Physical, where Information is a Warfighting function. Yet, the development of universal analytics with utility for man, agents, and machines is marginally expanding. Despite growing enthusiasm for analytics, there remains a critical lack of resourcing for enterprise knowledge systems and tools. World Models inherent to autonomous systems and mission space can be based on ontology, symbolic AI, deep learning AI and Autonomy yet each remains unique to each problem space. This effort builds on research in Unmanned and Autonomous Systems Test, Autonomous Systems Test and Evaluation, Pattern Frameworks, and Cognitive Networks for Expeditionary Cyber for Survivability and Lethality.

The cognitive framework for this effort comes from a multi-disciplinary perspective emphasizing Win in a Complex World. Analytics of defense must expand into evolutionary frameworks of cognates composable across Warfighter Functions for 10x, 100x, 1000x improvements. Each cognate of limited extent can be enhanced in a variety of ways (temporally and semiotically) to enrich collective intelligence and reduce ambiguity continually. The cognate framework must continually ensure modification enhances inclusivity across applications. Analytics adaptation and curation are critical given expected emergence in Revolutions in Military Affairs (RMAs) involving new military tactics, strategies, doctrines, along with innovations in technologies and discoveries in basic research or science.

Location: TH310
Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

66062 - Integrating Data Analytics in the Robotics and Autonomous Systems (RAS) Domain Space for Military Applications

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Titus Rice; Jaylen Hopson; George Edward Gallarno; Mr. Jed Richards; Dr. Ifezue Obiako; Robert Hilborn		
Abstract: As Robotics and Autonomous Systems (RAS) technology evolves, the U.S. Army must develop innovative solutions ahead of its adversaries to maintain a competitive advantage globally. In order to achieve economical and resilient solutions within the novel and competitive domain of RAS, RAS systems require simulation to explore system behavior in a wide variety of complex environments and scenarios. The U.S. Army Engineer Research and Development Center (ERDC) supports the enhancement of existing RAS capabilities through the technological maturation of the U.S. Army Ground Vehicle Systems Center's (GVSC) Combat Vehicle Robotics (CoVeR) program. The CoVeR program seeks to reduce capability gaps in robotic and autonomous combat platforms. Thus, CoVeR Engineering Evaluation Test (EET) events are conducted annually in the field, to technically assess the software performance of all participating vendors' solutions. The ERDC has developed a capability, the Virtual Engineering Evaluation Test (EET), which seeks to replicate the semi-to-fully autonomous performance conducted during the physical EET events via a complex, software-in-the-loop (SIL) modeling and simulation (M&S) solution. Ideally, the performance of the virtual EET should match the performance of the EET, to the point where no differences can be observed in the quantitative data produced by each test. Over the past two years, this research has focused on three primary tasks to support enhancing RAS capabilities: (1) defining the SIL's M&S system requirements, (2) performing data analytics and metrics analysis on low-level, Robot Operating System (ROS) data output, and (3) replicating RAS performance from the physical EET events to provide predictive analytics to improve physical EET events. Researchers have developed code infrastructure using multiple programming languages to conduct both one-to-one comparisons and predictive analysis between the physical EET and the virtual EET. Moreover, regression models have been applied to this domain space using explanatory variables and response variables relevant to RAS for military applications. This presentation will include an overview of current and ongoing research, including potential future work. Location: TH310 Classification: UNCLASSIFIED // FOUO Working Group: WG24 Test and Evaluation (T&E) and Experimentation		

65164 - DHS S&T C-UAS Testing Results and T&E Best Practices

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Teddy Damour		
Abstract: The U.S. Department of Homeland Security (DHS) Science and Technology Directorate's (S&T) National Urban Security Technology Laboratory (NUSTL) plans, designs, and executes Counter-Unmanned Aircraft System (C-UAS) and Air Domain Awareness (ADA) test and evaluation events in support of DHS Components, federal agencies, and state and local authorities. In 2021 and 2022, S&T's NUSTL conducted major C-UAS and ADA operational test events in various environments. For example, a test event occurring in North Dakota, representing a flat plain environment and another test event, which occurred in Montana, representing a mountainous environment. S&T evaluated several sensor modalities such as radars, radio frequency (RF) detection systems, acoustic systems, and EO/IR cameras. NUSTL evaluated sensor capability to detect, track, identify, and mitigate (DTI-M) unmanned aircraft systems (UAS). In addition, NUSTL executed a series of C-UAS tests in realistic		

urban environments. This presentation will cover test activities results, C-UAS testing best practices, and lessons learned from previous events

Location: TH310
Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

65712 - Constructing a Simulation-Ready Data Framework

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr. Christopher Morey; Dr. Niki C. Goerger, FS; Mr. Jed Richards; Mr. William Leonard; William Anderson; Robert Hilborn; Jaylen Hopson

Abstract: The U.S. Army relies on simulations to examine operational concepts to refine warfighting requirements, make design choices regarding military systems, and inform resourcing decisions, among other purposes. In their application of simulations, Army organizations that conduct experimentation or analysis must establish an appropriate operational context by developing or adapting scenarios that represent military operations. Preparing a scenario for instantiation in a simulation is a time-consuming process. This process typically consists of starting with an approved, higher-echelon scenario, which gives a narrative of the events leading to a conflict, the blue and red units engaged in the conflict, concepts of operation, and many other elements that describe the operational situation. From this higher-echelon scenario, the organization draws a vignette and, with input from warfighting experts, adds more resolution to blue and red unit actions and capabilities to enable answering the experiment or analysis question. Modeling and simulation (M&S) experts then instantiate the military operations depicted in the vignette into their simulation, request and obtain system performance and terrain data, act as subordinate-level commanders or leaders for the units represented in the simulation, run the simulation, and produce output data. In this process of developing scenarios for simulations, organizations may duplicate effort because already-created information or data they might use are difficult to find, are in different communities, or lack visibility on assumptions. In many of these cases, it may be because organizations develop their products without considering that others may want to re-use them. Regardless, the time required to recreate datasets detracts from the opportunity to produce new data or perform additional simulations and analysis. A desire exists to make scenario information and data more easily available and configurable for simulations used to support answering decision-makers' questions. Based on insights from examinations of existing data repositories as well as M&S expert input, this work supports making scenario information and data more reusable and available. Its product is a framework for "data at the ready" for use in simulation and analysis. This presentation will describe the current need, objective, and approach as well as highlight insights, lessons learned, and recommendations geared toward incorporating data and scenarios across the Army community into more routine, standardized use.

Location: TH310
Classification: UNCLASSIFIED // FOUO
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

66114 - Simulation Experimentation of Swarms: Methodologies and Analyses

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Melissa Jablonski; Dr. Ross Arnold; CDT Shawn Mather; CDT Kayla Jones; Jonathan Jablonski; Michael McBride; Dr. Elizabeth Mezzacappa
Abstract: Collections of autonomously behaving systems, or swarms, are predicted to be an important component of the US DoD strategy. Therefore, research into how to create swarms with suitable characteristics, behaviors, and function for these different purposes is in the interest of the US military. However, there are challenges in swarm research, including technical limitations of existing hardware, the need to address both individual drone level behavior as well as the complexities of the entire swarm behavior, and the sheer number of parameters that may be relevant to swarm performance in operations. This presentation proposes methodologies for the computer simulation research and analyses for experimentation on swarm behavior. The work is a result of a collaboration between USMA Cadets and DEVCOM Armament Center. Swarm performance data from computer simulation experimentations using simulation software were analyzed through multiple steps to investigate how individual and entire swarm characteristics might affect how well the swarm performed a mission. The DroneLab Unmanned Aircraft System software used the operational scenario of rendering humanitarian aid after a natural disaster (e.g., earthquake, tsunami). The task for the drone swarm in the DroneLab simulation experiment was to locate survivors who were situated throughout the 2 X 2 km terrain. Inputs were both individual drone characteristics (i.e., types of search behaviors) and entire swarm characteristics (i.e., number of drones in the swarm, communication range, proportion of drones performing type of search behaviors). Output from the software included location of drones, inter-drone communication events, survivors found, and time to complete the mission, defined as locating 90% of the survivors. Data were from 2000 unique swarm configurations which were run with 10 repetitions. Several methods were used to analyze the data output by the simulation. Each drone's location throughout the mission were graphed; this was used to gain an overall pattern of the swarm behavior. Visualization greatly aided identification of bugs in the programming. Next, computer design of experiments was used to examine the relationship of swarm parameters to performance, and to identify the best and worst performing configurations of swarms. Communication networks that emerged within the swarm were identified using social network analyses software. Social network parameters that described, for example, the densities of interconnections among the individual drone were derived. Then the best and worst configurations were compared on these social network parameters. Analyses are ongoing; however, these preliminary analyses identified characteristics of the well performing swarms versus poorly performing swarms. More importantly, the work demonstrates a general approach to experimentation for developmental engineering and optimization of swarms. Location: TH310 Classification: UNCLASSIFIED Working Group: WG24 Test and Evaluation (T&E) and Experimentation

65691 - Verification, Validation, Assurance, and Trust of Machine Learning Models and Data for Safety Critical Application in Armament Systems

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Jon Vigil; Mikel D Petty; Shane N Hall, PhD		
Abstract: As the use of machine learning (ML) models proliferates in commercial and defense applications, the United States Army (Army) faces significant challenges in evaluating the effectiveness, robustness, and safety of these ML models in armament systems. Relying on ML-		

informed recommendations and decisions in these systems requires very high confidence that any resultant behaviors will fall within intended operational and mission bounds. Ensuring reliable and safe behaviors involves both ensuring accurate and comprehensive data is used in the creation and training of these ML systems and that the ML models are robust, accurate, and appropriately behaviorally bounded when employed using real data in military operations. ML models come in many forms, and the technologies used to create them are rapidly evolving, and hence, the Army needs 1) a process and framework to assess and measure the quality of training data and identify shortcomings that may lead to poorly trained ML models, and 2) a process and tools for ML model exploration that can assure confidence of model behavior within defined data boundaries and can also identify unintended or poor behavior in ML models if they exist. This presentation outlines the existing literature on the metrics and measures used to verify and validate (V&V) ML training data and models and describes the process, framework, and tools to analyze these metrics and measures. Results that demonstrate these metrics, measures, framework, and tools are provided for an open-source classification ML model and an autonomous vehicle reinforcement learning (RL) model. This comprehensive methodology for ML training set and model V&V is meant to provide additional assurance and trust in Army ML systems and help determine the readiness for more formal operational test and evaluation (OT&E) of the Army armament systems that employ ML models.

Location: TH310
Classification: UNCLASSIFIED
Working Group: WG24 Test and Evaluation (T&E) and Experimentation

WG25 AoAs and Capability Development

65384 - STRIDE: Using Digital Engineering to Inform Research Investment Decisions

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Annie Jones-Wyatt, Ph.D.

Abstract: This presentation will provide an overview of a methodology that integrates digital engineering with engineering models and lifecycle analysis to inform Science & Technology (S&T) investment decisions. A prototype S&T investment roadmapping tool, STRIDE (Science and Technology Research and Investment for Digital Engineering), has been developed with a Model-Based Systems Engineering (MBSE) core and implemented in MATLAB with a notional hypersonic system and technology portfolio. The methodology considers benefits and costs across the entire system lifecycle; it is applicable to any S&T portfolio; and it can be tailored to provide roadmapping for a specific system. The STRIDE methodology integrates Cameo models, performance models, operational analysis models, and cost and sustainment models in a digital thread. It leverages the Technology Identification, Evaluation, and Selection (TIES) methodology as well as Multi-Attribute Decision Making (MADM) to present research investment options to decision makers. Potential use cases for STRIDE include supporting trade studies across technologies to identify areas of greatest impact; performing Analyses of Alternatives or Capability Based Assessments; integration of simulation efforts across organizations; and identification of additional areas for model improvement.

Location: TH369
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG25 AoAs and Capability Development

66453 - A Crew of Two: A Comparative Analysis of the Optionally Manned Fighting Vehicle (OMFV) and Apache Helicopter

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Arrio Granum

Abstract: Since the inception of modern armored warfare, armed forces have contended with the trades of weight, size, mobility, and survivability. As armament capability increased, armor requirements similarly increased to provide adequate protection. As increases to armor protection are limited by size, space, and weight limitations, one potential solution was reducing the crew required on a platform. Today, these tradeoffs and plans for crew reductions are present in the development of some next generation combat vehicles. In fact, the Army's potential next Infantry Fighting Vehicle (IFV), the Optionally Manned Fighting Vehicle (OMFV), has stratified platform requirements mandating smaller crews than its Bradley Fighting Vehicle (BFV) predecessor. This crew manning attribute is a departure from today's crew of three in the BFV to a crew of two in OMFV.

In 2021, the Commanding General, Army Futures Command (CG, AFC) directed The Research an Analysis Center to conduct an OMFV workload study. The purpose of the study was to consider how OMFV might best be crewed with only two personnel by providing a comparison to the current use of two crew members in the Apache helicopter. The analysis was organized primarily on the personnel, doctrine, organization, and training domains of DOTmLPF-P. Over the course of the study, the team individually interviewed more than 30 subject matter experts (SME), synthesized information, and conducted three collaborative panels with SMEs from multiple Army organizations.

These engagements led to confirmation of major OMFV implementation themes and implications related to reducing an IFV crew from 3 to 2, given OMFV's anticipated technological suite. The study answered the questions of interest and illuminated several interesting implementation considerations that apply specifically to the OMFV program, but also to other new vehicles that are similarly planning on reducing crew manning. The study results included courses of action and recommendations support CG, AFC decisions and provided potential areas for future analytic work: Should the OMFV crew stations be specialized or identical? What knowledge and attributes should an OMFV crewmember possess? Should the OMFV crew and the passengers be the same Military Operational Specialty? How does an OMFV-equipped formation perform priorities of work and handle the loss of a crewmember? What does technological redundancy mean for the OMFV? Should OMFV crews be qualified individually or collectively? What training should be provided by the institution, installation, or unit? How might OMFV technologies (and AI) impact qualification?

The study also explored these additional points of interest: Enterprise-level Culture Change; Trust in Technology; New Equipment Training and Fielding.

This presentation will explore how the study team elicited and communicated SME feedback to inform capability development and senior leader decisions.

Location: TH369
Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

66140 - Optimal M4 Zeroing

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Aidan Gray Looney; Thomas Kendall
Abstract: Soldier lethality is of the utmost importance for the effectiveness of the United States Army. A key component of this lethality is soldiers' accuracy with their individual weapon systems. The Army improves soldier accuracy through a process called zeroing. The Army assesses the accuracy of soldiers using the Army Rifle Qualification Test. The Army has used the same zeroing method for decades despite changes to the standard issue weapon and ammunition. We seek to find an optimal zero for an M4 carbine which accounts for modern weapons and munitions. We develop a three-dimensional model and leverage several numerical integration techniques, including a fourth order Runge-Kutta technique to derive a measure of a bullet's net deviation from the line of sight. We then minimize this measure to produce an optimal trajectory. We propose a new target to be used for zeroing which incurs the optimal zero. Soldiers who use this target should then be more lethal in the typical engagement range. Location: TH369 Classification: UNCLASSIFIED Working Group: WG25 AoAs and Capability Development

65809 - Future Logistics in a Dispersed and Contested Environment

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Nick Ulmer		
Abstract: This presentation covers a capstone study with expected completion in March 2022, that attempts to use simulation and an analysis of alternatives (AoA) to recommend a procurement strategy for aircraft or airships that perform logistics in a distributed and contested environment. In addition to legacy assets the study will consider five new craft concepts. Status-quo as well as contested scenarios will be included to help simulate anticipated future conflicts. The overall goal is to provide a strategy that procures a logistics solution that is more flexible, rapidly fielded, sustainable, adaptable, and less vulnerable. Location: TH369 Classification: UNCLASSIFIED Working Group: WG25 AoAs and Capability Development		

65372 - Combining bilevel optimization, simulation, and uncertainty to assess technology investments against adaptive adversaries

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: John Flory		
Abstract: Performance assessment of future technologies often requires high-fidelity "Red vs Blue" simulations. Although such simulations can provide insights, they usually do not consider how the Red adversary may adapt its technology investments against those of Blue. Thus, technologies that appear ideal against a static adversary may actually be susceptible to future technological adaptations, and vice versa. The ability to mathematically model this complex, game-theoretic landscape of adaptive investments is key to understanding how current decisions become force multipliers (or, perhaps unfortunately, force dividers). To address this challenge, we have developed an analytical approach that combines simulation with a game-theoretic decision framework -- integrating AFSIM, an engagement simulation developed by the		

United States Air Force Research Laboratory, with Dakota, an optimization framework developed by Sandia National Laboratories. Our approach models the investment decision process as a bilevel optimization in which the Blue player seeks to optimize its technological capabilities knowing Red will respond by deploying technologies that optimally mitigates performance. As an additional feature, this bilevel decision framework includes extensions for modeling uncertainty in Blue's ability to realize risky technologies and Red's knowledge of Blue's decisions.

This talk outlines our bilevel/simulation/uncertainty framework. We discuss surrogate modeling approaches that enable faster solution times and mitigate computational resource burdens. We conclude with several applications of our decision capability applied to high power microwave distributed systems for defense against hypersonic glide vehicles and drone swarms.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525

Location: TH369
Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

66802 - Acquisition Readiness Assessment (ARA) for Pre Programs of Record

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Ralph Korthauer

Abstract: Background: As technology matures, it is implemented into a conceptual system to demonstrate operational applicability. From amongst a pool of candidate conceptual systems, the capability development community should identify those concepts of highest operational potential relative to cost and schedule targets.
Problem Statement: The ARA process was developed by AFLCMC/XA which provides a formal, rigorous method for assessing the acquisition readiness of projects and serve as a communication tool between XA and external customers. Air Force Futures (HAF A5/7) already uses a Technology, Mission, Resource and Organization (TMRO) framework which characterizes capabilities as being in discovery phase, worthy of incubation, or push to accelerate fielding. However, XA believes the TMRO framework can be extended to include a capability's largest cost driver – operations and sustainment. Additionally, while speed is desired, technical rigor must be maintained through the use of critical systems engineering processes. Therefore XA extended HAF's TMRO framework to reflect the importance of "-ilities", captured via Supportability (S) and Critical System Engineering Processes (C); abbreviated as TMRO+SC.
Methodology: The ARA process begins by capturing top-level project objectives, identifying key stakeholders, resources and projected milestones, as well as a project team's developmental strategy / Adaptive Acquisition Framework (AAF) pathway. The DoD has implemented AAF pathways in an effort simplify Acquisition Policy, empower Program Managers, actively manage risk, and emphasize sustainment. The ARA process then evaluates a project's relative progress of team's claimed approach relative to statutory ad regulatory requirements. The resultant assessment reports concept maturity for each of the six factors (TMRO+SC), identifies areas of particular concern (i.e., low probability of achieving target performance within allocated timeframe and resources) and provides recommendation for continued incubation or accelerated progression to a program of record.

XA sees value in its application both internally, as well as externally, to organizations such as Air Force Futures, the Air Force Research Laboratory, and System Program Offices. The ARA document may be used as decision support for the Milestone Decision Authority (MDA). ARA assessments can be completed using the full framework (based upon empirical data) or compressed "quick look" assessments which are more applicable for concepts still in the discovery stage.
Results: To date, the ARA methodology has been applied to Future Game 23 concepts, Directed Energy systems in the early incubation phase as well as software intensive command and control systems about to be accelerated into fielding. Lessons learned have been captured and applied in subsequent evolutions of the ARA methodology.

Location: TH369
Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

65989 - Long Range Precision Munition (LRPM) Trades Analysis

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Bryant Austin Hummel

Abstract: "Which comes first: the sensor or the munition?" is an issue that militaries around the world wrestled with at every modernization and transformation opportunity. Many different capabilities on both sides of the equation are part of the U.S. Army's plans for transforming the force for 2030 and beyond. One such capability is the Long-Range Precision Munition (LRPM). LRPM is an Army Aviation-delivered lethal capability that compliments the extended-range sensing capabilities offered by another Army transformational capability, air-launched effects (ALE). Paired together, the LRPM and ALE substantially extend the reach of Army Aviation to organically find and prosecute targets, offering an answer to the initial question – the sensor and the munition can be developed at the same time. Ensuring complementary capabilities is an important factor in simultaneous developments which led to the LRPM Requirement and Framing Analysis (RFA) study to determine the attributes, performance levels, and potential solutions for the munition. The TRAC-led LRPM RFA team drew from across the Army Analytic and Aviation communities to explore trade-space among system attributes, operational attributes, cost, and schedule risk to help refine requirements and inform senior leader decisions.

A key output of the study was the identification of two functionally different ways to create the LRPM capability – missile-like munitions and loitering munitions. The trades analysis generated over 150 potential design points across these two approaches, identifying the estimated cost, schedule, and performance impacts, risks associated with changing attribute levels and technologies, and the effect on operational outcomes. The trades analysis provided LRPM operational risks and benefits regarding materiel solution suitability, acceptability, and feasibility that balance benefit, cost, and technical risk.

This presentation describes the techniques used to conduct the trades analysis for LRPM and the methods and tools used during the trades analysis.

Location: TH369
Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

65686 - Using Architecture to Support Capabilities Analysis of the Advanced Reconnaissance Vehicle

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: John Park		
Abstract: In support of the USMC's Capabilities Development Directorate, Ground Combat Element Division, the Operations Analysis Directorate, Capabilities Analysis Branch, conducted capabilities analysis, high resolution modelling, and combat simulation to support and refine the requirements of the Advanced Reconnaissance Vehicle (ARV). In a novel application, this study leveraged Cameo Enterprise Architecture to conduct analysis of Marine Corps and Joint capability gaps and identify solution space opportunities. The insights from this portion of the larger study provided potential courses of action regarding the concepts of employment, structure, and material solution requirements to capability developers. Location: TH369 Classification: UNCLASSIFIED // FOUO Working Group: WG25 AoAs and Capability Development		

65743 - Cloud Based Enterprise Capability Development Data Architecture

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Clarence Williams; Elizabeth Frakes		
Abstract: To effectively prioritize and track Capability Development (CD) efforts, relevant data must be captured, analyzed, and maintained across the DoD Enterprise. When tasked with answering questions related to the current state of these efforts and understanding their contribution to the future fight, action officers (AOs) are often faced with insufficient analytic tools and a need for structured data. Current data sources are often disjointed and created for a specific function leading to the inability of AOs to use the data for different needs. Additionally, cross-DCS, MAJCOM, and PEO collaboration and version control are difficult due to the inherent lack of flexibility of network boundary layers and network restrictions. With the continued need to digitize CD data and modernize the process of enterprise CD, A5/7 created the Air Force Capability Analysis and Tradeoff Tool (AFCATT). AFCATT provides distributed data access, two-way communication between visualizations and the database, Gantt Chart / Critical Path capabilities, and linkages to the AF Data Fabric (PBES, EP2, PMRT, etc.). AFCATT is a cloud-based data management and visualization application. It is built using the Flask microframework powered by a PostgreSQL relational database. The Python programming language was chosen for its extensive library of packages related to data analytics, data visualization, and web development. Users can create, read, update, and delete their CD data and develop linkages to other datasets across the AF Data Fabric. AFCATT stores the captured information in a sophisticated relational database that can handle nearly infinite recursive dependencies and relationships. In addition, a common data model allows users from different organizations to individually decompose their CD efforts and demonstrate the complex relationships between existing enterprise efforts. As a use case, A5/7 used AFCATT to prioritize initiatives for HAF A8's summarizing event. The data was collected, decomposed into the AFCATT data structure and tied to the Universal Joint Task List and the Joint Warfighting Concept. Having a common data model in place allows for linkages to be made using SQL queries. As a result, A8 was able to show each initiatives relevance to each fight objective and inform funding decisions going forward. In summary, AFCATT supports the USAF enterprise to track capabilities and unveil mission critical gaps. The web application presents a novel solution to the arduous task of data wrangling, cleaning, and maintenance by providing access to a living database through a cloud-based user interface and data management system. By integrating CD initiatives into a single source, the enterprise will be able to identify and address critical gaps and resource prioritized CD efforts, thus maximizing future mission success.		

*Disclaimer: References to specific products or programming languages are for informational purposes only and are not to be construed as an endorsement.

Location: TH369
Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

66643 - Parametric Exploration of Directed Energy Engagements

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Nicole Boykins		

Abstract: (U) High Energy Lasers (HEL) have the potential to provide offensive and defensive capabilities without restrictions to shipboard weapon inventories. However, HEL systems generally impose significant impacts on their host ships and possess other inherent limiting factors in their operational employment. To understand the tactical situations and operational effectiveness of HEL, this parametric study examined self-defense and sea-based area defense against various threats. This unique parametric study was laser-system agnostic in that no specific laser systems were evaluated. Instead, primary properties of the laser system were varied to provide insight into how different capabilities perform in various environments. From the Design of Experiments, laser properties, threat physical characteristics, threat trajectories, and threat vulnerability factors were identified and ranked by HEL effectiveness. Also identified were minimum characteristics for different tactical scenarios.

Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG25 AoAs and Capability Development

66644 - Comparing Exploration Approaches to Complex Operational Evaluations

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Nicole Boykins		

Abstract: (U) Design of Experiments (DoE) are frequently used to explore large or complex trade spaces to help guide decisions. While there are accepted “best practices” at the technical level, there is no systemic or overarching DoE schema by which the analyst can definitively define an exploration framework to guarantee success. Instead the designer must generally craft an ad hoc framework that best suits their needs and situation. This presentation examines how two warfighting studies employed significantly different approaches to the DoE problem but individually yielded meaningful insights to decision-makers. We compare and contrast how each study’s inherent system complexity; data availability and granularity; and objective questions shaped the implemented DoE. From the comparison, we provide insights regarding when one approach is more suitable.

Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG25 AoAs and Capability Development

65604 - "Measuring” Deterrence: How to Assess a Complex and Unknowable Subject and Achieve AoA Success

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Jeff Braun		
Abstract: The 2018 Nuclear Posture Review called for a new nuclear capability: a Sea-Launched Nuclear-tipped Cruise Missile (SLCM-N) to “provide a needed non-strategic regional presence [and] an assured response capability.” In response, OSD/CAPE initiated an AoA, which was conducted by the SPA, JHU/APL, and 2 Circle analysts of NAVAIR’s Multi-domain Investment Tradespace Environment (MITE) team. This AoA needed to determine a solution that covered the “deterrence gaps” called out in the NPR. Assessing one’s ability to deter is not as simple as plugging in an equation and seeing if you end up with greater than X “deterrence” to see if you succeed. There is an art to it as well, and it is not truly quantifiable. However, history has shown us the kinds of things that bolster deterrence. The precise amount and mix of those things needed at any given time is not a certainty, but in general, increasing one’s ability in any or all of these deterrence contributors results in increased deterrence. Example deterrence contributors: -Ability to achieve persistent presence geographically -Ability to hold important targets at risk day-to-day -Perceived threat the system attributes would likely invoke on enemies -Ability to hedge against risks Each contributor is measurable, whether by hard scientific analysis or by assessment. We measured each concept’s ability to contribute to each of these categories and determined the associated costs (e.g. development/production/fielding cost, operation platform and weapon risk, etc.). We then developed a method to compare concepts that performed well in different contributors that used a 100-point weighting system. We scored each concept both with an even weighting across the contributors and with a relative scoring based on discussions with decisionmakers in the Pentagon, authors of the 2018 NPR, and deterrence subject matter experts. By being transparent about the weighting schema used, we enabled decisionmakers the insight they needed into our assumptions about the relative weights to feel comfortable about our findings. We assessed over 50 discrete concepts, spanning several different platforms (including surface, subsurface, and air), weapon types, warheads, and fielding options, and conducted the scoring at the fully-informed level. The SLCM-N AoA has been touted by OSD/CAPE as a best-in-class study and to this day informs the Nuclear Weapons Council’s decisions regarding the pursuit of a US SLCM-N capability. Location: TH359 Classified Classification: SECRET NOFORN Working Group: WG25 AoAs and Capability Development		

66024 - Developing a New Space Architecture Resiliency Assessment

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Christopher Wishon; Dr. John Dulin; Dr. Jason Reiter		
Abstract: There has been a decisive shift in US military policy regarding the space domain over the past decade; the US can no longer rely on large, expensive, and exquisite space systems that have little to no redundant coverage or capabilities. The US Space Force has instead transitioned to placing an emphasis on designing future space constellations with a focus on resiliency. This has required a shift from nodal level resiliency analysis to constellation-level analysis. This shift, championed by the Space Warfighting Analysis Center (SWAC) through their study of force design alternatives and		

supported through analyses by the Space Security and Defense Program (SSDP), has resulted in a new mission-specific analysis paradigm focused on two branches: left of mission failure and right of mission failure. In left of mission failure, analysts seek to understand how a failure can be avoided and/or minimized, or how quickly a failure would be achieved through adversary intervention if avoidance is impossible. In right of mission failure analysis, the aim is to study the reoccurrence of mission failures and the ease with which further adversary action could induce additional failures. The tools and capabilities used for these analyses span methodologies from simple physics-based models to complex discrete event simulations. The approach has been successfully applied to the SWAC's proposed Missile Warning/Tracking and Ground Moving Target Indication constellations and has raised constellation level resiliency to be an equal decision criterion alongside performance and cost for future national space architectures.

Location: TH369
Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

66026 - Simulating Space Architecture Resilience Against Emerging Threats

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. John Dulin; Christopher Wishon; Dr. Jason Reiter		
Abstract: The resiliency of future US space systems has become a point of emphasis in the past decade, best demonstrated by the cancellation of future acquisitions which have been deemed to be insufficiently resilient to emerging threats. Leading the push to develop resilient space systems has been the Space Warfighting Analysis Center (SWAC) and the Space Security and Defense Program (SSDP), who propose new architecture concepts that balance resiliency, performance, and cost for a variety of missions. To assist the SWAC with this analysis, a custom discrete event simulation (DES) has been developed to test the candidate architectures against various threat CONOPs and strategies. With dozens of candidate architectures evaluated by the SWAC and a large trade space of possible adversary threats in future epochs, a DES implementation was required which could process thousands of iterations across a large set of conditions in an efficient manner. This environment can handle multiple threat types, satellite processes, and active mitigation strategies, all geared towards assessing the resiliency of a constellation given an adversary strategy for inducing mission failure. The environment, its components, and the nuances that set it apart from other simulation techniques will be discussed, along with the impact it has had on two of the SWAC's initial products: a Missile Warning/Tracking constellation and a Ground Moving Target Indication constellation. Location: TH369 Classification: UNCLASSIFIED Working Group: WG25 AoAs and Capability Development		

66153 - Threat-Based Space and Cyber Analysis: The Impacts on the Terrestrial Fight

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Dr. Donald Williams, Jr.		
Abstract: This abstract describes an unclassified 3-month study that examined how to effectively model space and cyber threats in campaign analysis. The study explored the research question, "How can operations research models represent the campaign and decision-making effects of space and cyber threats in campaign analysis, using the Army opposing forces doctrine?" According to Army		

Regulation 350-2, page 1, the Opposing Force (OPFOR) Program is a “plausible, flexible military and/or paramilitary force representing a composite of varying capabilities of actual worldwide forces (doctrine, tactics, organization, and equipment) used in lieu of a specific threat force for training and developing U.S. forces.” This program provides a lens by which threats-based analysis may inform operations research models; specifically, the vulnerability in blue systems in the space and cyber domains.
The tactical and operational effects of space and cyber systems have emerged as pivotal to contingency planning. Both domains impact all phases of the continuum of conflict, have joint implications, relevance in commercial, private, and public sectors, and lack internationally accepted standards. However, few operational research models have addressed the way threat cyber and space systems affect actions on planning in terrestrial domains such as air, land, and sea. Further, few studies have examined the specific way space and cyber systems integrate with terrestrial operations. This analytical gap has led to gross misrepresentation of space and cyber effects in joint military planning, including how friendly systems account for these systems in threat analyses and how they possibly alter operations research modeling and simulation.
This study contained two phases using quantitative and qualitative analysis. Phase one included examining 22 space and cyber systems within the Army’s opposing forces doctrine. The phase yielded a list of 102 effects on terrestrial domains. Phase two explored how adversaries may tactically or operationally use the 102 effects in a simulated campaign.
This study is relevant to operations research because it illuminates two domains that affect all military services, as well as many commercial and public sector organizations. This research is relevant to this year’s symposium because it used an innovative analytical approach in an under-researched area. Finally, it integrated a threat-based operations research approach with peer-reviewed, reputable qualitative data analysis. The presentation will include a detailed summary of the study’s two phases and findings.

Location: TH369
Classification: UNCLASSIFIED
Working Group: WG25 AoAs and Capability Development

65981 - A Timeline to Execute Defensible Operational Effectiveness Analysis

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mr. Evan Bradshaw

Abstract: Beginning in fiscal year 2022, The Research and Analysis Center executed analysis focused on identifying the operational impacts of adding Vehicle Protection Systems (VPS) capabilities at the platform and formation levels to inform future science and technology investments for Product Manager VPS. The study analyzed operational effectiveness impacts of eight technology trades: Soft Kill (Electronic Warfare), Hard Kill (Kinetic Energy/Chemical Energy), Obscurants, Armor, Top Attack Protection, Pre-Shot, Hostile Fire Detection, and Mobile Camouflage. To address stakeholder questions, three analytic vignettes were explored: a battalion attack, a company deliberate breach, and a brigade hasty defense. The analysis was conducted using Combined Arms Analysis Tool for the 21st Century and a novel model developed in Python specifically for this study.

This presentation will cover the design of experiments used, with a focus on the individual technology trades, as well as looking at combinations of VPS technologies to provide layered-defense effects. Additionally, the presentation will highlight the post-processing techniques and interactions with warfighters and other subject matter experts utilized for operational effectiveness analysis to directly

address study questions. Finally, the presentation will address how the study team created both defensible visualizations and summarized output data that clearly and efficiently conveyed key information to stakeholders to enable informed decisions and follow-on cost-benefit analyses, with a discussion on lessons learned.

Location: TH369
Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

65998 - Building Threads to Identify and Analyze Cross-Portfolio Capabilities

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Benjamin Soderstrom

Abstract: Army Futures Command (AFC) leads U.S. Army transformation to ensure the Army is equipped to defeat adversaries in future operational environments. Analysis of modernized capabilities, delivery schedules, and their impact across warfighting functions is essential to deliver Army 2030 and the design Army 2040. AFC leads the development of Army Capability Threads (ACTs): system-of-systems architectures that define relationships and interdependencies among materiel programs and formations, across multiple warfighting functions, required to deliver a capability to the Joint force. These architecture frameworks facilitate shared understanding of critical system dependencies, operational vulnerabilities, and opportunities for further capability development.

AFC's Systems Engineering and Architecture Division (SE&AD) and the Research and Analysis Center (TRAC) developed and executed an approach to build ACTs, capture authoritative data obtained from organizations across Army Commands, and visually depict required materiel programs. The ACTs provide the Army a cross-portfolio organizing framework with which to evaluate force effectiveness, capability gap mitigation, capability investment, and other measures to inform Army planning and programming.

This presentation summarizes AFC's methodology for developing ACTs and TRAC's assessment of these future capabilities.

Keywords: ACTs, Army 2030, Army 2040, capability development, system of systems

Location: TH369
Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

65992 - Enhancing Live Experimentation: Using Simulation to Scale Satellite Communications for Large Scale Combat Operations

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Matthew Wesloh

Abstract: The Army Futures Command (AFC) launched Project Convergence 22 to assess the evolution of Army transformation for future Large Scale Combat Operations (LSCO). The Research and Analysis Center (TRAC) spearheaded data collection and analysis, identifying network integration and interoperability as crucial areas to focus on during the field experiment. However, the study team encountered two major obstacles: the experimental effects on a network differ from combat

operations, and the data collected only represented the experimental scope which provided incomplete views of prototype technologies and procedures. To surmount these obstacles, the study team employed large-scale operational communications simulations. Experimental data was primarily collected through observational and instrumented systems which would usually necessitate months to clean and prepare before incorporation into simulation; however, results were due six weeks after the experiment. This presentation will describe how the study team used simulation to overcome these obstacles within the required timeline. It will also describe the lessons learned along the way.

Location: TH369
Classification: UNCLASSIFIED // FOUO
Working Group: WG25 AoAs and Capability Development

WG26 Cost Analysis

65602 - Best Practices to Develop Comprehensive, Accurate, Well-Documented, and Credible Cost Estimates

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Mr William Laing		
Abstract: The Government Accountability Office is an independent, nonpartisan agency serving the Congress by helping to improve performance and ensure accountability in the federal government. To this end, the Science, Technology Assessment, and Analytics team at GAO has developed best practice guides for effective project controls for federal acquisition programs. This presentation will provide an overview of the recently revised GAO Cost Estimating and Assessment Guide (GAO-20-195G), including an overview of the best practices to develop a comprehensive, accurate, credible, and well-documented cost estimate. The presentation will also review case studies on the use of the guide and briefly discuss related topics covered in the guide such as performing an effective Analysis of Alternatives, and monitoring a project's execution using Earned Value Management. The foundational tenets for cost estimating serve to underpin effective cost analysis. When used in conjunction with the other GAO Best Practice Guides for Schedule Assessment (GAO-16-89G), Technology Readiness Assessment (GAO-20-48G), and Agile Software (Exposure Draft available), agencies can effectively address both novel and emerging technologies and associated program management challenges. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

66014 - A Goal Programming Approach for Optimizing the Sustainment of the Canadian Armed Forces

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr Stephen Weber		
Abstract: The materiel division of the Canadian Department of National Defence oversees the National Procurement Program (NPP) which is responsible for the sustainment of all the fleets and systems that compose the Canadian Armed Forces CAF. The NP fund consists of approximately 15% of the total defence budget and resources a wide variety of activities including maintenance, repairs, upgrades, materiel acquisition and engineering services. In the fall of 2022 an anticipated funding		

shortfall of over $3B was identified over the subsequent five fiscal years of the program. Underperformance of the NPP can imperil the interoperability of the CAF with its allies. It can also seriously degrade the CAF's advantage over its adversaries.

The anticipated funding pressure is forcing decision makers to make difficult choices about what aspects of the program to resource and to what degree. This work focuses on improving the technological sophistication of the portfolio planning process of the NPP. This includes developing a consistent data schema to logically represent the relationships between the organisations, program elements, activities and desired outcomes (military capabilities) of the program. The conceptual patterns identified in this work are widely applicable to other enterprise resource planning problems.

The problem at the core of the NPP management is the optimal allocation of marginal funds. The status-quo solution involves opaque heuristics applied within each sub-organisation (e.g army, navy and air force) with limited CAF wide optimization. This work explores and implements optimization solutions and the data necessary to implement them, including goal programming, knapsack optimization and approximate dynamic programming. Optimization is used herein as an aid to support decision makers to iteratively construct a desired portfolio. This is accomplished by combining optimization with the incumbent heuristics to find locally optimal solutions in the neighbourhood of familiar robust solutions.

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

65898 - Marine Corps Long-Range Capital Planning/Force Design Affordability Analysis (FDAA) in support of Program Objective Memorandum for 2025-29 (POM-25) and beyond.

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. JJ Bancroft; Major John Bailey; Ms. Brittlea Brown; Mr. Davis Greenwood; Elena Heit

Abstract: This years' submission serves as an update to the first version of the FDAA which was presented during the 90th MORSS in June 2022. The Marine Corps' concept for Force Design 2030 calls for major changes across the service, both structurally and programmatically. These changes created significant shifts in programmed resources and re-prioritized future funding in an already fiscally-constrained environment.
The Marine Corps' Deputy Commandant for Programs and Resources (DC P&R), Program Analysis and Evaluation Division (PA&E) has developed a repeatable process to assess affordability of USMC programs with respect to the USMC topline, Force Design, and relevant portfolios within the current and potential future budgetary environments. Through this process, PA&E created a framework for assessing current and future programs that drive or constrain Force Design implementation.
This year's version of the assessment includes a 15-year look at the three pillars of the Marine Corps Force Design effort: Equipment Modernization, Talent Management, and Training and Education. Additionally, this analysis will consider the Installations Plan for the Marine Corps in response to updates in the Marine Corps' Pacific Posture. To enable repeatability, PA&E has developed a Tableau-based affordability tool to facilitate the visualization of long-range capital planning. This assessment also includes potential levers, such as reductions to the Marine Corps Programs, to better assess sensitivity to relieving budgetary pressure.

It is envisioned that DC P&R's FD affordability study will continue to serve as a centerpiece for trade space analysis for the Commandant of the Marine Corp's Force Design transformation initiatives.

Location: TH358 Classified
Classification: SECRET NOFORN
Working Group: WG26 Cost Analysis

66687 - Quantitative Analysis for Autonomous Systems

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Ryan E Fitzgerald; Tom B Apker

Abstract: The US Department of Navy (DoN) has seen significant Congressional cuts against its uncrewed systems (UxS) programs in recent years. There are countless news articles about entrenched thinking and hesitancy in fully developing and employing UxS. While the purported cause of the cuts and this thinking is often cited as reliability concerns, the DoN, and the Department of Defense (DoD) as a whole, suffers from not having a compelling, data-based case to invest in development and proceed with employment of UxS and autonomous systems. Discussion surrounding investment often involves anecdotes about single use cases, aspirational cost savings not supported by analytics, and varying thoughts about how best to use these systems.

The DoD must present a better case for development of, investment in, and employment of UxS. While culture is a difficult thing to change, using data can begin to reshape it. Quantitative Analysis for Autonomous Systems, aka Quokka, is a tool that does just this. Given a mission, locations for desired effects, information about the targets, and a database of platforms and their key characteristics, Quokka quantitatively computes dozens of effects chains of nested systems capable of creating the desired effect. The "best of breed" chains are then modeled and the mission is simulated via Advanced Framework for Simulation, Integration, and Modeling (AFSIM) to generate key measures of effectiveness (MOE) such as probability of mission success, number of adversary countermeasures expended, time to neutralize targets, etc. These are compared to conventional effects chains for which the identical M&S is performed and MOEs generated. A holistic cost assessment is completed, calculating both mission and total cost, to produce a cost per effect metric. The tool provides data on several factors of effectiveness for new and novel effects chains and associated cost, perhaps for the very first time.

Quokka provides the data the DoD is lacking and which it desperately needs to make a case for development of, investment in, and employment of UxS and autonomous systems. Quokka can help develop, design, and explore effective methods of employing UxS and autonomous systems and provide the data that makes clear the advantage in doing so.

Quokka determines systems which are most effective when nested together and can steer investment towards physical integration and interoperability for systems of systems. It executes analysis on platforms that operate in any and all domains. Its current exemplar capabilities focus on developing kinetic effect chains involving UAVs, USVs, and UUVs. Non-kinetic effects are currently being incorporated into the tool to increase the effects chains Quokka can posit.

Quokka shows new and novel uses for new and existing platforms that provide asymmetric advantage when stitched together into effective warfighting capabilities at lower cost and much sooner than new Program of Record platforms will be delivered.

Location: TH370
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG26 Cost Analysis

65664 - Naval Postgraduate School Cost Estimating & Analysis Master's Degree and Certificate Programs

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Karen Richey Mislick		
Abstract: Abstract: This presentation provides an overview of the Naval Postgraduate School's two distance learning programs in the cost estimation field. The master's program is a two-year, 16 course curriculum with 216 graduates so far. There is also a four-course certificate program that encompasses one course per quarter over one year leading to a Certificate in Cost Estimating and Analysis. Further information is available at: https://my.nps.edu/web/dl/degProgs_MCEA Extra verbiage: The presentation will incorporate details and requirements about the programs, achievements to date, research undertaken by current students, possible teaching opportunities for MCEA, and lessons learned from our experience so far in these innovative and challenging educational programs. We commenced our thirteenth cohort in March 2023 and look forward to you joining us in March 2024! Upon graduation, students will meet all education and training requirements to be DAWIA Level I and II complete in the DAU Business-Cost Estimating (Business-CE) career field (Practitioner and Advanced level). Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

66195 - Cost analysis to support effectiveness based design of rotorcraft

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Jed Richards; Mark Bodie; Mr. William Leonard		
Abstract: Producing accurate predictions of the life cycle cost of large military systems is difficult during early concept development. However, the ability to make informed requirements, design, and affordability decisions using well-informed cost estimates increases the likelihood of budgetary success of these programs. Therefore, integration of costing with conceptual design and performance simulation is useful for early program development. These models are best integrated within an orchestrated computational environment to enable the exploration of many possible designs and system contexts. Often initial system life cycle cost estimates generated independently by the cost community typically lack easy integration with the engineering and design community and span a smaller number of design points. Current research efforts employ this methodology for a generic rotorcraft system cost model leveraging an automated workflow in a high-performance computing environment linking both engineering design model and operational analysis simulation output. The development of a dynamically linked cost model with a time-phased cost breakdown provides opportunities for decision makers, in requirements and design communities, to understand the financial resources associated with a proposed system. This work overcomes difficulty of synchronizing parameters over a set of disparate models to allow for an automated set of tools. It proposes a user interface to allow for cost model management and recommends a set of output visualizations that are critical to early systems decision making. Case study involving a rotorcraft		

system demonstrates the utility of this approach, particularly when system complexity and program scope are large (e.g., for major defense acquisition programs).

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

66730 - Modeling the FARA Airframe's Design for Supportability

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: MAJ Sam Yoo; Andrew Bellocchio; Kyle Ditonto; Madison Kusano

Abstract: The US Army Future Attack Reconnaissance Aircraft (FARA) aircraft structure will be composed primarily of advanced composites compared to the current fleet of Army helicopters made largely of sheet metal. Advanced composite maintenance is much more complex and difficult to make repairs in comparison to metal structures. This study examines the airframe structure's design for supportability, with a focus on the materials engineering, to provide an objective model for comparison between the two FARA Competitive Prototype (CP) aircraft: Bell's Invictus and Sikorsky's Raider X. Most of a system's lifecycle costs occur during the support and sustainment phase. An early and deliberate analysis of the FARA airframe's design for supportability could help inform senior decision makers understand important distinctions between the two competing designs, which could save the Army billions of dollars in support costs over the life of the program. This study will be comprised of three parts. First, a literature review and stakeholder analysis inform the essential supportability requirements, functions, and objectives for the airframe. Second, a qualitative and quantitative value model is developed in support of multi objective decision analysis. Lastly, the airframe data and relevant assumptions about cost are made to highlight the cost vs. value trade space for decision makers.

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

66729 - Determining the Coast Guard Enforcement Cutter Fleet Sufficient to Meet Current and Emerging Missions

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Joshua Kitenko; Daniel Winter

Abstract: The United States Coast Guard maritime enforcement cutter fleet projects surface presence domestically and abroad. The fleet is undergoing its largest recapitalization effort since World War II with three, simultaneous acquisition programs. Given recent growth in emerging mission demands, and the mission overlap with these recapitalized assets, Congress requested analysis to determine the fleet sufficient to meet current and emerging mission needs with which to base follow on acquisition and homeporting decisions. Coast Guard analysts in the Office of Requirements and Analysis elicited presence requirements and capability constraints from tactical commanders and evaluated trends in historical data. Analysts then crafted a mixed integer optimization model to optimize the enforcement cutter fleet force structure by minimizing the estimated total fleet lifecycle cost while meeting the capability requirements for each mission area. This presentation will provide an overview of Coast Guard enforcement cutter missions, platforms, and general force planning business rules and

how analysts completed a research study to optimize the future recapitalized fleet to meet future needs.

The views expressed herein are those of the author and are not to be construed as official or reflecting the views of the Commandant or of the U. S. Coast Guard.

Location: TH370
Classification: UNCLASSIFIED // FOUO
Working Group: WG26 Cost Analysis

66148 - Cost Data Power BI Analysis Tool

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Alexandria Rae Meade

Abstract: The Power BI Cost Tool was created as an all-encompassing tool to include contracts data, CCDR, and Flexfile submissions. This allows for analysis of each each data set as well as a comparison between the actual spending of the program against the original funding when the contract was awarded. First the cost and contracts data are pulled from Cost Assessment Data Enterprise (CADE) and Electronic Document Access (EDA) then they are refined through the Extraction, Transform, and Load process (ETL) into the Open Cost Database. They are then tagged and undergo a cost rollup. These data sets are then pulled from the database into the Power BI tool. The tool houses and aggregates the cleaned data into visual representations of the data as well as creates back-end connections to allow for direct comparisons between the data sets. An example of this is Contract Line Item Number (CLIN) awarding compared to actual Flexfile reported CLIN costs. The tool shows analysis in a clear and concise manner including Program Overviews such as total funding and vehicle buys, as well as cost views including labor rates, cost growth, and process costs over time. Finally, it also incorporates Flexfile views such as contract funding breakdown, order or lot/end item growth, and the aforementioned Flexfile CLIN usage. This functionality allows this to be utilized as both a pre-process and post-processing analytical tool.

Disclaimer: This is an unclassified tool but is still in the process of gaining sponsor approval for public release.

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

65763 - Cost Estimator Accuracy over Time and Program Characteristics that may Affect Accuracy

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Patrick Thomas Bennett

Abstract: Cost growth in Major Defense Acquisition Programs (MDAPs) is a perennial concern. As a result, a large literature examining the magnitude, trends, and root causes of MDAP cost growth has been published. However, there has been little research exploring how cost estimating error directly contributes to MDAP cost growth. This research employs a novel investigation of the accuracy of cost estimating error via an analysis of the Selected Acquisition Report's (SAR) cost variance category called Estimating Changes. More specifically, we analyze the Estimating Change category for 166 development programs from 1997 to 2020. Descriptive statistics and non-parametric inferential tests

are used to analyze how cost analyst accuracy has changed over time, between the services, between different program commodities, and between joint and non-joint programs. While evidence of improved accuracy over time was not found, a downward trend in the variance was detected. The reduction in variance over time is a good news story. This indicates that either the variance of cost estimating is improving, or perhaps more provocatively, that the variance of cost estimating reporting is improving.

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

66109 - Extracting Pricing Information from Raw Text Data with a Machine-Learning Pipeline

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dennis Robertson; Robert Murphy; Clark Van Lieshout

Abstract: Data-driven decisions are crucial to an effective cost negation process. Assessing if proposal costs are fair and reasonable relies on reference data sources, which may not have sufficient samples to form a persuasive position on proposed costs. In some cases, additional data is available, but difficult to incorporate into the cost analysis without substantial manual effort. The extraction of information in this way is an enabler to Digital Transformation efforts, driving improved efficiency and effectiveness.

In this work, an automated pipeline was built to process ten thousand GSA eLibrary multiple award schedule (MAS) documents. Over half a million labor categories (LCATs) and key cost-related details were extracted. Currently, less than 20% of this data is in an accessible, structured format within GSA CALC. While the focus is on GSA MAS documents, this work serves as a case study for the potential of AI/ML-powered text extraction to reveal and structure data that is otherwise inaccessible.

Text extraction is particularly challenging for MAS documents as there is no set format or structure to the documents. Advanced techniques including named-entity recognition (NER) as well as other artificial intelligence/machine learning (AI/ML) techniques were applied to extract key information. Labor categories, minimum education requirements, minimum years of experience, and price were among the fields extracted from the documents.

The ensemble of models extracted 80% of available content, with an accuracy of about 90%. This automated process can potentially save GSA over ten thousand hours of manual extraction across ten thousand contracts. Additionally, these results enable tens of thousands of new LCATs (and their prices) to be extracted, and the number of samples for already structured LCATs was expanded. This larger sample size will yield cost analyses with higher statistical weight, even among already common LCATs.

These results represent a substantial increase in the amount of information compared to GSA CALC, providing a pathway to expand the publicly available pricing data. The techniques presented in this work can be applied to other Digital Transformation and data extraction efforts as well.

Location: TH370
Classification: UNCLASSIFIED
Working Group: WG26 Cost Analysis

65665 - Finding the Story in Your Data

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Karen Richey Mislick
Abstract: Hook: Tired of boring presentations? Learn these simple storytelling techniques to enhance your slides and keep your audience's attention on you! Abstract: This presentation will cover data visualization and how to find the story within your data. It discusses how people process information and offers tips for creating effective graphics using data visualization principles and techniques to inform decision-making. Different approaches to visualizing data will be discussed including decluttering your graphics, choosing informative visuals, focusing the audience's attention using pre-attentive attributes, thinking like a designer, and implementing effective storytelling techniques. Throughout your formal schooling, you had to take both math and English classes. However, rarely, if ever, are cost analysts taught how to merge these two areas of study together to effectively tell the story associated with the data they have collected. This presentation will teach you how to tell the stories associated with the cost estimates you create and how to use effective visualization techniques to turn your data into information that can be used to drive important decisions. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis

66005 - Overcoming Cost Data Challenges for Early Acquisition

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Daniel Meadows		
Abstract: Framing Analysis (FA) refines desired capabilities in terms of attributes, priorities, and how they contribute to operational effectiveness. It establishes the trade space to examine how adjusting schedule and cost effect operational risk. The Maneuver Support Vessel – Heavy (MSV-H) FA will be used to support development of an Abbreviated Capability Development Document to enable a Mid-Tier of Acquisition Other Transactional Authority action to procure a virtual MSV(H) prototype. The cost analysis supporting the MSV(H) FA presents a case study for providing cost analysis for a set of requirements and concepts rather than a set of designs or alternatives. This presentation discusses challenges such as scarcity of modern analogous systems, low fidelity historical data, interdependence of system attributes, and uncertainty of design specifications. It presents the cost team's efforts to overcome these challenges to provide cost drivers, rough order of magnitude costs, and support trades analysis. It provides a brief overview of the various datasets and relationships that were explored with methods ranging in sophistication. The presentation also covers topics such as cost estimating method selection, data selection, variable selection, model selection, and cost uncertainty. Location: TH370 Classification: UNCLASSIFIED // FOUO Working Group: WG26 Cost Analysis		

66251 - Cost Engineering a MVDC Power & Energy Design for Navy Surface Combatants

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Richard Shea; Ms. Ann Hawpe; Mr. Henry Jones, III; Victor Sorrentino		
Abstract: Since maritime MVDC systems do not exist, a statistically significant cost estimating relationship is not easily determined. The components required for a MVDC system do exist at some scale and technical level of maturity. However, there is nothing in production meeting all the same requirements of a Navy surface combatant ship installation. Therefore, this paper follows an approach to compare the theoretical costs of a MVDC to a MVAC architecture in a US Navy Ship. As the Navy transitions to a new era of electronic warfare, ship power system becomes the critical foundation to support the future. I recent years, combat systems and mission loads grew significantly and consumed the power margin that was inherent in traditional power generation and distribution designs. Future combat capabilities will not only increase power demand and increased power transients on the system. While qualitative and heuristic arguments have been made for why MVDC systems should be more affordable and energy efficient than MVAC systems, a comprehensive feasibility and cost analysis has not been performed to date that provides quantitative rationale. The challenge with completing a comprehensive feasibility and cost analysis is that MVDC technology still requires significant investment in research, design, development, and production. The purpose the study is to present a quantitative cost comparison of MVDC and MVAC architectures based on an independent cost engineering approach. This study will identify the parameters that will impact the cost of MVDC components, along with the uncertainty, associated with those parameters. Also identify relative cost comparison to MVAC components; industry investments in MVDC to support development of Navy components; and factors that will impact producibility of MVDC components and producibility risks. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

65636 - COST ESTIMATING RELATIONSHIPS FOR RECURRING T100 FLYAWAY COSTS

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Kyrie Michelle Rojo; Edward D. White, III; Brandon Lucas; Jonathan Ritschel		
Abstract: This research investigates a dataset of over 80 Air Force and Navy aircraft and applies regression techniques to create two cost estimating relationships (CERs) for predicting recurring T100 flyaway costs, depending on where in the acquisition lifecycle the estimate takes place. The first CER has an R2 of 0.89 and can be applied prior to Milestone B (MS B). The second CER has an R2 of 0.88 and can be applied between MS B and MS C. Significant cost drivers identified include stealth, cohort, empty weight, the natural log of speed, legacy aircraft, fighter aircraft, and Engineering and Manufacturing Development costs. This research is the largest aircraft regression study to date for recurring T100 flyaway costs and can be used by cost analysts as a reliable cross-check in early estimates. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

65364 - RATE EFFECTS IN AIRCRAFT LEARNING CURVES

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Caleb J Ahern; Jonathan Ritschel; Edward D. White, III; Brandon Lucas; Dr. Robert David Fass		
Abstract: Across the Department of Defense (DoD), a wide variety of analytical tools are employed by cost analysts to estimate weapon system costs. One of the techniques widely employed by practitioners is the learning curve. Although learning curves have been widely studied, using rate-adjustments or production rate effects (PRE), have only intermittently been evaluated in place of using the traditional learning curve. Previous studies analyzing production rate found mixed results. This research aims to examine aircraft production data to determine if a production rate model is preferable in United States Air Force programs. Additionally, this PRE research seeks to determine if there exists a minimum production size necessary for using rate. Once a minimum size, or conditions, is determined, information is then mapped to show where PRE occurs within the acquisition process timeline. The results of the study find the PRE models to have less error than the traditional learning curves. Additionally, the minimum rate size for production data was found based on specific model constraints. Finally, tracking for when PRE occurs relative to Initial Operational Capability (IOC) shows a statistical significance of occurrence after IOC. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

66393 - At What Cost? A Lifecycle Cost Calculator for Aviation Security Checkpoints

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Julianna Rose Puccio		
Abstract: In the wake of September 11th, 2001 the United States has allocated a tremendous number of resources into improving aviation security practices and developing new passenger and baggage monitoring technologies. With the development of new technologies naturally comes the question: how much will this cost? The Aviation Security Screening Optimizer for Risk and Throughput (ASSORT) Cost Model was developed to estimate the 10-year lifecycle cost for implementing and operating a future security checkpoint that includes new CONOPS, technologies, and traveler types. Cost Model users can specify the lane type (i.e., general, trusted, trusted+), number of lanes for each type, and lane configuration (i.e., technology mix) for each lane type. In the Cost Model, lifecycle costs are modeled as a function of acquisition, operations and maintenance (O&M), and labor associated with each lane within a security checkpoint. Technology acquisition costs are modeled as one-time payments made when each technology is first procured and installed; O&M represents the cost required for general operation and maintenance of the checkpoint lanes and technologies over the 10-year lifecycle; and labor is based on the hourly wages of staff operating the checkpoint over the 10-year period. The current Cost Model is captured in a prototype Excel model but will eventually be implemented and used in tandem with other ASSORT tools (i.e., ASSORT Risk Model). This talk will review the methodology and include a short demonstration of the ASSORT Cost Model. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

65755 - Chance-Informed Contract Management

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Maximillion Disla; Dr. Sam Savage
Abstract: Many government agencies manage both civilian and defense contracts. These agencies manage thousands of contracts per year and must contend with an ever-growing range of uncertainties such as as labor rates, material costs and supply chain delays. In spite of significant data on past contracts, and ranges of future conditions, it is nonetheless difficult to estimate the chances of delays and cost overruns. The discipline of probability management allows the creation of stochastic libraries from both historical data and expert opinion to monitor the chances that contracts will be ready when needed and come in within budget. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis

66097 - Adopting a Data Science Paradigm: Merging Traditional Cost Estimating Methodologies with Advanced Computational Analysis

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Kyle Connor Ferris		
Abstract: In today's world, the availability of large unstructured datasets facilitated through autonomous data collection and warehousing makes the application of data science methodologies a critical necessity. Emergent methodologies leveraging automated data extraction, mining, clustering, cleaning, modeling and visualization are increasingly important for effectively estimating the lifecycle costs of federal government acquisition programs. Incorporating these data science methodologies can yield significant improvements to cost analysis by streamlining data collection and normalization, promoting effective data governance, and providing systematic processes for automated analysis. Continued adherence to legacy paradigms of manual data collection and processing inhibit cost analysts from maximizing on the computational power of programming languages such as SQL, Python, and R, which in turn inhibits accessibility to complex and diverse datasets found in unstructured repositories. Traditional cost estimating methodologies – such as the manual assignment of uncertainty/risk parameters or subject matter expert elicitation – can result in highly subjective inputs and unsubstantiated results. In comparison, statistical models using programmed algorithms can collect and process vast amounts of raw data and utilize these larger datasets for more defensible predictive analysis. By encouraging the adoption of a data science paradigm, this presentation will evaluate the tools and skillsets required for advanced computational modeling and analysis, as well as planning considerations for data science curriculum and training development. Location: TH370 Classification: UNCLASSIFIED Working Group: WG26 Cost Analysis		

WG27 Decision Analysis

66017 - A Goal Programming Approach for Optimizing the Sustainment of the Canadian Armed Forces

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Dr Stephen Weber

Abstract: The materiel division of the Canadian Department of National Defence oversees the National Procurement Program (NPP) which is responsible for the sustainment of all the fleets and systems that compose the Canadian Armed Forces CAF. The NP fund consists of approximately 15% of the total defence budget and resources a wide variety of activities including maintenance, repairs, upgrades, materiel acquisition and engineering services. In the fall of 2022 an anticipated funding shortfall of over $3B was identified over the subsequent five fiscal years of the program. Underperformance of the NPP can imperil the interoperability of the CAF with its allies. It can also seriously degrade the CAF's advantage over its adversaries.

The anticipated funding pressure is forcing decision makers to make difficult choices about what aspects of the program to resource and to what degree. This work focuses on improving the technological sophistication of the portfolio planning process of the NPP. This includes developing a consistent data schema to logically represent the relationships between the organisations, program elements, activities and desired outcomes (military capabilities) of the program. The conceptual patterns identified in this work are widely applicable to other enterprise resource planning problems.

The problem at the core of the NPP management is the optimal allocation of marginal funds. The status-quo solution involves opaque heuristics applied within each sub-organisation (e.g army, navy and air force) with limited CAF wide optimization. This work explores and implements optimization solutions and the data necessary to implement them, including goal programming, knapsack optimization and approximate dynamic programming. Optimization is used herein as an aid to support decision makers to iteratively construct a desired portfolio. This is accomplished by combining optimization with the incumbent heuristics to find locally optimal solutions in the neighbourhood of familiar robust solutions.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66068 - Solving Maintenance Scheduling Using Business Logic and Linear Integer Programming

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ryan D Monson; Chris Gritton

Abstract: Systems Planning and Analysis, Inc. (SPA) supports enterprise stakeholders across multiple platforms with state-of-the-art decision support through the Inventory Decision Support Process (IDSP). At the core of IDSP is a simulation engine that forecasts the future state of each asset in the inventory. The simulation engine supports the use of custom logic that can be tailored to meet the requirements of the specific customer. The custom logic is typically used to automate the scheduling of maintenance events based upon a set of business rules. However, the implementation of said business rules in the model can be cumbersome at times, or the set of rules lead to less-than-ideal solutions. SPA has recently included the use of integer linear programming to find globally feasible and optimal solutions. This paper discusses several scheduling approaches and how they can be integrated with IDSP.

Location: TH372

Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66088 - Improvements to Optimized Tactical Route Planning

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Jacob Hyatt; Thomas Kendall

Abstract: It is of paramount importance for maneuvering units not to be detected by enemy forces for as long as possible. Military planners and leaders attempt to avoid detection by thorough enemy and terrain analysis. Enemy and terrain analysis is complicated by the uncertainty of the enemy's location. In our previous work, "Optimized Tactical Route Planning," we created a robust optimization model that finds the best route a unit can take while minimizing chances of being detected under a given set of environmental conditions and the inherent uncertainty in the enemy's position. This paper improves upon that model through leveraging vegetation data from satellite imagery, introducing multiple enemies, introducing enemy types and capabilities, and incorporating more realistic probability models. These additions increase the reliability and accuracy of the route planning model.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66712 - Modeling Information Fusion for Military Operational Planning and Decision Support Systems as a Neural Network

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Dr. Jeff Durst

Abstract: Multi-domain Operations (MDO) are at the center of modern military operations planning. Military missions today require juggling a disparate set of systems and resources operating across complex environments. For example, even a simple resupply operation requires coordination and optimization across MDO assets and environments, including logistic supply points, vehicles, manpower, weather, and geography. It has become impossible for a team of human analysts to effectively process this amount of data and make fully-informed operational decisions. As a result, mission planners are often tasked with making life-or-death decisions with limited options for timely data processing.

To be successful in MDO, military planners need new decision support system (DSS) algorithms capable of synthesizing these data into operational actions. These DSS need to fuse information from across MDO assets to make robust, data-driven decisions about operations, both in the planning and execution phases. Fortunately, modern machine learning and artificial intelligence techniques, and neural networks (NN) in particular, have brought about tools capable of processing and synthesizing massive amounts of data. Moreover, AI/ML algorithms can process these data much faster and more robustly than a human analyst. Military planners now need an Information Fusion (IF) framework capable of taking in MDO information, fusing it into human-interpretable results, and recommending optimal decisions.

Conceptually, a NN is a ML construct containing input nodes with associated weights, computational nodes, and an output layer. Each input is mapped through the computational network according to its weight, or importance, and ultimately combined with other nodes to form an output; similarly, IF is

the combination of information from multiple disparate sources to provide a single output with less uncertainty than each individual information source.

The presented research proposes a new DSS for military operations by conceptualizing an IF framework as a NN. Data about each asset (vehicles, supplies, etc.) can be thought of as pieces of "information." At the same time, each source of information can be thought of as a neuron inside a neural network. The value of each neuron is its encoded information, and that piece of information's relevance to the mission is its associated weight within the network. Using this framework, each asset's "information" can be fused into operational decisions.

Using historical mission performance data, these decisions can then be optimized through training and backpropagation. In much the same way traditional ML uses backpropagation to compare expected and actual outputs and update neuron weights, here backpropagation can compare expected and actual mission success metrics and update the relative value of each information source. This framework will result in an optimized DSS that can be trained to support any given mission.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

65714 - Quantitative Intelligence Source Uncertainty Analysis Using Multi-Objective Decision Modeling

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Adam Nesmith

Abstract: An all-source intelligence analyst’s primary job is delivering timely, well-sourced assessments on relevant targets based on uncertain and incomplete information. Each assessment includes a likelihood that the assessment is true, and a confidence level based on the uncertainty of the sources used. Quantitative all-source intelligence analysis is not widely implemented despite the acknowledged limitations of qualitative intelligence assessments and the existence of proposed quantitative methods. This is due to the challenge of quantitatively representing uncertainty in text-based intelligence reporting (i.e., HUMINT, OSINT, SIGINT), which limits the effectiveness and usability of previously suggested methods. This research creates a novel framework for quantitatively assessing text-based intelligence source uncertainty by adapting quantitative decision models used in multi-objective decision analysis. This novel model allows analysts to easily identify and mathematically account for the underlying causes of a source’s uncertainty, weight the importance of these causes, and output a single value in between 0 and 1 representing the source’s overall uncertainty. The analyst can then use this numerical output as an input into the previously proposed quantitative intelligence analysis methods. Ultimately, this framework for quantifying source uncertainty facilitates the use of previously proposed methods and creates more traceable and defendable intelligence assessments.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66038 - Stochastic Value Modeling

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Abe Payne; Dr. Kristen Obst		
Abstract: INTENT: Frame and understand the systems and their interrelated elements that can assist with more structured and quantitatively-grounded decision suppor Design improved data, system, process, analysis, and insight-generating requirements, recommendations, and models that could enable improved resource decision-making. METHOD: Stochastic value modeling to compare value and cost while incorporating uncertainty Developed a value model, based on risk metrics from the SME engagements Test runs to demonstrate impact of risk in different areas of resourcing Will demonstrate model, how the team arrived at the values, and how the model supports resource decision making CONTEXT: This is a collaborative project between the West Point Systems Analyst Capstone course and the JSOC J8. Location: TH372 Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

66240 - A Cursory Analysis of Project Dependencies in the Canadian Department of National Defence

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Carolyn Chen; Dr. Kendall Wheaton		
Abstract: The strategic planning for major capital acquisitions in the Canadian Department of National Defence is initiated with a capability-based planning process which informs future capability plans and results in the Defence Investment Plan. The process by which capability gaps are identified and new projects are created is not the subject of this study. Given a set of planned projects, strategic planners want to consider how these projects support each other and combine to provide an effective future force. In this study, analysts were provided access to the departmental data repository for ongoing major capital projects. They reviewed the documentation for the projects and identified relationships between projects based solely upon the contents of project files. This information was used to conduct an analysis of the dependencies between planned projects for the objective of informing strategic planners of the broader potential impacts of decisions on the Defence Investment Plan. New tools developed by the National Research Council of Canada were used to perform this analysis. This presentation will describe the analysis process and the tools used in the study. Location: TH372 Classification: UNCLASSIFIED // FOUO/CUI Working Group: WG27 Decision Analysis		

66000 - Building Threads to Identify and Analyze Cross-Portfolio Capabilities

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Benjamin Soderstrom		

Abstract: Army Futures Command (AFC) leads U.S. Army transformation to ensure the Army is equipped to defeat adversaries in future operational environments. Analysis of modernized capabilities, delivery schedules, and their impact across warfighting functions is essential to deliver Army 2030 and the design Army 2040. AFC leads the development of Army Capability Threads (ACTs): system-of-systems architectures that define relationships and interdependencies among materiel programs and formations, across multiple warfighting functions, required to deliver a capability to the Joint force. These architecture frameworks facilitate shared understanding of critical system dependencies, operational vulnerabilities, and opportunities for further capability development.

AFC's Systems Engineering and Architecture Division (SE&AD) and the Research and Analysis Center (TRAC) developed and executed an approach to build ACTs, capture authoritative data obtained from organizations across Army Commands, and visually depict required materiel programs. The ACTs provide the Army a cross-portfolio organizing framework with which to evaluate force effectiveness, capability gap mitigation, capability investment, and other measures to inform Army planning and programming.

This presentation summarizes AFC's methodology for developing ACTs and TRAC's assessment of these future capabilities.

Keywords: ACTs, Army 2030, Army 2040, capability development, system of systems

Location: TH372
Classification: UNCLASSIFIED // FOUO
Working Group: WG27 Decision Analysis

66486 - Delivering Decision Support for Strategic Planners

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Kendall Wheaton		

Abstract: Strategic planners in the Canadian Department of National Defence (DND) model the value of potential investments and develop risk analyses to assess capital investment options and provide advice on decisions. They presently have a well-developed portfolio management process that supports Force Development. This presentation will describe recent research and development by Defence R&D Canada (DRDC) to provide more advanced tools to analyse portfolios of investments.

The Strategic Portfolio Analyser with Reconfigurable Components (SPARC) was developed recently through a collaboration by DRDC and the National Research Council of Canada. The unique feature of this tool is an ability to import a wide variety of problem types. The tool has been designed specifically to ingest user reconfigurable datasets. It has several algorithms for selecting an optimal set of investments and it has a wide range of interactive visualizations for viewing the data and the solutions. This presentation will describe the tool and its application for strategic planning problems.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

65949 - Integrating data collection with reporting and process flow

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Robert Lasater		
Abstract: This project explored methods for generating reports from the lowest level and having them immediately populate dashboards and actions for Command and Control (C2). Our use case demonstrates an intel report that reports that a network vulnerability exists in a specific sector. The report is injected into a dashboard that compiles all threats and vulnerabilities for operational awareness, while simultaneously a report gets sent to the action officer for that sector identifying the threat. This example may be expanded on for automated actions such as defensive measures, e.g., network scans. Our implementation utilizes a federated suite of data science and information technologies to provide a multi-prong solution that balances innovation at the leading edge of data science with the ability to transition solutions to operations. Location: TH372 Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

65710 - Does Intelligence, Surveillance, and Reconnaissance (ISR) Experience influence Future Prediction Probability when Evaluating a Conflict Scenario: An ISR Assessment

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr Justin Nelson		
Abstract: Introduction: ISR analysts are tasked to assess intel across the Joint All-Domain Command and Control (JADC2) community and provide guidance to leadership for future military direction. These recommendations can significantly influence military superiority within contested regions. Therefore, developing teams of analysts to support these decisions isn't something that should be taken lightly. Task: Sphinx is a collaborative tool that breaks down critical questions requested by military commanders (Priority Intelligence Requirements/PIR and Essential Elements of Information/EEI) into smaller, more manageable questions (Indicators and Observables). Methods: The study consisted of 9 ISR analysts from the 178th ISRG. To begin, each analyst was presented a storyline depicting an ongoing military conflict within a contested region and Sphinx. Within Sphinx, the PIR and EEI was provided by leadership. At this point, analysts were required to provide an initial prediction probability assessment on the likelihood of the EEI occurring. Next, 4 Indicators were developed by SMEs from outside organizations which contains information to support the decision-making process. Analysts were then provided with collected intel from 20 open-source outlets. Their objective was to filter through the content and develop 2 Observables per Indicator (8 in total). Once the Observables were developed, the analysts were required to update their prediction probability. Lastly, the analysts were presented with a wisdom of the crowd (WOC) prediction. After reviewing all the information hosted within Sphinx, the analysts were requested to update their prediction probability assessment. Results: Analysts were divided into two groups to determine if ISR experience plays a role in prediction probability. Groups consisted of analysts with less than 5 years' experience (N=5) and analysts with 5 or more years' experience (N=4). An ANOVA was conducted to determine if a significant difference is observed between groups based on prediction probability. Greater variation in prediction probability for the initial prediction was observed, especially for analysts with 5 or more		

years' experience, compared to the subsequential predictions. Moreover, as information was provided into Sphinx by ISR SMEs, 178th analysts, and WOC, prediction probability converged between groups (p=0.98). Analysts with less than 5 years' experience had a prediction probability of 33.4% whereas analysts with 5 years or more experience had a prediction probability of 33.0%. Conclusion: It's been discovered that personal characteristics can be an influencing factor when providing recommendations, particularly in a military setting. In this study, the objective was to determine if ISR experience resulted in a significant difference in prediction probability. The findings provide evidence that as SA is enhanced through the implementation of Sphinx, prediction probability converges – regardless of ISR experience.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66041 - Quantifying the Marine Littoral Regiment's Contribution to Deterrence

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: LtCol Roy L. Miner

Abstract: This presentation attempts to examine the MLR's effect on deterrence using a modification to the risk construct model Risk = Threat*Vulnerabilities*Consequences (TVC) where we modify the Risk equation to be Risk = (Threat*Consequences)/Defensibility and incorporate Dr. Michael Armstrong's Stochastic Salvo Model into the Risk equation.

In the modified risk construct model, we can define force A's threat value from adversary force B as: Threat = (B Offensive #SSMs)*P(Hit)*Target in Range*Target Acquired where "P(Hit)" is the probability of an unimpeded hit on the targeted ship by an SSM. "Target in Range" and "Target Acquired" are binary variable (yes = 1, no = 0). The notation can be expressed as nB* pB * rB* tB.

We define force A's consequences value with respect to adversary force B as: Consequences = ((Lethality of B Offensive SSM)*(# B Offensive SSMs))/(# A Ships at Risk) where lethality is the number of SSMs required to put an adversaries ship out of action. For example, an SSM that requires 5 hits to put a ship out of action would have a lethality of 0.2. The notation can be expressed as (lB*nB)/A.

We define force A's defendability value with respect to adversary force B as: Defensibility = (Defensive #SAMs)*P(Intercept) where the notation can be expressed as nY* pY and "Y" represents force A's defensive SAM capability.

This yields the risk to Force A as: RA = (nB^2pBlBrBtB)/(A(nYpY))

Essentially, we have the product of two ratios to determine a risk value. The first ratio is between the product of the # of offensive SSMs and their probability of hitting the target to the product of the number of defensive SAMs and their probability of intercept. (nB * pB * rB * tB) / (nY * pY). The second ratio is between the product of number of offensive SSMs and their associated lethality to the number of ships being placed at risk. (lB*nB)/A.

To determine the true risk value, we need to examine the risk between a unit's salvo capability to their adversary's salvo capability as they engage in offensive and defensive actions. This can be done through a ratio to determine the scalable deterrent effect the MLR may have in an area of operations.

We can compare the offensive and defensive risk ratios (Ro/Rd) and their respective deltas for a force without the MLR and a force with the MLR.

With the risk equations established we can begin to analyze some fundamental effects of changes in the various parameters used in the stochastic salvo model. We can also show the effects to the risk equation across a range of values for an adversary and examine the results using a heat map to further understand the MLR's contributions to deterrence

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66194 - Decision Making Via Plotly Dash

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Dr. Elsa Schaefer; Dr. Martin Edwards; Ruth Galaviz-Schomisch; Maj Joseph Kilian

Abstract: Many large organizations are challenged to merge the wisdom and priorities from multiple internal departments to make unified organizational-level decisions. These macroscopic decisions are informed by broad strategic goals and mandates and require balanced input from SMES and stakeholders at the microscopic level. How do we help groups charged with this task make good decisions that meet high level needs while being mindful of nuanced input? We applied several types of artificial intelligence (AI) packaged into a Decision Dash prototype to solve this problem.
Our current setting is the assignment of limited resources to the selection of a subset of projects (a portfolio) recommended for funding. Constraints are applied that mandate certain end-conditions for the portfolio, such as a minimum number of high-risk projects, mission areas or specific projects that must be included, or a funding ceiling that must be maintained. A portfolio's fitness is a numerical value resulting from a weighted average of objectives. In our case, we considered the objectives of strategic fit (which is determined using an NLP approach), SME reviews, and high achievability across technical, sustainability, and economic criteria.
An individual (or group) specifies the relative importance of portfolio objectives and chooses portfolio constraints within the Decision Dash tool. The Decision Dash Tool then activates a genetic algorithm to create real-time portfolio choices. An initial population is created with randomly selected portfolio vectors which are modified to meet any stated constraints. Each vector's fitness is measured against the weighted fitness objectives, and breeding fun ensues to create a new population: elite vectors with high fitness continue to next generation, low fitness vectors are banished, immigration is allowed, and parent vectors are chosen with statistical preference for attractive vectors to produce offspring, which share genes (projects) from each parent. Within a computationally reasonable time frame, the evolutionary computing engine provides visualizations and statistics for top-performing portfolios.
In multiple ways, we demonstrate the good advice the tool can offer, such as projects that are included or excluded across a wide range of decision criteria, as well as detailed results showing alternative project choices that perform with similar strength. We envision intermediate project inclusion choices to be established as constraints, with the tool run multiple times during a decision-making session as a final portfolio is created. The Decision Dash helps decision makers balance the needs and recommendations from stakeholders across the organization.
The views expressed are those of the authors and do not reflect the official guidance or position of the United States Government, the Department of Defense the United States Air Force or the United States Space Force.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66179 - Dynamic Multi-Criteria Decision-Making for Artificial Reasoning

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr Justine Caylor Rawal

Abstract: Decision-making is present in everyday life and can have significant impact in environments that are complex and dynamic. Information is a major driver in the decision process—influencing alternatives and criteria for judgement to yield informed decisions. In addition, there are many different techniques for aiding decision making. One is Multi-criteria Decision-Making (MCDM), which is popular in operations research and can aid in the decision-making process by providing suitable algorithms that can help evaluate and prioritize the criteria and alternatives of a particular problem.

Prior research focused on improving decision-making in complex and dynamic environments. Augmenting traditional MCDM methods with dynamic-case handling and Multi-Variable Logic to create a novel approach that improves decisive performance was explored. The expected outcomes of this research were not to necessarily develop the "one solution", but to set up a common architecture for decision-making in complex and dynamic environments. Several MCDM augmentations were evaluated using various datasets and case studies related to the COVID-19 pandemic. Results highlighted that FAHP-TOPSIS with dynamic-case handling shows promise for providing the most realistic and improved decision for a problem in a complex and dynamic scenario. This research is now being extended upon to have a focus within the field of artificial reasoning. As previously stated, decision-making is a very complex task that considers a wide range of information. While information is necessary for informed decisions, it can present a multitude of challenges. One of the critical challenges is that information comes with different levels of uncertainty. This motivated the research on Uncertainty of Information (UoI). One aspect of the UoI research involved creating complex scenarios to uncover prioritization of UoI in relationship to decisions. A path forward consists of the continuation exploring the preliminary framework that has been established and explore existing state of the art approaches to identify computational models that automate decision making leveraging dynamic MCDM and UoI research.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66123 - Formulation of a Fidelity/Pedigree Metric to Support Rapid Modeling Decisions

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Andrew Abraham

Abstract: When running a large modeling and simulation effort it is critical to possess the ability to succinctly communicate the fidelity and pedigree of a particular study with the stakeholders involved. These stakeholders are oftentimes inundated with several analysis reports to digest from multiple efforts and usually do not possess the time nor resources necessary to conduct a "deep dive" into the various modeling approaches and assumptions that went into a given study. This issue becomes especially acute when operating at the scenario or campaign level of analysis where systems are

formed from the aggregation of other complex systems and a judicious selection of modeling resources must be applied to bound the cost and schedule of a particular modeling effort. Of course, a lengthy discussion between the analysts and stakeholders may ensue when attempting to balance cost and schedule with modeling fidelity and pedigree. All too often it is the case that busy schedules and time constraints on the part of the stakeholders/customers prevents effective communication from occurring and may lead to incongruent expectations between what modeling is requested and what is delivered.
To resolve this issue the authors propose a "Fidelity, Pedigree Metric" which is intended to act as a standard metric describing the utility of a given model. Many are familiar with the Technology Readiness Level (TRL) which assigns an integer number to a new invention's "readiness" in an attempt to quickly communicate its maturity. Regardless of the details of a particular invention, a TRL of 1 implies something very different from a TRL of 9 and this expectation is instantly communicated between all parties involved. The authors of this work, when attempting to create the analogue of the TRL for modeling and simulation efforts, have opted for a two parameter description consisting of 1) fidelity (quantifying the faithfulness of the model to physics/engineering) as well as 2) the model's pedigree (quantifying the degree of buy-in and finality a particular organization has for a given system).
In this work the authors will further flesh out their concept of a Fidelity/Pedigree Metric, their thought process when formulating such a metric, its application to internal use cases, and a summary of feedback from stakeholders. While the authors have tested this metric internally they recognize a greater need for an industry-wide standard and are eager to work with external stakeholders to tweak or replace their metric with a more universal one that becomes ubiquitous throughout industry, academia, and government.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66050 - Pricing Military R&D: Insights from Options Pricing

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Mr. Franco Villongco; Dr. Mark A. Gallagher, FS		
Abstract: We propose a novel framework for optimizing defense R&D investments based on insights from financial options pricing and campaign analysis. We provide a theoretical framework that explicitly accounts for the opportunity costs of R&D investments and contend that advances in military utility analysis, campaign analysis particularly, render such considerations practicable. We also show how option-pricing uniquely captures the value of the R&D investment under conditions of scenario uncertainty Location: TH372 Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis		

66061 - Integration of Weather and Traffic Data Analytics for Installation Decision Dashboards – A One Year Update

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr. John Richards; Dr. Randy Buchanan; George Edward Gallarno; Natalie Myers; Christina Rinaudo
Abstract: The Smart Base Artificial Intelligence (AI) for Traffic and Weather project aims to support modernization of installation inclement weather-related decision-making processes by applying complex computational analytics and high performance computing assets. Current inclement-weather decision processes are based solely on weather data and require extensive human interactions and ad-hoc community coordination. This research seeks to integrate weather and traffic data with real-time analytics in order to develop a decision dashboard that can more effectively communicate the impact that weather may have on transportation safety, to create a more data-driven decision on installation early closures, delayed reporting, or mission essential personnel only reporting. This approach identifies, captures, processes, analyzes and leverages various data streams to inform the decision-making process in a methodology not currently implemented by military installations. Project deliverables will enable informed decisions for the management of weather-related operations on installations, reducing risk to the installation population and increase decision-making efficiency. This presentation provides an update on project progress since the 90th Symposium presentation. Key technical aspects that underpin weather and traffic decisions at installations, the various data streams being utilized, and emerging advances in systems engineering methodology currently used to support installation modernization and readiness with automated systems, data fusion, and data analytics will be discussed. Researchers will share progress updates on smart installation prototype projects at Fort Carson, CO and Fort Benning, GA. Location: TH372 Classification: UNCLASSIFIED Working Group: WG27 Decision Analysis

65687 - Using Architecture to Support Capabilities Analysis of the Advanced Reconnaissance Vehicle

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: John Park		
Abstract: In support of the USMC's Capabilities Development Directorate, Ground Combat Element Division, the Operations Analysis Directorate, Capabilities Analysis Branch, conducted capabilities analysis, high resolution modelling, and combat simulation to support and refine the requirements of the Advanced Reconnaissance Vehicle (ARV). In a novel application, this study leveraged Cameo Enterprise Architecture to conduct analysis of Marine Corps and Joint capability gaps and identify solution space opportunities. The insights from this portion of the larger study provided potential courses of action regarding the concepts of employment, structure, and material solution requirements to capability developers. Location: TH372 Classification: UNCLASSIFIED // FOUO Working Group: WG27 Decision Analysis		

66149 - ASSET Management Value Models

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl		
Abstract: The United States Army Corps of Engineers (USACE) Civil Works (CW) program includes $250 billion worth of assets. USACE seeks to use asset management techniques to acquire, operate,		

maintain, and retire physical assets (e.g., locks, dams, port infrastructure). Our Engineer Research and Development Center (ERDC) led project team has reviewed existing Navigation Business Line performance metrics for asset management and are creating a line-of-sight model using Multiple Objective Decision Analysis. Our current focus is on locks and dams that support cargo transport and recreation navigation through U.S. inland waterways. Our next focus will be on the recreation business line with the eventual addition of other USACE business line value models. The project goal is to enable USACE to make budget work package trade-offs using the recommended set of performance metrics.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

66254 - Geographic data visualization method through PCS housing decision support tool case study

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Sam Fritz-Schreck		

Abstract: Every year, thousands of Service Members must make a decision on where they will live following a PCS move. The vast availability of open source information regarding listings, comparison of on-base vs off-base, rent vs buy makes the choice daunting and complicated. This problem provides a framework on how to leverage computational methods to procure, collate, and visualize open source, geographically tagged data. Data is collected via various APIs, merged/cleaned, and visualized via a dashboard. The dashboard enables the user to dynamically visualize the geographic data and explore how individual parameter changes affect the decision space.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

68151 - Optimizing Surveillance Satellites for the Synthetic Theater Operations Research Model

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Steven Warner; Mr. Johannes Royset		

Abstract: The Synthetic Theater Operations Research Model (STORM) simulates theater-level conflict and requires inputs about utilization of surveillance satellites to search large geographical areas. We develop a mixed-integer linear optimization model that prescribes plans for how satellites and their sensors should be directed to best search an area of operations. It also specifies the resolution levels employed by the sensors to ensure a suitable fidelity of the resulting images. We solve large-scale instances of the model involving up to 22 million variables and 11 million constraints in scenarios derived from STORM. On average, the model yields 55% improvement in search coverage relative to an existing heuristic algorithm in STORM.

Location: TH372
Classification: UNCLASSIFIED
Working Group: WG27 Decision Analysis

WG28 Advances in Modeling and Simulation Techniques

66422 - A framework for modeling of battlefield & platform electrification within combat simulations

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Greg Dogum		

Abstract: Ground vehicle electrification is going to dramatically change the future battlefield environment, and yet the Army lacks a sufficient approach to suitably represent electrified platforms in combat simulations. An electrified battlefield will have wide reaching affects including potential changes to tactics, techniques, and procedures. These complex interactions will require a refined approach to Modeling & Simulation (M&S) for power and energy in support of combat simulations and the representation of sustainment & logistics within those simulations to adequately capture the benefits and considerations of electrification.

This effort describes an approach for electrified vehicle Physical model Knowledge Acquisition Document (PKAD) algorithms which includes a description of the development of a simplified (system-level) framework and illustrates an example application. While more detailed component level models exist, they do not match the fidelity required of combat simulations. A holistic approach is employed to characterize steady-state power rates in a consistent manner such that it can describe a range of future powertrain combinations and topologies at all levels of hybridization (mild, full, plug-in, or fully electric), to include various technology layout compositions (series hybrid, parallel hybrid, auxiliary power units (APUs), etc.), complex battery management systems, and advanced battery chemistries or energy sources (lithium-based batteries, supercapacitors, hydrogen fuel cells, flow batteries, solid state batteries, flywheels, etc.).

While future vehicles will employ unique energy management strategies, the objective of the PKAD approach is to focus on modeling the tactical advantages (e.g., silent mobility, silent watch) of advanced powertrains in military vehicles using a rule-based strategy focusing on battery state of charge, mobility, and non-mobility power demands. The framework would support assessment of new vehicle capabilities and the advantages that they offer. The goal is to provide tailored sustainment-centric energy estimations to align with modern and future vehicle capabilities and to support mission scenario-driven decisions or requirements in Multi-Domain Operations (MDO) and Large-Scale Combat Operations (LSCO).

The methodology provides a more refined point-to-point energy estimation and improves accounting of energy at the operational level. It can be applied across military platforms to include a range of charging technologies, methods, and fuel sources by using system-level attributes to characterize electrification of the future battlefield.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66243 - Limiting Lines of Approach Risk-Based Assessment Model

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr. Sandra Beaulieu; Lauren Boulay		

Abstract: The issue of clearing a lane for moving units against slower aggressor threats is classically referred to as a limiting lines of approach (LLOA) problem. The current model was developed as an addition to existing tools, such as Advanced Framework for Simulation, Integration, and Modeling (AFSIM) and Naval System Simulation (NSS) that are used to analyze the effectiveness of future air anti-submarine systems as part of the overall warfare analysis process. The LLOA tool was developed

in Matlab to quantify and visualize the risk score for the LLOA using a variety of sensors and tactics over distance and time. The specific features are: to determine, quantify, and visualize threat environment for moving units; to quantify and visualize potential clearing screens in front of moving units; to combine threat environment and clearing analysis to produce overall dynamic risk score for a given instantaneous configuration; to determine appropriate roll-up metrics for evaluating engagement scenarios; and to explore effectiveness of various tactics against specific threat configurations. The study approach began with quantifying the threat environment using the key metric of intercept time for a threat at a given position against the moving unit. Next, the effect of the clearing screen using a variety of sensors was addressed. The key metric was the probability of the target being at a given location at a given time. Third, the target probability at each location was adjusted over time based on a combination of the initial probability, the target speed and grid spacing, and proximity to regions of greater or lesser probability using a diffusion model of target movement. Then, target probability and threat environment were combined to determine dynamic risk score at each time step of the simulation. At each time step, the roll-up score was determined by taking the average score across all locations with non-zero risk. For each scenario, a baseline score was determined by running the model with no clearing screen (no sensors). The score of the scenario using a clearing screen was compared with the baseline to quantify and visualize the reduction of risk based on tactics and sensors. The risk scores and visualization of various combinations of notional sensors and tactics are shown for illustrative purposes and do not reflect the performance or actual risk of any specific system.

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Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

66040 - Joint Mission Analysis: Simulating Operational Demand in the Future Operating Environment

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Kristen Obst; Craig Brewer; Dr. Christopher E. Marks

Abstract: INTENT:
Identify and characterize force structure requirements with rigorous analysis
METHOD:
Identified core tasks based on strategic guidance, characterized conditions of future operating environment (FOE)
Using operational scenarios, aligned capabilities and capacity against scenarios
Built a simulation that projects operational demand over the FOE
800 runs of simulation helps project capacity of capabilities required and identify areas of risk

CONTEXT:
JSOC's JMA was conducted over 3 months. It is intended to quantify operational demand, which then can inform discussions of force structure needed in the FOE.

Location: TH359 Classified

Classification: SECRET//REL TO FVEY
Working Group: WG28 Advances in Modeling and Simulation Techniques

66043 - Leveraging Simulation, Artificial Intelligence, and Multi-Attribute Tradespace Exploration to discover enterprise solutions: F-35 Aircraft Engine Exemplar

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Zachary Shannon; Ms. Kelly Bush

Abstract: The United States Air Force (USAF) relies on logistics networks to support its mission at bases and other operating locations during both peacetime and contingencies. Because of its global mission, the USAF needs to accurately predict future combat readiness resulting from the incremental investment in spare inventory and repair capability. This accurate prediction is essential for holistically capturing the impact of a robust supply chain on sortie generation capabilities. Current efforts, such as traditional Readiness Based Sparing (RBS) models , derive sortie generation insights from solvable mathematical formulas which determine the sparing levels from a given set of demand parameters. Traditional RBS models have limited stochastic functionality which enables some statistical analysis; however, performance predictions are not precise and offer little insight regarding the wide range of possible outcomes given specific input parameters. This research effort developed an innovative proof of concept that utilizes SimPy, a discrete-event simulation library in Python, to simulate an aircraft spares servicing network in support of the Pratt & Whitney (P&W) F-135 engine to formulate network resource requirements. The simulation is combined with a machine learning application called Harness for Adaptive Learning (HAL) and Making Robust Lifecycle Decisions (MRLD) software. HAL employs numerous machine learning methods to efficiently sample and explore the vast trade space that is applicable to any problem set. MRLD is an analytic tool that enables the Multi-Attribute Trade Space Exploration (MATE) methodology and provides insight into the compromised solutions across various stakeholder needs. Specifically, this novel solution is intended to support optimal strategic level decision making, identify and isolate inherent cost-performance relationships, and to forecast resulting performance from the incremental investment in network resources.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66163 - Artificial Intelligence Algorithmic Requirements to Evaluate National Statecraft

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes an ongoing unclassified, 18-month experiment that examines how an artificial intelligence algorithm could describe the effectiveness of national statecraft instruments. Strategic competition is a relationship between two or more states in which one states seeks a competitive advantage over other states, hoping to maximize aspects of its national instruments of power and minimize those of its competitors. Assumptions between nation-states guide each other's use of their national instruments of power within strategic competition; that is, a state makes assumptions as it determines how it engages in statecraft. However, these assumptions result from the information a state has about another state. Governments may not have the required information to make informed assumptions that subsequently guide their statecraft. Once a state develops assumptions, it faces uncertainty about how its instruments of national power will demonstrate its resolve and deter a competing state or how its statecraft decisions will embolden its competitors. This

study explores how artificial intelligence may assist a state in developing assumptions so that governments may effectively use statecraft to reach desired objectives and avoid strengthening the resolve of its competitors. This study's research problem addresses if strategically competing nation-states can use artificial intelligence technologies to develop better assumptions for statecraft decision-making, as well as the requirements for an operations research model that outputs the point at which strategic competition is counterproductive to a state's national interests. The study has two hypotheses:
Hypothesis 1: Competing nations could use artificial intelligence within operations research models to reduce uncertainty for statecraft deterrence decisions.
Hypothesis 2: Competing nations could use artificial intelligence to balance statecraft deterrence strategies that demonstrate resolve and avoid statecraft decisions that instead embolden competing nation-states.

The researcher will test the hypotheses with existing literature on strategic competition from the United States, Japan, and China. Further, the research will use four existing quantitative operations research models to explore the analytical gaps in modeling diplomatic, informational, military, and economic national statecraft efforts. The study will conclude in September 2024.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65516 - Using Machine Learning (ML) to Train Threat Kill-Chains Models for Warfighter Support (a.k.a. AIrborne GreMLin)

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. June Rodriguez; David Gohlich; Jeffrey Hay

Abstract: Critical asymmetric warfare questions often involve complex kill-webs for peer and near-peer adversaries that can be effectively captured through simulation. Running these simulations faster would enable a fuller options evaluation for the warfighter/planner. The objective of this study is to develop a repeatable process using Machine Learning (ML) models to replicate large scale kill-web simulations. The process will be developed through testing different classes of ML techniques on kill-webs using Integrated Threat Analysis and Simulation Environment (ITASE) as the simulation environment. The outcome is a framework for the Intelligence Community (IC) to identify advantages against integrated threats by running fast surrogate models that allow for real-time exploration of options. Using this blueprint, the IC will be able to rapidly create IC-informed, higher-fidelity, light weight models of threat kill-chains, allowing DoD planners to build threat kill-webs in hours instead of weeks/months. A full surrogate modeling and analysis capability will be transitioned to the government sponsor and used to support real-world military planning against adversarial threats. The use of the proposed framework will contribute to saving lives, saving time and money, and preparing the warfighter.
The vision of the study is to Improve military planning on adversary kill-web threats with authoritative threat models by developing a process to produce fast running and shareable models through machine learning. Our government sponsors have named this idea "AIrborne GreMLin".
These models are built and run in the Defense Intelligence Agency's (DIA) Integrated Threat Analysis and Simulation Environment, or ITASE. ITASE is the Intelligence Community's M&S environment for supporting integrated forces analysis and is a common framework for the Intelligence Community to develop, test, validate, and conduct analysis with the authoritative threat representation (i.e.,

models, laydown, CONOPS, tactics, etc.) in an integrated system-of-systems context. Unlike many of the models in AFSIM, NGTS and other simulation frameworks, all ITASE models are verified and validated by the Intelligence Community both as individual threat systems and as an integrated kill-web.
This study involves developing a repeatable process for building machine learning models that capture the input-output relationships of pre-built IC models to generate light weight surrogate models that enable real-time exploration Critical to the effort is creating models that are not only useable by U.S. and allies/partner planners, but trusted, so that IC system level analysts have confidence that the metamodels faithfully represent the authoritative models in an integrated kill-web and planners can understand the expected threat kill-web response in a way that improves planning.

Location: TH359 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG28 Advances in Modeling and Simulation Techniques

66171 - Accelerated Emergent Behavior Exploration Using Bayesian Optimization with Agent-Based Simulation

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Alexander Braafladt; Dr. Alicia Sudol; Professor Dimitri Mavris

Abstract: During capability design, the required pace needed for technology investment decision-making has encountered challenges as modernization efforts focus both on impacts in larger-scale operations and on driving increases in simulation fidelity to enable successful iteration towards fielded capability. This prompts a critical need for acceleration of simulation-based analysis, especially to search efficiently through expensive, high-fidelity simulation with tools like AFSIM or STORM. The search goals during iterative AFWIC Assess-Develop-Evaluate design loops and AFRL SDPE E-MS&A simulation-based analysis are to highlight gaps in knowledge about the technology, concept, and scenario, focus the simulation to update understanding, and perturb the scenario sufficiently to develop confidence in the analysis. The key behavior in this process is emergent behavior – hard to predict, critical changes in the outcomes as alternative scenarios are considered. Existing approaches for finding these behaviors rely on experts – who are limited resources – or on brute-force Monte Carlo Simulation – which is infeasible with expensive high-fidelity simulation. In response, a variety of approaches using optimization have been evolving in the military simulation community that have improved the search for important behaviors. However, these approaches need to be further enhanced to work effectively with the high-fidelity simulation in use which is often expensive, highly nonlinear, and non-stationary. In addition, cases where emergent behavior is encountered as rare, extreme events are critical to analysis, but the existing optimization approaches often struggle with these types of events. This work builds on existing techniques for Bayesian Optimization, focused on developing an approach that is effective for the challenging behavior characteristics encountered with military agent-based simulation. A benchmark across the state-of-the-art techniques for adaptive sampling and active learning was completed, and effectiveness of these techniques and a new algorithm specifically targeting the rare, extreme events of importance was demonstrated in a proof-of-concept simulation case in AFSIM.

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

65747 - Using Particle Swarm To Optimize Base Defense

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Stephen Paul Jones		
Abstract: Determining appropriate placements of defensive assets in an ABAD environment is an overwhelming problem for a SME, especially when the types, capabilities, and quantities of these assets vary greatly. In order to augment SME judgment, a novel approach was developed to place combinations of defensive assets based on machine-learning informed analysis. This brief will cover the swarming methodology created using AFSIM and Python to find a more optimal position for each asset within a defensive laydown. The material presented will also cover some of the pitfalls and tradeoffs, as well as a comparison of various assets and the specific hurdles when utilizing a swarming solution based on AFSIM simulations. Location: TH359 Classified Classification: SECRET//REL TO FVEY Working Group: WG28 Advances in Modeling and Simulation Techniques		

65660 - Sensor-Capabilities Visualization Techniques Using an AFSIM Sensor Coverage Diagram Tool

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Christopher Huffman; J. Scott Thompson		
Abstract: Visualization techniques to capture important aspects of sensor performance are essential to understanding sensor-model capabilities and mission-simulation results interpretation. A Sensor Coverage Diagram tool was developed as a diagnostic testbed to determine the capabilities of a sensor using Vertical Coverage Diagrams (VCDs), Horizontal Coverage Diagrams (HCDs). These outputs provide the user with diagnostic information regarding the elevation and azimuthal limits of the sensor against a particular signature. The plots may also be used to provide information on the effects of beam steering on sensing capability. When VCDs are paired with a threat altitude, speed, and signature information, they may be useful in helping interpret the results of a mission-level simulation. This briefing focuses on visualization techniques for understanding a sensor's capability and diagnosing simulation environment results. Location: TH314 Classification: UNCLASSIFIED // FOUO Working Group: WG28 Advances in Modeling and Simulation Techniques		

66435 - Advanced Joint Effectiveness Model (AJEM) Application Programming Interface (API) and On-the-Fly Vulnerability/Lethality

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Gregory Navaline		
Abstract: The Advanced Joint Effectiveness Model (AJEM) is DEVCOM Analysis Center's (DAC) premier vulnerability/lethality model. DAC uses AJEM in part to produce post-processed vulnerability/lethality (V/L) data files such a cell-by-cells (CxC), TAPE19s, and IUAs. These files are used by downstream, 1-on-1, few-on-few, and force-on-force models both in and outside DAC. These files have accurately modeled V/L effects for many years but recently have begun to show limitations for cumulative damage and other complex effects. Cumulative damage effects are especially critical as the Army is		

increasingly engaging threats with multiple smaller and smarter munitions. These smarter munitions have a greater probability of placing multiple munitions on target producing a cumulative effect.
To improve modeling of cumulative damage and other effects, DEVCOM Analysis Center (DAC) and DEVCOM Armaments Center (AC) are embarking on an ambitious Army Modeling and Simulation Office (AMSO) funded effort to improve Army analysis. Instead of post-processed data files, DAC and AC are developing an AJEM Application Programming Interface (API) that will allow customers such as AC to call AJEM on-the-fly. The concept is that DAC will provide customers the AJEM model and certified AJEM inputs and the customer will run AJEM on-demand to calculate probability of kills (PK) as needed. This approach is ideal for 1-on-1 and few-on-few modelers such as AC who model smaller engagements, require the highest possible level of fidelity, and can accept longer runtimes.
The AJEM API is a significant change to existing business processes and creates numerous concerns such as data governance and sharing. To ease issues with data sharing DAC has developed the AJEM Data Package (ADP) concept. Instead of providing customers the raw AJEM inputs which would consist of dozens of files with thousands of inputs, DAC has developed the technology to encrypt inputs into a single binary file. The encryption allows DAC to share data simply and easily while at the same time protecting sensitive certified inputs from being modified or corrupted. The package format also allows for limiting the input conditions that can be analyzed such as enforcing terminal velocity to within certain valid bounds.
The AJEM API software was completed in FY22. DAC and AC are currently undertaking an AMSO funded proof-of-concept analysis. The effort will compare legacy post-processed data files to the AJEM API and verify the improvements in the results. The effort is also an opportunity to test the numerous business process changes the API introduces as DAC makes the capability available to the community.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65238 - Application of the Adaptive Kill Web Framework to Cyber and Non-Kinetic Modeling & Simulation

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Christopher Santos; Jeff Hughes

Abstract: At the 90th MORS Symposium, LinQuest presented “An Adaptive Kill Web Framework for Mission Engineering and Concept Exploration Analysis” as a way to standardize kill web terminology and to generalize similar conceptual approaches used in different stakeholder communities throughout the Department of Defense. The Adaptive Kill Web Framework (AKWF) extended Mission Engineering constructs in a scalable manner for the purpose of conducting concept exploration at the theater-wide level. Understandably, given its Mission Engineering lineage, initial applications of the AKWF focused on physical or kinetic effects and effectors. However, comprehensive, informed analysis of multi-domain kill web, requires cyber, non-kinetic, and informational fires and effects need to be considered.

Traditionally M&S of cyber and non-kinetic fires, to include space support, tends to focus on system- or even engineering-level modeling. Abstraction to the mission-level can be a difficult topic to broach and resolve, and may require highly customized, unique kill chains and/or kill paths. This customization does not scale in the theater-wide M&S context, especially when dynamic targeting and re-targeting is required at FTRT speed. To implement scalable, dynamic decision-making within a

FTRT simulation, the authors explore the applicability of the generalized AKWF approach to cyber, space, and non-kinetic missions, along with recommendations for conducting M&S of the same.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65469 - USAF Maritime Strike: Optimizing AFSIM Runs

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Lt Col Brian J Pascuzzi

Abstract: SAF/SAF has developed a complex, mission-level AFSIM scenario based on Joint Force Operating Scenario guidance, aimed at investigating the effectiveness of certain munitions in executing the maritime strike mission set. Due to a large number of variables and long run times, exploring the DOE space via a full-factorial analysis has proven impractical. SAF/SAF has made good use of optimization software, OptDef, to efficiently search this space via multi-objective optimization. In this presentation, we will demonstrate how OptDef facilitated the quick generation of insights that directly informed SecAF procurement decisions. Moreover, beyond the benefits of wrapping our simulation and running our DOE, OptDef can also be used to improve individual components within an AFSIM scenario. In this case, we will show how OptDef helped determine optimal settings for weapon aerodynamic parameters.
In line with the theme of "Analytics as a Force Multiplier," OptDef has become a standard tool for analysis of AFSIM outputs. When combined with our High Performance Computing system, OptDef has boosted SAF/SAF productivity and improved our ability to deliver insights at the speed of relevance.

Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

65705 - AFSIM Innovations for Modeling, Simulation and Analysis of Surface-to-Air Missions

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: CDR Phillip E. Pournelle, USN Retired

Abstract: Group W supporting the USMC conducted a study examining the execution of surface-to-air engagements missions and aircraft counter responses using Advanced Framework for Simulation, Integration and Modeling (AFSIM). The modeling team created new Method, Models, and Tools (MMTs) in AFSIM which the framework lacked including jamming, decoys, battle management, and emissions control measures. This presentation will explore the innovative approaches to portray these phenomena in AFSIM.

Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

66090 - Automating MBSE Studies with Gitlab CI/CD Pipelines and Parallelized Simulations

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Mrs. Katherine L McCartney; Robert Reaney
Abstract: This talk will overview the tech-stack modernization of a research lab at AFRL/RW responsible for AFSIM studies upwards of a million simulations each month. By leveraging Continuous Integration/Continuous Deployment (CI/CD) pipelines, automation drives these studies at development milestones by utilizing contributions from teams of teams including MBSE-created artifacts, scenario updates, software upgrades, etc. It will also showcase SOFA, a software developed by Anyar, Inc. to manage, deploy, and retrieve information from jobs across a cluster. Our analysis ecosystem leverages container technology to ensure reproducibility and generalization to any MS&A tool or process. SOFA facilitates communication between disparate tools and applications while also serving as scaffolding for migration to cloud-computing and distributed computing enclaves. Location: TH314 Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques

65650 - AFSIM Kill-Chain Research

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: David Collins; Christopher Huffman		
Abstract: An end-to-end understanding of the kill-chain and how it performs allows us to make better informed decisions on the constituent building blocks that make it up. To this end a twelve step kill-chain was conceived and implemented in AFSIM to observe the effects of each step in the overall goal and lower-level metrics unique to each step. Through a series of hooks developed in the AFSIM scenario each step of the kill-chain can be modeled at variable levels of fidelity or with entirely different models performing the same function. Each step can be turned on or off to be replaced by a better representation of that step in the kill-chain. These provide the capability for each model, and more importantly its effect on the kill-chain, to be investigated in degrees of isolation or integration with other fleshed out steps. The kill-chain is tested using a simple vignette with variable levels of red intervention available. This briefing focuses on the processes of creating the kill-chain in AFSIM at different levels of fidelity and proving analytic capability all using native AFSIM. Location: TH359 Classified Classification: SECRET NOFORN Working Group: WG28 Advances in Modeling and Simulation Techniques		

65373 - Combining bilevel optimization, simulation, and uncertainty to assess technology investments against adaptive adversaries

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: John Flory		
Abstract: Performance assessment of future technologies often requires high-fidelity “Red vs Blue” simulations. Although such simulations can provide insights, they usually do not consider how the Red adversary may adapt its technology investments against those of Blue. Thus, technologies that appear ideal against a static adversary may actually be susceptible to future technological adaptations, and vice versa. The ability to mathematically model this complex, game-theoretic landscape of adaptive		

investments is key to understanding how current decisions become force multipliers (or, perhaps unfortunately, force dividers).

To address this challenge, we have developed an analytical approach that combines simulation with a game-theoretic decision framework -- integrating AFSIM, an engagement simulation developed by the United States Air Force Research Laboratory, with Dakota, an optimization framework developed by Sandia National Laboratories. Our approach models the investment decision process as a bilevel optimization in which the Blue player seeks to optimize its technological capabilities knowing Red will respond by deploying technologies that optimally mitigates performance. As an additional feature, this bilevel decision framework includes extensions for modeling uncertainty in Blue's ability to realize risky technologies and Red's knowledge of Blue's decisions.

This talk outlines our bilevel/simulation/uncertainty framework. We discuss surrogate modeling approaches that enable faster solution times and mitigate computational resource burdens. We conclude with several applications of our decision capability applied to high power microwave distributed systems for defense against hypersonic glide vehicles and drone swarms.

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65616 - Airbase Damage-Assessment and Resiliency Model (AD-ARM)

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Andrew Langland

Abstract: What does the war look like from the airbase's perspective? For the Air Force, combat modeling often revolves around the aircraft's fight against the enemy. However, when considering potential future conflicts against peer or near-peer adversaries, understanding the airbase's fight becomes increasingly important. After all, our greatest aircraft are quite useless without fuel, weapons, maintenance, and a place to take-off and land. SAF/SA developed AD-ARM to help better understand this piece of the fight. AD-ARM is a mission level, discrete event simulation to model an airbase as a power projection platform while under attack, with a focus on the support elements of sortie production. Enemy attacks are assessed for damage to aircraft, equipment, surfaces, and other resources. Resulting damage can be repaired, given sufficient resources and time. With fuel, munitions, maintenance, and a viable runway available, sorties can be produced. All combined, AD-ARM provides the user with a modular and powerful analytical tool to examine airbase operations in a contested environment.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66142 - Optimizing Supply Blocks for Expeditionary Units

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Jefferson Huang		
Abstract: Marine expeditionary units (MEUs) are compact Marine air-ground task forces (MAGTFs) within the United States Fleet Marine Force that are capable of rapidly responding to crisis situations. Each operates according to a fifteen-month cycle, which includes a six-month deployment period during which external resupply may be infeasible. Blocks of materiel are usually deployed with MEUs for the purpose of being the MEU's sole source of resupply during these periods. Due to the enormous number of potentially combat-essential parts and practical (e.g., volume, weight, and budget) constraints on the size of a deployable block, care must be taken in selecting which parts to include. We propose a tractable formulation of this part-selection problem as a multidimensional knapsack problem with a nonlinear Newsvendor-type objective function, called OptiStock. Both the objective and constraints account for factors that existing methods do not, such as left-over costs and multiple space/budget constraints. We show empirically that OptiStock can produce blocks that outperform those recommended by existing methods (e.g., in terms of the number of shortages), using a practically feasible amount of computational time and resources. Location: TH368 Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

66080 - Analysis and Evaluation of Kill Webs via Graph Theoretic Methods

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Ali K Raz; Mohammed A. Bhuiyan; Michael R. Hieb, PhD; Cameron Schlonski; Dr. Daniel Thomas Maxwell; Christopher Santos; Dr. Jose Bricio-Neto		
Abstract: Mosaic warfare concept promotes dynamic composition of kill chains in a system of systems (SoS) where multiple sensors and weapons can be opportunistically linked in near real-time to address emergent threats. This presents a major shift from the status-quo where the kill-chain composition is defined via a static SoS architecture. Dynamic composition of kill chains presents a novel challenge of first identifying a super set of all potentially feasible paths to link distributed systems into a kill chain and then reducing this super set to most promising paths based on risk, performance, and engagement metrics. This network of kill paths and kill chains with ability to engage one or more targets and missions is referred to as a kill web. Our team is using an Adaptive Kill Web Framework (AKWF) as a foundation for conducting concept exploration, feasibility assessment, and performance evaluation of kill webs at a theater-wide level for the US Department of Defense. The AWKF provides a conceptual formulation of kill web representations via mathematical notation—derived from set-based principles—and pairs it with technical analytical methods to facilitate analysis. This presentation focuses on Graph theory formulation within the AKWF to analyze kill chains in a given theater. Graph theory provides a mathematical approach to study networked systems where an individual system (or the task/function it performs) is represented as a node and information flow between the nodes as edges. By using graph theory to model Kill Webs, we are able to depict not only the relationships between individual sensors, weapons, targets and communications, but also to identify if they contribute to finding, fixing, tracking, targeting, and engaging (F2T2E) a target which forms the basic constructs of a kill chain. These constructs are then investigated with mathematical		

metrics such as eigen vector centrality, betweenness centrality, and node degree etc., to develop a better understanding of Kill web, e.g., identify critical systems or bottlenecks. Furthermore, this is extended by introducing the platforms that sensors and weapons are attached to. These graphs can be then filtered based on the nodes of interest to find the best target/weapon pairing.

We present an overview of the AKWF, show how we use graph theory to model the AKWF, give a detailed example in Air/Sea warfare, and discuss future work.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65976 - Simulation Threads for Modeling Uncertainty in BEAM

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. Mark A. Gallagher, FS; Jeremiah Bill; Brian Huck; Michelle McGee

Abstract: The Bilateral Enterprise Analysis Model (BEAM) accounts for uncertainty through a novel approach. For all the assets in the campaign, BEAM maintains a statistical distribution of their quantities by region. Each simulated day, BEAM implements a design of experiments (DOE) that starts a simulation thread at each of the design points. The probabilistic weight threads account for the uncertainty of the simulation outcomes. Each thread is simulated through the daily processes with the combat adjudication adding probabilistic uncertainty to each thread's outcomes. BEAM consolidates across all the threads outcomes prior to starting the next simulation day with a new set of simulation threads. This process results in passing through simulated time once yet producing the statistical distributions of outcomes. Since this approach does not use Monte Carlo pseudorandom draws, no replications are required as the same inputs produce the same outcome distributions. The simulated threads are computationally efficient approach to account for uncertainty. This presentation demonstrates the approach on several simple models with known theoretical means and variances before concluding with sample BEAM results.

Location: TH368
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65654 - AFSIM Sensor Coverage Diagram Tool

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Christopher Huffman; J. Scott Thompson

Abstract: An understanding of the capabilities of sensor models against various signatures is essential to understanding model capabilities and mission-simulation results interpretation. A Sensor Coverage Diagram tool was developed as a diagnostic testbed to determine the capabilities of a sensor against both a baseline signature and a mission-specific threat signature. The tool allows the user to alter characteristics of the threat and analyze the effects of the threat's altitude and signature and the sensor's azimuth and elevation on the sensor's ability to detect the threat. The tool may be configured to produce both Vertical Coverage Diagrams (VCDs) and Horizontal Coverage Diagrams (HCDs) of sensor capability. Additionally, the VCD configuration may also run at off-centerline azimuths to observe the effects of beam-steering losses. VCDs and HCDs provide capability to confidently understand a sensor's "as-modeled" capability and insight into observed performance in

mission-level analysis against a threat. This briefing focuses on the tool's methods employed, possible configurations, and types of results with emphasis on the utility of these results in a mission-simulation environment.

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

66058 - Uncertain Waters: Integrated Modeling of Fuel-Constrained Operations in Contested Environments

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Lucas McCabe; Stephanie Brown; Simon Whittle; Nathan Danneman; Brian Cheng; Michael Anderson

Abstract: The evolving battlespace has underscored a critical need for de-risked energy supply lines, which warrant innovation in energy demand, fuel production, and contested logistics. Toward the latter end, we introduce COLOGEN (COntested LOGistics ENgine), a library for synthesizing information about the global contestedness landscape and solving constrained routing problems using graph algorithms, and FuelSim, an agent-based simulation application for analyzing fuel-constrained operations and alternative fuel paradigms. Our integration of these software components provides a robust framework for modeling and simulation of contested maritime logistics, where increased attention has been paid to the operational feasibility of sustainable fuels. We illustrate the coherence of our framework via example, focusing on naval exercises in the Pacific.

Location: TH368
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66675 - An Intuitive Interface for AFSIM to Support Analysis and Optimization

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Mr. Chris R. Linhardt; Shane N Hall, PhD; Jon Vigil

Abstract: Hypersonic weapon systems are designed to travel long ranges at high speeds (above Mach 5) offering the potential to strike defended targets with large amounts of kinetic energy. The strike performance of a system configuration within the context of a specific mission can be represented by the Probability of Kill (PK) against the intended target. Evaluating PK in contested scenarios through modeling and simulation is useful for rapidly evaluating performance of different technology options in a variety of scenarios, but can be challenging as the components of PK, Probability of Arrival (PA) and Probability of Damage (PD) are sensitive to parameters that define the system design as well as the mission scenario. This study uses simulation and optimization to improve the Navy's capability to rapidly study, design and field hypersonic systems that have increased performance and employment flexibility for future military operations. The analysis framework features the optimization and experimentation capabilities provided by OptDef driving the Advanced Framework for Simulation, Integration, and Modeling (AFSIM) and lethality simulations such as the Air Force Targeting and Effects Software - Exploratory (AFTES-X) or Advanced Joint Effectiveness Model (AJEM). A major element of the simulation environment is a Graphical User Interface (GUI) for users that may have little or no experience with AFSIM. This briefing will describe the existing and planned features and capabilities for the GUI that includes integration with OptDef, a simulation optimization,

experimentation, and post-run analysis tool. The briefing will also discuss the impact of this analysis framework for the end user of the environment.

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

66127 - Simulating a Stochastic Approach on Maintenance for Future Vertical Lift (FVL) Aircraft

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Kyle Ditonto; Andrew Bellocchio; MAJ Sam Yoo; MAJ Courtney E Razon

Abstract: The Future Vertical Lift Cross Functional Team (FVL CFT) is seeking to expand - and continue - on the Maintenance Free Operating Period (MFOP) initiatives previously conducted by USMA's Operations Research Center (ORCEN). In the development of Future Vertical Lift Aircraft for the United States Army, simulation has helped drive the Abbreviated - Capability Development Document (A-CDD) for sustainment requirements. In the approach modeled for Future Vertical Lift, we use a stochastic approach to develop a realistic maintenance model for forecasting the probability of meeting these Maintenance Free Operating Periods. A discrete event simulation with historical data allowed us to model a FVL aircraft throughout a life cycle before major maintenance must be performed.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66021 - Balancing Computation and Runtime in a Python Combat Model

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Lloyd Waggoner

Abstract: Beginning in fiscal year 2022, The Research and Analysis Center (TRAC) executed analysis focused on identifying the operational impacts of adding Vehicle Protection System (VPS) capabilities at the platform and formation levels to inform future science and technology (S&T) investments for Product Manager (PdM) VPS. TRAC worked alongside the Combat Capabilities Development Command Analysis Center, the Maneuver Center of Excellence Maneuver Requirements Division, and the Ground Vehicle Systems Center to help the PdM VPS determine which technology or combination of technologies should provide the most impact to United States force survivability and lethality. No existing combat model provided a simple method for examining a subset of technologies that would be most useful in a limited set of operational conditions, so TRAC designed and built a python brigade-level echelon combat model specifically focused on indirect fires and casualty/medical evacuation missions. The model is behavior-based which allowed quick integration on a short study timeline. The resulting model is a robust and flexible tool that can be integrated quickly and adapt to multiple study needs. By allowing both medium and high fidelity, the user can provide detailed analyses on areas of high interest while preserving time with lower fidelity in areas of less interest. This presentation will highlight the decision-making process in electing to build a new model, lessons learned throughout the development, and applications beyond VPS. Focus will be on how the team adapted to time limitations and found a balance between time spent improving model efficiency, increasing fidelity, and optimizing model runtime. Determining and achieving a sufficient balance

between fidelity and time available is a challenge every study team must overcome, which was refined several times throughout the VPS study.

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

65905 - NextGen Launcher Throughput Model

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dean Mengel

Abstract: As the Army looks to design and build the next generation of rocket and missile launchers, many design features of current systems are being considered as possible trades to gain new features such as autonomous operations. This new design could impact other features such as loadout and reload times for the launcher. As a result, the ability of a battery to service fire missions over a specified time period could be impacted.
This study estimated the throughput that could be expected from a battery of launchers. A spreadsheet model was used to replicate the requests for missions and the ability of launchers in a unit to service the requests. The model incorporated the reload times for empty launchers, the time to move to and from hide, firing and reload positions and the time a launcher is otherwise inactive. Distributions for the various parameters were established in the model to allow for Monte Carlo analysis. Three metrics were tracked and reported; the number of missiles required by the missions over a three-day period, the number of missiles fired, and the percentage of the missions that were successfully serviced.
The model provided an easy way to explore the trades between reload times and launcher loadout and examine other factors such demand rates for missions and number of rounds per mission.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66033 - Combat Modeling in Python in Support of Vehicle Protection Systems Analysis

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Devon A Thompson

Abstract: Beginning in fiscal year 2022, The Research and Analysis Center (TRAC) executed analysis focused on identifying the operational impacts of adding Vehicle Protection System (VPS) capabilities at the platform and formation levels to inform future science and technology (S&T) investments for Product Manager (PdM) VPS. TRAC worked alongside the Combat Capabilities Development Command Analysis Center, the Maneuver Center of Excellence Maneuver Requirements Division, and the Ground Vehicle Systems Center to help the PdM VPS determine which technology or combination of technologies should provide the most impact to United States force survivability and lethality. A key area of interest to the PdM was addressing brigade-level impacts of VPS technologies with a focus on indirect fires and casualty evacuation. To achieve this end state, TRAC developed a medium-high-fidelity, Python-based, combat model which leveraged hierarchal, behavior-based principles. This novel approach allowed for higher fidelity modeling of behaviors in areas of high interest (identified by subject matter experts), while also allowing lower fidelity modeling in areas of less importance, ultimately preserving integration time and computational resources.

This presentation will cover the study team's roadmap for creating the new model, the paradigm for tool development: "rapid deployability and minimal integration", and the key differences in comparison to established combat simulations TRAC typically employs, with a focus on the pros and cons of deploying a bespoke, purpose-built behavior-driven model. The presentation will also include lessons learned during the development process.

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

65703 - AFSIM Innovations for Modeling, Simulation and Analysis of Anti-Surface Warfare (ASuW)

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: CDR Phillip E. Pournelle, USN Retired

Abstract: Group W supporting the USMC conducted a study to evaluate Anti-Surface Warfare (ASuW) using the Advanced Framework for Simulation, Integration and Modeling (AFSIM). The modeling team created new Method, Models, and Tools (MMTs) in AFSIM which the framework lacked including cooperative battle management behavior for supporting units, area of uncertainty of target location and seeking weapon behavior to address it, time on target coordination, modeling of tactical decoy, and environmental effects on munitions. This presentation will explore the innovative approaches to portray these phenomena in AFSIM.

Location: TH359 Classified
Classification: SECRET NOFORN
Working Group: WG28 Advances in Modeling and Simulation Techniques

66117 - DISCO: End-to-end simulation model for networked supply chain operations

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Minerva Song

Abstract: DISCO: End-to-end simulation model for networked supply chain operations
One of the challenges in developing a counter-logistics strategy is the need for understanding a supply chain, its strengths and weaknesses as a system. Developed in support of a wargame, the Disruptive Intervention of Supply Chain Operations (DISCO) is a hybrid model utilizing discrete event simulation model in node and edge network framework that allows us to understand the impacts and consequences of disruptions and mitigations to a logistics system. DISCO is currently used to analyze production and distribution of jet fuel for both military and civilian demands. It can be used to model any class of supply. This initial version modeled the movement of crude oil via sea, pipeline or rail, to ports and associated refineries, the transformation from crude oil to jet fuel and other refined products; and then tracked the distribution of jet fuel to operating bases, assessing whether supply could meet OPTEMPO requirements.
The user-friendly interface graphically displays the supply chain network and allows users to implement and observe the impact of disruptions and mitigations on the network to evaluate the resilience of the logistics process. The network is adaptive, meaning that in the event of a disruption, the network will attempt to find an optimized mitigation strategy, which may include adjusting its sources of supply, finding new transport routes, or redirecting resources to high priority areas at the expense of others. This allows for the quick comparison of multiple strategies and can provide

detailed insight into an otherwise opaque logistics process. If information on the supply chain is lacking, DISCO can be used to infer the supply relationships based on proximity to the demand, and the available transportation system.
DISCO was built to support a Joint Staff J4 wargame looking at Red Logistics. However, the utility for analyzing Blue logistics is obvious, and new work is being conducted to expand the model's capabilities. As DISCO is designed to be industry-agnostic and is built on an Object-Oriented Programming (OOP) structure that provides the flexibility for modeling various materials and information, it has been used to analytically examine U.S. munitions resupply in a specific INDOPACOM scenario, and to look at NATO fuel distribution in support of EUCOM fuel planning. Other applications and analyses are currently taking place.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66137 - Airborne Defense in AFSIM, including Zoned Battle Management

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Stephen Paul Jones		

Abstract: Defending high value assets with an airborne patrol is an important mission; and determining a way to assess various aircraft types, weapon combinations, geographic placements, and orientations to defend those assets from multiple threat types and attack vectors is a difficult challenge. Through the use of flexible zones, custom scripting, and basic constraints; a robust test bed using AFSIM was developed for reviewing effectiveness of each of the airborne patrol selection against different threats. This brief will showcase basic implementation practices, the use of zones to simulate real-world battle management, pitfalls and tradeoffs, and finally suggested updates.

Location: TH359 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG28 Advances in Modeling and Simulation Techniques

65934 - Dr. Justin Wiens

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Justin Wiens; Dr. Brian Pate		

Abstract: Modeling Energetic Releases of Pharmaceutical-Based Agents Employing A Two-Step Computational Fluid Dynamics–Diffusion Model

Given the widespread and increasing illicit use of pharmaceuticals, increased attention has been drawn to their potential weaponization in improvised devices. DTRA Technical Reachback has considered a scenario wherein a pharmaceutical-laden IED is placed on the ground in a large building, e.g. a convention center. We modeled the space- and time-dependent agent concentrations in a closed, single-story barn for comparison to recent field trials and the CONTAM indoor airflow model. The multi-scale nature of the problem makes modeling difficult: heat from the explosion results in the generation of a distribution of phases and particle sizes for transport. We implemented a 2-phase modeling approach to estimate the airborne hazard from the initial release: (1) A computational fluid dynamics code, RAVEL, tracks mass packets from the initial explosive release until the particle motions are subject to normal building flows and pressures, then (2) the packets are propagated via

Python implementation of an analytical diffusion model developed by Drivas et al. that accounts for surface deposition losses. Armed with an understanding of the initial energetic particle dissemination provided by RAVEL, agent concentrations were calculated in just a few minutes' computational time. The results could then be correlated to health effects. We will demonstrate utility of this approach in specific operational assessments to support the warfighter.

Distribution C, but forgot to add FVEY government representatives to
the permissible attendees

Location: TH314
Classification: UNCLASSIFIED // FOUO
Working Group: WG28 Advances in Modeling and Simulation Techniques

65699 - Anti-Surface Warfare (ASuW) Analysis using Hughes Salvo Equations and AFSIM

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: CDR Phillip E. Pournelle, USN Retired		
Abstract: Group W supporting the USMC conducted a study to evaluate Anti-Surface Warfare (ASuW) requirements using a revised version of the Hughes Salvo Equations and the Advanced Framework for Simulation, Integration and Modeling (AFSIM). By employing both models, the team was able to cross compare and tune the two models. The revised salvo equation instantiated in R was very effective in a rapid exploration of the decision space to enable a more effective use of the high-fidelity modeling in AFSIM. This presentation will provide an overview of the power of combining these two modeling approaches. Location: TH359 Classified Classification: SECRET NOFORN Working Group: WG28 Advances in Modeling and Simulation Techniques		

65904 - Investigating Coast Guard Investigators: A Discrete-Event Simulation Approach

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Jack B. Smith; Margaret Harward; Craig Nilson		
Abstract: There is a reason that simulation is taught late in any robust operations research curriculum: it presents the ultimate capstone to the full body of academic work across mathematics and computer science disciplines, and tests the analyst’s mettle in properly employing the correct tools to address the problem at hand. Our discrete-event simulation combines elements of queueing theory, network graphs, systems theory, and uses Monte Carlo methods to understand the stochasticity of these models. We will discuss our approach to modeling the behavior of a segment of the U.S. Coast Guard officer corps: the marine investigators. Our project sponsor sought to ensure that the current workforce structure is a feasible system, and to build out “what-if” capabilities to address current bottlenecks and workforce shortages. We will take our audience from framing the business problem to the implementation of our discrete-event simulation in Python and present our findings. We will then discuss next steps for the Coast Guard’s use of simulation as a key component of workforce analytics. Location: TH312		

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66711 - Verification and Validation of Simulation Tools for Autonomous Vehicle Systems

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Jeff Durst

Abstract: Modeling and simulation (M&S) are critical in engineering and basic research processes. However, M&S is only useful if the model and simulation outputs are accurate. As such, the broader engineering community has conducted significant research to establish what "accurate" means for simulations and what subsequent level of "trust" should be given to M&S outputs. The primary means of establishing trust in models and simulations across M&S applications is verification and validation (V&V) testing. Verification ensures that a model or simulation outputs the correct type of data, while validation ensures that a model or simulation outputs realistic data.

The concept of V&V of simulation models became formalized in the 1970s as theoretical frameworks and methods for V&V were introduced. The concept of V&V became necessary once M&S was applied to practical engineering problems. V&V is a critical step in the model development process; assurances must be made that the simulation provides accurate results before a model/simulation can support practical engineering problems. While a significant amount of research focuses on V&V for traditional M&S, more research needs to be done to define a methodology for the V&V of simulations of complex, intelligent, and autonomous systems.

Specifically, no methodology for V&V of simulations of autonomous vehicles (AVs) has been developed to date. To that end, this presentation proposes a new framework for the V&V of simulation environments for autonomous systems, focusing on unmanned ground vehicles. The new V&V framework is built on the theories and frameworks already established and used by the simulation community. The new framework proposes a sequential, layered approach to V&V, with V&V taking place over multiple steps within the simulation environment. The proposed verification starts by validating the most basic components of an AV: its sensors and mobility platform. After verifying and validating these "building blocks," autonomous perception outputs are validated by comparing perception algorithm outputs using simulated and real-world sensor data.

The proposed presentation starts with a brief overview of the current V&V methods used for traditional simulations. Next, in light of this review, a novel framework for the V&V of simulations for predicting the behaviors of AVs will be presented in detail. Also presented will be the application of this V&V framework to the use-case of an autonomous unmanned ground vehicle driving along a roadway. The framework is applied for model validation of Global Positioning System (GPS), inertial measurement unit (IMU), and RGB camera sensor models. The framework is further applied to validate these sensor models for a camera-based autonomous navigation algorithm, stop sign detection.

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

66257 - Implementing a Production-grade Pipeline for Image Segmentation

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Ben Lucas Faircloth		
Abstract: While image segmentation has been facilitated in recent years by the introduction of pre-trained models, getting this use case to production is still difficult due to several challenges: -It's difficult to keep track of experiments -It's difficult to reproduce code -There's no standard way to package and deploy models -There's no central store to manage models This session will illustrate how Databricks Lakehouse ML empowers teams to prepare and process data, streamline cross-team collaboration, and standardize the full ML lifecycle from experimentation to production. -Session Outline -Ingesting satellite images into Databricks using multi-layered, medallion architecture approach -Distributed Pytorch segmentation model development, logging, and tracking using MLFlow -Deployment of segmentation model for batch serving and REST API for low latency predictions Location: TH312 Classification: UNCLASSIFIED Working Group: WG28 Advances in Modeling and Simulation Techniques		

66718 - System Vulnerability Performance Data Recommendation System

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Spencer Potter; Ryan Barker		
Abstract: The Modeling and Simulation Community (M&S) depends on the vulnerability data of materiel systems to accurately represent battlefield effects in models and simulations. The U.S. Army DEVCOM Analysis Center (DAC) provides standard vulnerability data to the M&S community. DAC's vulnerability file contains data for the probability of kill given a hit for an incoming munition against a ground target. In many cases, vulnerability data does not exist for certain specific interactions between munitions and targets. In order to represent these interactions, one common approach analysts take would be to use the closest or most similar dataset that we have on-hand. The process for choosing a suitable vulnerability dataset requires knowledge of what datasets already exist and for certain munitions against targets, the optimal selection is not always obvious. DEVCOM DAC has developed a recommendation system using machine learning that produces the top recommendations for munitions and targets for a new munition and target pairing. There have been multiple models developed to tackle this problem including independent munition and target models along with a feed-forward model that takes the output from the target model and produces munition recommendations. These models take munition and target characteristics as inputs and output the top recommended munitions and targets to use as representatives. The models are decision trees that were developed in python leveraging common packages and libraries such as sklearn, pandas, and numpy. These recommendations will help guide analysts to decisions on choosing representative vulnerability datasets. This capability will increase the efficiency of data fulfillment process for new munition/target interactions as well as enable quality assurance practices for identifying data issues based on model outputs. This briefing will cover the work that has been completed along with future plans for additional work. Location: TH314		

Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65671 - Logistics Sustainment Modeling and Analysis for Agile Combat Employment

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Richard K. Null; Jacob Locker

Abstract: Agile Combat Employment (ACE) shifts Air Force operations from centralized physical infrastructures to a network of smaller, dispersed locations or cluster bases. Flight operations from dispersed operating locations drives a need for robust, responsive logistics sustainment support. This presentation will introduce a discrete event simulation developed to assess ACE logistics sustainment and sample analysis of air mobility assets needed to support combat sortie generation from dispersed operating locations. Airlifter force composition and performance metrics including payload, range and speed are examined.

Location: TH312
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

65584 - Modeling and Simulation Techniques for Logistics Planning and Decision Support

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Michael Hugos

Abstract: After the skill and bravery of the troops, logistics is perhaps the next most critical component in the success of any campaign. Based on work over the last three years with the U.S. Air Force, and the U.S. Army, I show how combining the use of a commercial-off-the-shelf (COTS) supply chain modeling and simulating (M&S) application with Agile Combat Employment (ACE) methodology enables effective logistics planning and decision making in a fast-paced, unpredictable environment.

The COTS application uses discrete event simulation (DES) with a deterministic, non-linear model. We apply DES using the fixed-increment time progression method. Time in the simulations is broken into one hour increments, and the supply chain system state is updated according to the events happening each hour. Our simulations combine DES with agent-based modeling. The model agents are instances of four entity classes (Products, Facilities, Vehicles, and Routes).

The agent-based modeling employs a map-based, geospatial user interface (UI). People define logistics entities such as warehouses, vehicles, and transportation routes, and their entity icons appear on a digital map. In the same manner as placing game pieces on a game board, people drag and drop these icons to place them on the map. They zoom in on the digital map and turn on the satellite view to place icons in exact and appropriate Locations.

This UI makes the application easy to use by a wide range of military, government, business, and academic people. By defining and placing icons on a digital map, rigorous mathematical models of supply networks are defined that can then be run in simulations. But people do not need advanced math or engineering skills because the computer handles the math. AI algorithms can be applied to the supply chain data generated by simulations to find optimal facility locations, delivery routes,

delivery frequencies and amounts. This enables logistics personnel to quickly model and simulate new supply chain configurations to respond to changing situations and support decision making by the mission commander.

My presentation will show work done by logistics officers in the Advanced Study of Air Mobility (ASAM) program at the Air Force Institute of Technology (AFIT). This work was published in August 2022 by the Modern War Institute at West Point in an article titled, “Logistics Determine Your Destiny”. I will also present models and simulations of contested supply chain networks in the INDOPACOM AOR developed for presentation at the Air Force Special Operations Command (AFSOC).

Key Words:
Agent-based simulation
Decision-support
Logistics
Mission planning
Wargaming

Location: TH314
Classification: UNCLASSIFIED
Working Group: WG28 Advances in Modeling and Simulation Techniques

WG29 Computational Advances in OR

66091 - Automating MBSE Studies with Gitlab CI/CD Pipelines and Parallelized Simulations

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mrs. Katherine L McCartney; Robert Reaney		
Abstract: This talk will overview the tech-stack modernization of a research lab at AFRL/RW responsible for AFSIM studies upwards of a million simulations each month. By leveraging Continuous Integration/Continuous Deployment (CI/CD) pipelines, automation drives these studies at development milestones by utilizing contributions from teams of teams including MBSE-created artifacts, scenario updates, software upgrades, etc. It will also showcase SOFA, a software developed by Anyar, Inc. to manage, deploy, and retrieve information from jobs across a cluster. Our analysis ecosystem leverages container technology to ensure reproducibility and generalization to any MS&A tool or process. SOFA facilitates communication between disparate tools and applications while also serving as scaffolding for migration to cloud-computing and distributed computing enclaves. Location: TH374 Classification: UNCLASSIFIED Working Group: WG29 Computational Advances in OR		

66164 - Achieving Multi-Resolution Campaign Modeling in AFSIM – Framework Update

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Alexander Braafladt; Sai-Aksharah Sriraman; Dr. Alicia Sudol; Professor Dimitri Mavris		
Abstract: This work is a continuation of the efforts presented previously at MORS Symposiums evolving a ‘Campaign-Lite’ methodology for aggregating information across fidelity levels in		

simulation. This aggregation supports effective analysis of means and ways options in a design context for large-scale military operations. The aggregation of information is used to provide analysis scope at the decision-level of interest (e.g., campaign-level), while maintaining technical credibility and transparency through traceable connection to the other levels (e.g., physics, engagement, and mission). Ongoing research efforts are working to better support analysis by tailoring fidelity – resolution, scope, and abstraction – to the specifics of the case, while working within runtime constraints and providing improved re-usability and re-configurability of simulation. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) provides an open architecture for these efforts and is successfully in use supporting simulation and analysis focused on the engagement and mission levels. Building on previous Campaign-Lite efforts for modeling larger-scale operations in AFSIM using execution control, mission modularity, and multi-level information objects, this work focuses on greatly improving scalability and reconfigurability with enhancements to the modular, object-oriented Command and Control (C2) and intelligence information management framework. These changes support improved plug-and-play modeling for decision-making algorithms and modular missions in a simulated multi-domain tasking cycle. Specifically, object-oriented encapsulation and inheritance techniques are used with updated information models to make managing target, geographic, resource, and sortie databases and behaviors for campaign-level, airbase-level, and squadron-level activities more flexible with clearer interfaces and intent. These new simulation capabilities are showcased in a proof-of-concept, multi-domain, large-scale operation, with new vignettes looking at space communications and the impacts of Electromagnetic Warfare (EW), and looking as well at joint strike packages that combine assets from multiple geographically separated airbases. The analysis considerations are based in an updated data-driven dashboard with closer linkage to Mystic visualization and geographic campaign outcomes.

Location: TH374
Classification: UNCLASSIFIED // NOFORN
Working Group: WG29 Computational Advances in OR

66120 - Reduced Order Non-INtrusive (RONIN) Modeling Methodology Formulation for Military Operations Analysis Applications

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Major Mark Bateman; Professor Dimitri Mavris; Dr. Alicia Sudol

Abstract: With the Department of Defense (DoD) shifting focus to prepare for peer and near-peer adversaries, there is a big push to out-innovate these adversaries through many different approaches. A specific area of interest is the use of Modeling, Simulation, and Analysis (MS&A) to provide analytical support for strategic decisions related to capability development. While extensive experimental and empirical data from past system development activities exists, there is a lack of similar data for proposed advanced concepts that are still in the early stages of research and development, which makes it difficult for military operations analysts to evaluate the military utility of a new concept in a cost-efficient manner. Operations research analysts are working toward using advanced MS&A techniques such as discrete-event or agent-based approaches to capture complex system and system-of-system behaviors in greater detail, however these advanced methods come at a high computational cost, especially when the scope of the analysis grows to the strategic level. To address the computationally prohibitive nature of some of these high-fidelity methods, an approach of model abstraction through the use of surrogate models or meta-models which work to emulate the behavior of the computationally expensive model but with a reduced computational cost. A promising class of surrogate modeling methods that could be leveraged to enable high fidelity analyses is a non-

intrusive parametric field surrogate approach that utilizes reduced order modeling techniques to create computationally efficient models. These field-based approaches leverage vector approximations of model responses and have emerged as an alternative to more traditional approaches that rely on scalar-based approximations. This research works to formalize a methodology using Reduced Ordered Non-Intrusive (RONIN) modeling methods for military operations analysis, specifically focused at the mission and campaign level modeling.

Location: TH374
Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

66668 - Modeling Spectral Data using Functional Data Analysis

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Thomas A. Donnelly

Abstract: Curves and spectra are fundamental to understanding many scientific and engineering applications. As a result, curves or spectral data are created by many types of analytical, test, and manufacturing equipment. When these data are used as part of a designed experiment or a machine learning application, most software requires the practitioner to extract “landmark” features from the data prior to modeling. This leads to models that are more difficult to interpret and are less accurate than models that treat spectral/curve data as first-class citizens.
This talk will present an overview of functional data analysis applied to spectral data. It will feature a case study showing a reanalysis of published NMR spectra for 231 blends of three alcohols - propanol, butanol, and pentanol. Small subsets of the full data set are modeled and used to predict either the spectra or the composition of blends not used in the analysis.
Functional data analysis was performed using wavelets as the basis functions to break the spectra into Shape Functions and Shape Weights (Functional Principal Components scores). A prediction profiler can now be used to predict spectral shape as functions of the shape weights and shape functions. Predicting as a function of the Shape Weights is difficult to use practically as the Shape Weights are not components in the mixture. However, by modeling the Shape Weights as functions of the proportions of the mixture components, a prediction profiler can be used to predict the shape of any blend of these three alcohols as confirmed using the checkpoint formulations.

Location: TH374
Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

66166 - Modeling, Simulation, and Analysis for EMS Mission Thread Interdependencies in Large-Scale Operations

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: John Robinson; Dr. Alicia Sudol; Professor Dimitri Mavris

Abstract: The integration of missions across the joint activities that make up a campaign is a central part of decision-making in the context of large-scale operations. Support for planning, investment, and acquisition decision-making through modeling, simulation, and analysis is underway in a variety of lines of effort to improve understanding of how alternatives impact the integration and interactions that roll up to the campaign level. The work presented here focuses on the key importance of the Electromagnetic Spectrum (EMS) in enabling the integration of future operations,

where the ability to operate effectively is expected to be impacted by a more congested, contested, and constrained EMS environment. The existing modeling, simulation, and analysis of Joint Mission Threads (JMTs) individually has been very effective at providing insights to support decisions on improving mission effectiveness; however, with a shift in focus to larger-scale operations, new techniques are required to understand the interdependencies and connections between the JMTs. This prompts a need to enable analysis that includes the EMS interdependencies between JMTs, as well as the impacts of the integration of JMTs on the outcomes in campaigns. Leveraging recent development of the 'Campaign-Lite' methodology for agent-based simulation of large-scale operations in the Advanced Framework for Simulation, Integration and Modeling (AFSIM), and the recent architecting approaches developed using the Unified Architecture Framework (UAF), this work proposes a data-driven approach to analyzing JMT EMS interdependencies. The JMTs and their interconnections are modeled using a UAF architecting approach and the interconnections are simulated in AFSIM resulting in data on the outcomes in the JMTs and in the overall large-scale operation. To work effectively with the resultant data in analysis, the work presented here uses models of the combined mission threads using Dynamic Bayesian Networks (DBN). This allows scenarios of conditional interdependencies to be directly inferred and visualized between the dynamic events and outcomes using the simulation-based outcome distributions. The modeling, simulation, and analysis approach is demonstrated in a proof-of-concept, large-scale, multi-domain scenario with example analysis vignettes focusing on electromagnetic warfare (EW) impacts on a set of JMTs, the dynamic mission tasking cycle, and campaign-level outcomes.

Location: TH374
Classification: UNCLASSIFIED // FOUO
Working Group: WG29 Computational Advances in OR

65713 - Modelling Nuclear Weapon Effects in Wargaming Using Monte Carlo Simulations

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Tyler John Guetzke; MAJ Alex Withenbury; MAJ Zachary Dugger; Thomas Kendall

Abstract: The United States Army's calculations and views of nuclear weapon effects in war needs change and modernization. Modern threats against the United States have the capability of deploying a non-strategic nuclear weapon (NSNW), a nuke with a yield of less than 30 Kiloton. Wargaming simulations to model these modern combat environments often end with enemy forces deploying a NSNW, misleading commanders on the true effects to their units. The object of our research was to develop a tool for a battlefield commander to easily interpret quantifiable effects from a NSNW. Utilizing Monte Carlo Simulation, we have developed a new methodology to analyze nuclear weapon effects. During each iteration of the Monte Carlo Simulation, we randomized both the emplacement of the NSNW with a multivariate (three dimensional) normal distribution and the displacement of army companies on a battlefield with a uniform distribution inside a circle of radius 564 meters. We then used distance damage functions to calculate the nuclear effects of blast (PSI), thermal (cal/cm^2), and radiation (rad) that each unit will receive. We finally compared these values to vulnerability thresholds for each unit type to determine the counts of unit statuses (fine, injured/damaged, and dead/disabled). We repeated the simulation 1000 times to get the distribution of unit status counts. Using our tool, an army commander calculates the expected value and variance for their unit statuses which will aid in their ability to understand the true impacts of NSNW in a combat environment. The Monte Carlo Simulation method for analyzing nuclear effects offers a new approach to account for variation in nuclear effects while giving the commander an easily interpretable output that avoids convoluted probabilities.

Location: TH374
Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

65632 - U.S. Air Force Tanker Planning Optimization: New Methods

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr. Doug Altner		

Abstract: Building off previous work, this talk presents a new, local search based algorithm for optimally assigning Air Force tankers to receivers for aerial refueling as part of an in-advance planning solution. In addition to detailing the problem statement and solution approach, this talk will also compare the performance of this algorithm against a previously developed, integer-programming-based matheuristic on many test cases, showing the local search approach is 30x faster and produces significantly better plans. This is joint work between MITRE and Kessel Run (AFLCMC/HBB).

Location: TH374
Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

66022 - Balancing Computation and Runtime in a Python Combat Model

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Lloyd Waggoner		

Abstract: Beginning in fiscal year 2022, The Research and Analysis Center (TRAC) executed analysis focused on identifying the operational impacts of adding Vehicle Protection System (VPS) capabilities at the platform and formation levels to inform future science and technology (S&T) investments for Product Manager (PdM) VPS. TRAC worked alongside the Combat Capabilities Development Command Analysis Center, the Maneuver Center of Excellence Maneuver Requirements Division, and the Ground Vehicle Systems Center to help the PdM VPS determine which technology or combination of technologies should provide the most impact to United States force survivability and lethality. No existing combat model provided a simple method for examining a subset of technologies that would be most useful in a limited set of operational conditions, so TRAC designed and built a python brigade-level echelon combat model specifically focused on indirect fires and casualty/medical evacuation missions. The model is behavior-based which allowed quick integration on a short study timeline. The resulting model is a robust and flexible tool that can be integrated quickly and adapt to multiple study needs. By allowing both medium and high fidelity, the user can provide detailed analyses on areas of high interest while preserving time with lower fidelity in areas of less interest. This presentation will highlight the decision-making process in electing to build a new model, lessons learned throughout the development, and applications beyond VPS. Focus will be on how the team adapted to time limitations and found a balance between time spent improving model efficiency, increasing fidelity, and optimizing model runtime. Determining and achieving a sufficient balance between fidelity and time available is a challenge every study team must overcome, which was refined several times throughout the VPS study.

Location: TH374
Classification: UNCLASSIFIED // FOUO
Working Group: WG29 Computational Advances in OR

66169 - Accelerated Emergent Behavior Exploration Using Bayesian Optimization with Agent-Based Simulation

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Alexander Braafladt; Dr. Alicia Sudol; Professor Dimitri Mavris		
Abstract: During capability design, the required pace needed for technology investment decision-making has encountered challenges as modernization efforts focus both on impacts in larger-scale operations and on driving increases in simulation fidelity to enable successful iteration towards fielded capability. This prompts a critical need for acceleration of simulation-based analysis, especially to search efficiently through expensive, high-fidelity simulation with tools like AFSIM or STORM. The search goals during iterative AFWIC Assess-Develop-Evaluate design loops and AFRL SDPE E-MS&A simulation-based analysis are to highlight gaps in knowledge about the technology, concept, and scenario, focus the simulation to update understanding, and perturb the scenario sufficiently to develop confidence in the analysis. The key behavior in this process is emergent behavior – hard to predict, critical changes in the outcomes as alternative scenarios are considered. Existing approaches for finding these behaviors rely on experts – who are limited resources – or on brute-force Monte Carlo Simulation – which is infeasible with expensive high-fidelity simulation. In response, a variety of approaches using optimization have been evolving in the military simulation community that have improved the search for important behaviors. However, these approaches need to be further enhanced to work effectively with the high-fidelity simulation in use which is often expensive, highly nonlinear, and non-stationary. In addition, cases where emergent behavior is encountered as rare, extreme events are critical to analysis, but the existing optimization approaches often struggle with these types of events. This work builds on existing techniques for Bayesian Optimization, focused on developing an approach that is effective for the challenging behavior characteristics encountered with military agent-based simulation. A benchmark across the state-of-the-art techniques for adaptive sampling and active learning was completed, and effectiveness of these techniques and a new algorithm specifically targeting the rare, extreme events of importance was demonstrated in a proof-of-concept simulation case in AFSIM. Location: TH374 Classification: UNCLASSIFIED // FOUO Working Group: WG29 Computational Advances in OR		

66330 - Cloud Information System Design - Achieving VAULTIS

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: COL Paul F Evangelista; Mr. Clint Sikes		
Abstract: Cloud computing resources and databases available to DoD organizations have grown significantly, spawning information systems addressing a variety of needs. Each of these information systems deserve thoughtful design and functionality. The United States Military Academy embarked upon the creation of a common information system designed to deliver data and analytics to empower leader decisions at all levels. The iterative design of this information system converged on a solution that naturally supports the DoD data-centric goals: visible, accessible, understandable, linked, trustworthy, interoperable, and secure (VAULTIS). A fundamental premise of the design involved near total control of all data processing and presentation; minimal third-party tools have been employed. This approach supports flexible authorship and creativity without seeking or relying upon existing templates. Technology discussed will include Azure Web Apps, Azure DevOps,		

Databricks, Azure Active Directory, and an ASP.NET framework. This presentation will include a discussion of the information system design, to include technical specifications, and a demonstration of the information system.

Location: TH374
Classification: UNCLASSIFIED
Working Group: WG29 Computational Advances in OR

WG30 Wargaming

65891 - Optimizing Contextual Realism

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Dr. Ruby Booth

Abstract: Wargame design must appropriately balance contextual realism, analytical utility, and player engagement. Our sponsors and players often suggest that more realism is better. However, increasing aspects of contextual realism present in the game can increase complexity reducing player engagement and, at worst, rendering the game unplayable. In addition, extraneous "realistic" elements unrelated to the game's core purpose can distract players and researchers alike from the central issues the game is intended to address. Determining when a game is has sufficient realism to represent the problem of interest, but not so much to reduce its efficacy represents a meaningful and common design challenge. We will discuss a faceted approach, in which elements of the real are considered across a variety of games, allowing for a nuanced view without overloading any single game or playthrough.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525

Location: TH342
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

65458 - Wargaming within the Nuclear Environment - Part 2

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: LTC James Gifford; Mr. Michael A. Ottenberg

Abstract: Warfare involving nuclear, biological, and chemical weapons is a continuing concern of defense analysis. Wargames routinely examine the effects of these weapons on combat operations at all levels of war. The Nuclear Wargame and Analysis division of Defense Threat Reduction Agency (DTRA) provides physics-based adjudication of nuclear effects to DoD wargames. While there are multiple models that examine quantitative nuclear effects down to the engineering level, the level of play included in most wargames has been highly abstracted.
This presentation will demonstrate the results from the collaborative effort to combine the DTRA's Nuclear Events Software (MINES) M&S suite with OSD CAPE's Standard Wargame Integration Facilitation Toolkit (SWIFT) to build MCWAM-T-Nuclear. MCWAM-T-Nuclear incorporates nuclear effects into tactical ground combat wargaming provided by the SWIFT instantiated Marine Corps Wargaming and Analysis Method–Tactical (MCWAM-T). The demonstration will show how these tools can be used to examine the effects nuclear weapons employment on the tactical battlefield. MCWAM-T-Nuclear is the first result of a multi-year collaboration designed to integrate MINES into computer assisted, rigidly adjudicated wargames at the tactical and operational levels of war.

Location: TH341
Classification: UNCLASSIFIED // FOUO/CUI
Working Group: WG30 Wargaming

66230 - Jutland 1916, Steel Castles Clash

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Mr. Michael W. Garrambone, FS; Mr. Terrance James McKearney, FS; Paul W Vebber, CDR USN (ret)		
Abstract: The Battle of Jutland (German) or Skagerrak (Danish) was significant for being the largest naval battle of the First World War and the most severe in numbers of lives lost. The battle engaged a total of 100,000 men aboard some 250 warships over the course of 72 hours. It questioned the ability of the British navy to maintain a strategic blockade and severely diminished the German naval fleet's capabilities. This presentation provides background, describes the battle, and discusses battle results. The second portion of the session will describe the Jutland wargame and introduce the audience to the game playing system to be used later in the symposium. Location: TH342 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

66037 - Moving Beyond the White Card: Integrating Space Domain Actions & Effects into Global Wargames

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Michael Seminelli		
Abstract: Current wargames lack the capacity accurately represent multi-domain effects across the battlefield, forcing experts and game designers to use 'white cards' as crude approximations for effects. This undermines the multi-domain capabilities delivered by the joint force while creating negative learning for the players. US Space Command actively works with wargame designers to develop game scenarios that integrate actions and effects in, from, and to space. Additionally, US Space Command is actively working with research centers and industry partners to establish a modeling and simulation environment that replicates campaign-level space actions and effects, both on-orbit and for the terrestrial fight. Although this solution is still in development, we are optimistic about the potential for a truly integrated wargaming environment that creates Joint players and senior leaders who are knowledgeable about the roles, authorities, strengths, and limitations associated with space-domain warfare. Location: TH341 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

65815 - Wargaming with BEAM

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Liz Comar; Dr. Mark A. Gallagher, FS; Stephen Sturgeon		
Abstract: Title: Wargaming with BEAM		

WG(s):
Working Group 30: Wargaming

Classification: Unclassified

Presenters:
Liz Comar, LinQuest
Mark Gallagher, AFIT
Stephen Sturgeon, LinQuest

The Bilateral Enterprise Analysis Model (BEAM) is a campaign tool that provides an opportunity to break the paradigm of how and where campaign analysis has been used across the analytic landscape. BEAM was designed to allow for easy strategy, force structure, or infrastructure changes and its intuitiveness allows new users to learn to use it in a couple of days with no formal training. BEAM has an enterprise resolution so missions are the main modeling entity. Wargamers may input campaign phase objectives to drive major force movements and engagements. This combination of attributes makes it accessible to a broad spectrum of analytic functions and offers unique opportunities for the wargaming community. This presentation walks through various ways BEAM may be able to support a wargame, from pre-game scenario building and force positioning to in-game analysis and adjudication to post-game sensitivity analysis. We provide examples of how BEAM can prepare the adjudicators, facilitators, and white cell for the wargaming event by providing pre-game insights. Our talk shows how BEAM can be used to step through a strategy and allow for strategy changes based on predetermined "turn" lengths. Finally, we demonstrate BEAM's ability to analyze post-game results and quickly and easily analyze courses of action that may have been discussed but ultimately not chosen by the players in the wargame.

The views expressed in this paper represent the personal views of the author and are not necessarily views of the Department of Defense or the Department of the Air Force.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66186 - CASTLE – A Framework for building online strategic wargames for conflict analysis and experimentation

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr Nathan Fabian; Mr. Jon Whetzel		
Abstract: Online strategy wargames are seeing an upward trend in popularity due to their ability to collect large amounts of data in a repeatable environment where many random factors can be controlled for during the experimental process. We present a new framework known as the Conflict Analysis Strategy Testing Laboratory Environment, or CASTLE, that enables and simplifies building a novel turn-based game that defines its own rules, maps, pieces, and interactions. CASTLE is constructed so that we can design, build, and deploy these kinds of novel games quickly and cost-effectively. CASTLE's design requirements include support for web deployment, real-time networking, and data capture applied to any new games developed on the framework. We will present Tantalus,		

the latest game we have built on the CASTLE framework, and show how it takes advantage of CASTLE's generalized API to enable its unique gameplay features. We will also discuss some technical details of how CASTLE itself is implemented to support these games while meeting its requirements.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66403 - Pacific WINDS II: A Tabletop Intelligence Wargame Suitable for use in Maneuver Centric Wargames

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Steve Sallot; CPT Gabriela Barrera; Scott Lynch

Abstract: The Center for Army Analysis (CAA) developed the Pacific Warning, Indications, and Deterrence System (WINDS) II wargame to support U.S. Army Pacific's Unified Pacific Wargame Series (UPWS) 2023. The authors will present the intelligence, surveillance, and reconnaissance (ISR) adjudication schema used in the wargame for consideration as an alternative option for potential use in operational fire and maneuver wargames in which enemy units are sensed/detected/revealed/targetable for wargame players. CAA designed the ISR adjudication schema to strike a balance between highly granular discrete event simulations designed to examine the capabilities of specific ISR platforms and the highly abstracted probabilistic models typical of most combat adjudication methods. The ISR adjudication schema includes a manner to determine both probability of detection and quality of intelligence collected in various regions. These characterizations were based on specifications and quantity of sensors present in a region, the analytical capacity assigned to a region, and the volume of enemy activity and deception in that region. The schema allowed for subsequent characterization of target development quality of enemy units in the wargame.

Location: TH342
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66048 - Cyber-Wargame Commodity Course of Action Automated Analysis Method

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Alex Hoffendahl; Maj Chancellor A Johnstone, PhD; Mr. Richard NMI Dill; Dr Lance Champagne; Alexander Stephens

Abstract: In the modern operational landscape, strategic decisions are made with limited and uncertain information. In general, the goal is to minimize adversarial threats and mitigate risk to blue forces. Wargaming is a resource that allows decision-makers to translate theoretical ideas into practical execution, thereby enhancing critical thinking and problem-solving skills. Exploring how to complement kinetic effects with cross-domain capabilities, such as cyber-effects, in wargaming allows for a broader decision scope across an entire multi-domain operation. This research aims to enhance the analytical capabilities and overall usability of the Wargame Commodity Course of Action Automated Analysis Method (WCCAAM) by incorporating cyber-effects in determining optimal blue-team actions. The original WCCAAM model receives mission objectives, available units, and enemy targets as inputs. Then, a multi-commodity flow algorithm (MCFA) is applied to identify the optimal engagement approach to combat a known enemy course of action (COA). This proposed extension of

WCCAAM, aptly named the Cyber-Wargame Commodity Course of Action Automated Analysis Method (C-WCCAAM) balances engagement risk with blue-team cyber-effects to combat enemy targets. The resulting model utilizes an MCFA approach within a multi-objective mixed-integer program (MO-MIP) to determine an optimal blue-force COA. We explore a fictitious wargame scenario and compare C-WCCAAM results on this scenario
to previous results achieved with WCCAAM, achieving lower engagement risk by utilizing potential cyber-effects in our blue-force COA. We also assess the robustness of our optimal COA through sensitivity analysis

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66012 - Experimental wargaming and cyber deterrence

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Kiran Lakkaraju, Ph.D; Joshua Letchford

Abstract: Historically, wargames have often been single-play, focusing on qualitative data collection, and have been built primarily for exploration rather than developing data-driven analytical conclusions. Experimental wargaming, a new wargaming approach that employs the basic principles of experimental design to facilitate an objective basis for exploring fundamental research questions around human behavior, is a potential tool that can be used in combination with existing wargaming approaches. In this talk we will discuss the design of Tantalus, an experimental wargame designed to facilitate data collection at scale to contribute to the debate around the feasibility of deterrence in cyberspace and how the dynamics may or may not be different than other domains. Specifically, we are interested in studying the impact of one of the constituent characters of the cyber deterrence challenge – the trade-off between revealing and concealing clandestine cyber capabilities.
Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66155 - Threat-Based Space and Cyber Analysis: The Impacts on the Terrestrial Fight

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes an unclassified 3-month study that examined how to effectively model space and cyber threats in campaign analysis. The study explored the research question, "How can operations research models represent the campaign and decision-making effects of space and cyber threats in campaign analysis, using the Army opposing forces doctrine?" According to Army Regulation 350-2, page 1, the Opposing Force (OPFOR) Program is a "plausible, flexible military and/or paramilitary force representing a composite of varying capabilities of actual worldwide forces (doctrine, tactics, organization, and equipment) used in lieu of a specific threat force for training and developing U.S. forces." This program provides a lens by which threats-based analysis may inform

operations research models; specifically, the vulnerability in blue systems in the space and cyber domains.
The tactical and operational effects of space and cyber systems have emerged as pivotal to contingency planning. Both domains impact all phases of the continuum of conflict, have joint implications, relevance in commercial, private, and public sectors, and lack internationally accepted standards. However, few operational research models have addressed the way threat cyber and space systems affect actions on planning in terrestrial domains such as air, land, and sea. Further, few studies have examined the specific way space and cyber systems integrate with terrestrial operations. This analytical gap has led to gross misrepresentation of space and cyber effects in joint military planning, including how friendly systems account for these systems in threat analyses and how they possibly alter operations research modeling and simulation.
This study contained two phases using quantitative and qualitative analysis. Phase one included examining 22 space and cyber systems within the Army's opposing forces doctrine. The phase yielded a list of 102 effects on terrestrial domains. Phase two explored how adversaries may tactically or operationally use the 102 effects in a simulated campaign.
This study is relevant to operations research because it illuminates two domains that affect all military services, as well as many commercial and public sector organizations. This research is relevant to this year's symposium because it used an innovative analytical approach in an under-researched area. Finally, it integrated a threat-based operations research approach with peer-reviewed, reputable qualitative data analysis. The presentation will include a detailed summary of the study's two phases and findings.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66402 - How to Conduct a Quality Sustainment Wargame Focused on The Pacific

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ms Sarah Whitesides; CPT Gabriela Barrera

Abstract: The challenge of sustaining a combat-credible force in the Indo-Pacific for a variety of eventualities of unknown duration requires not only a joint understanding and synchronization of Service component interdependencies within the U.S. Indo-Pacific Command, but also a similar level of detailed understanding and synchronization with our allies and partners. To explore the end-to-end sustainment structure within the Pacific area of responsibility, the Center for Army Analysis tailored an analog sustainment wargame system, originally designed for the European theater, that prompts discussion with respect to the difficult and competing choices in resource allocation and future investments for Army Pacific sustainment force posture and structure. This briefing will peek behind the curtain for the game design and development; discuss some of the key insights that illustrate the game process; and address how the wargame enhanced the quality of analysis to inform development of doctrine and knowledge within the Army sustainment enterprise for an extremely challenging problem set – combined, joint logistics in the Pacific. This analog sustainment wargame system may be considered as an alternative or supplemental option for use in operational fire and maneuver wargames that involve player decisions regarding sustainment.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66032 - UK Land Concepts – Solving Tomorrow's Problems

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr Stuart Neil Taylor		

Abstract: The Land Concepts project within the UK's Defence Science Technology Laboratory (Dstl) develops and tests new approaches to solving tactical and operational challenges in the Land Domain. New concepts are developed by applying technology-aware innovative thinking to UK Land Forces. These are often designed to address known capability gaps, but the ambition is also to identify opportunities to achieve a greater or more enduring advantage, noting that our adversaries won't be standing still.

Land Concepts complements more specialized research by evaluating concepts within a system of systems context up to Divisional level. A range of manual and computerized wargaming tools are used, which include modified commercial games for rapid exploratory analysis and more detailed bespoke tools for more in-depth higher fidelity assessment. The aim is to improve our understanding of both the individual contributions of specific systems and the combined effects of multiple interdependent capability enhancements. Insights also include the behavioral changes of both Red and Blue resulting from the imposition of new dilemmas, which may then feed new insights about residual capability gaps and opportunities.

This iterative process of testing and refining has enabled Dstl to continuously improve our understanding of those capabilities which are most critical to success, enabling us to propose increasingly effective conceptual force mixes.

The scope of the project is not limited to just identifying idealized solutions, but is also responsible for stimulating the development of the most promising opportunities into concept demonstrators, thus helping to bridge the 'valley of death' from research to exploitation.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66133 - Wargaming the Future Army

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Curtis B Hudson, Jr; Dr. Suzanne Marie DeLong; Adwoa Gyekye		

Abstract: In planning for the Army's future operating concept, an environment in which to test ideas and concepts is imperative. Since system specifications and exact technologies are emergent, the environment must allow for unknown system parameters and technological concepts. Wargaming is an ideal approach in which to test operating concepts on a yet to be developed force. This presentation will address the design, wargame performance, and adjudication methodologies needed to conduct analytical wargaming with the Future Army Force.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66407 - Joint European Time-Phased Force and Deployment Data Sustainment Wargame-21 (JETS 21) Process and Methodology.

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: MAJ Christopher Ryan Ehlers		
Abstract: The Joint European Time-Phased Force and Deployment Data Sustainment Wargame-21 (JETS 21) examined critical sustainment factors and identified potential friction points in execution of joint time-phased force and deployment data (TPFDD) flow with simultaneous sustainment movements using commercial and military transport assets on an established European node network. The Center for Army Analysis (CAA) facilitated JETS 21 for the 21st Theater Sustainment Command (21st TSC) in Kaiserslautern Germany in late 2022 with CAA's Joint Logistics Wargame Analysis Model (LogJAM). In collaboration with 21st TSC, CAA created a novel logistics tracking system using modular placemats and blocks on an analog map board to represent TPFDD flow and sustainment status. CAA also developed dynamic digital displays in LogJAM to represent movement status during game execution. This presentation covers the methodology used to design and execute the JETS 21 wargame and seeks to facilitate a discussion of lessons learned and challenges of logistical wargames. Location: TH341 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

66042 - Left of Bang: The Need to Start Wargames in Competition to Leverage the Space, Cyber, and SOF Triad

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Michael Seminelli		
Abstract: Current Joint and Service wargames typically begin gameplay at the onset of armed conflict, often ignoring all of the coordinated actions that set the stage for conflict. The Space, Cyber, and Special Operations Triad plans to execute global actions during competition to provide off-ramps to crisis while setting conditions for Joint Force success in conflict. Wargames that start on "D-Day" often assume away the impact these early actions achieved, creating a game scenario unrepresentative of the conditions expected for conflict. Actions across the Triad aim to preserve space and cyber domain dominance while countering adversary sensor networks to reduce early warning and targeting of conventional forces. Games that fail to explore these actions with probabilistic uncertainty start scenarios with poorly assumed initial conditions. US Space Command has collaborated with service wargaming centers to educate game designers in the space domain and aid in building scenarios that accurately incorporate triad actions in competition. Additionally, US Space Command, in partnership with USSOCOM and USCYBERCOM, has led the movement for key wargames to start gameplay during competition to enable the Joint Force to explore the actions required to achieve favorable starting conditions for the onset of conflict. Location: TH342 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

65927 - Wargaming Non-Kinetic Competition

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: CDR Phillip E. Pournelle, USN Retired
Abstract: Kinetic, physics-based actions in war easily lend themselves to computer modeling, but what happens when a game sponsor wants to examine pre-war competition? Wargames focusing on competition often utilize seminar or matrix methodologies, but these methods generally allow for only a small set of actions to be discussed. This work seeks to elaborate on a new method of matrix wargaming utilizing a triage component to select the most relevant actions for matrix adjudication and allow players to generate more than 30 actions per turn. This presentation is unique because it strives to accelerate game play when a large number of moves could potentially be subject to matrix adjudication. Location: TH341 Classification: UNCLASSIFIED Working Group: WG30 Wargaming

66030 - Boxing Clever: Designing, developing and publishing strategic games for professional use

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Rikki Parsons		
Abstract: Strategic gaming is experiencing increasing demand within the UK defence and national security sector and DSTL, as a leader in this field, are well placed to serve this need. Traditionally, our strategic national security games have been bespoke in nature, with limited repeatability and long design and development times. We need to find more innovative ways to meet current and future demand, whilst still retaining the high quality of the outputs. One ongoing research project is working on 'boxing up' games for analytical or experiential learning use. These games can then be delivered and executed with less external support, whilst also helping to drive a culture of strategic gaming within key decision maker groups. In this session, we will explore when rigid adjudication methods can be used to replace free adjudication, through examples of different games. These games will help to highlight the choices that game designers need to make, but also the power of getting it right. We will also look to see what can be learned from the hobby gaming industry, where games go through intense design and development cycles before being distributed to potentially millions of players. How does this affect design choices and how important is playtesting in ensuring the games can be understood and played with minimal through-life support? Finally, the publishing of boxed games is also a challenge. There is a renewed focus on graphic design and visualisation methods to ensure that player engagement is strong. We have also spent time improving our physical game components and considering the costs and benefits of these. DSTL are keen to share our progress and seek further support on our mission to develop this method of strategic gaming into the future. Location: TH341 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

65720 - Hybridizing Digital Engineering and Operational Wargaming

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Brendan Bongi		

Abstract: Mission engineering brings the potential to manage complexity while evaluating a system of systems. Recently digital engineering has provided a number of powerful tools in this area, readily capturing information flows and mapping relationships between and within systems. Wargaming has provided valuable insights to the mission engineer as well, acting a venue to examine future warfare interactions, decisions, and stressors across the levels of warfare. However, to date these methodologies have remained largely separate within the mission engineering discipline. It has not been readily apparent how the two might overlap in the analytic process, as each has distinct strengths and weaknesses that could seem mutually exclusive or dissonant. For example, a digital engineering model might assign a high level of importance to the specifics of a system's precise software configuration to ensure accurate mapping of the system's capabilities, while in a wargame the same information might be considered too detailed to facilitate player decision making.
With these circumstances in mind, this presentation will describe a recent project that successfully integrated the mechanics of an operational tabletop wargame with the architecture of a digital engineering model in order to relate the contributions of systems to a force's creation of operational effects. The artifacts from the wargame captured by the model were also used to explore the impacts of force composition, sequencing, and novel capabilities on warfighting effects in the context of the wargame's scenario. We will cover the process of developing and integrating the model and wargame, lessons learned during execution, and additional cross-discipline opportunities that could further expand upon this approach.

Location: TH353 Classified
Classification: SECRET NOFORN
Working Group: WG30 Wargaming

66381 - Modeling Theater-level Intelligence Collection for Wargaming

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Robert Ward

Abstract: To inform measures of intelligence "access" in the Pacific Warning, Intelligence, and Deterrence System (WINDS) II wargame, the Center for Army Analysis (CAA) built the Theater Intelligence Model (TIM), a simple quantitative model of theater-level intelligence collection in the Pacific. The model uses readily available data on the capabilities and usage of intelligence, surveillance, and reconnaissance (ISR) platforms across all domains to estimate the extent to which the United States and its partners and allies have persistent, layered ISR access to the regions on the wargame's map. The team also created a user-friendly, cloud-hosted frontend that enables analysts to rapidly explore a variety of wargame starting conditions with different investments in future ISR capabilities, adjudicate the effects of in-game operational decisions on intelligence collection, and display the results to wargame participants. This talk will address the model's methodology, interface, and role in the wargame, as well as the potential for enhancements to the model's fidelity and application to other games and geographic regions.

Location: TH353 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG30 Wargaming

66406 - Rapid Response Wargaming (R2W) using the Center for Army Analysis Accelerated Wargaming System (CAAAWS)

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Andrew C Dillon; MAJ Paul M Kearney		
Abstract: The Center for Army Analysis (CAA) executes strategic and operational wargaming through capabilities resident in its Strategic and Campaign Wargaming divisions. CAA uses its Accelerated Wargaming System (CAAAWS) to conduct deliberate and planned operational wargaming for the joint community. The CAAAWS model uses correlation of forces and means values and structured adjudication techniques to produce quantitative and qualitative comparisons of courses of action (COAs). CAAAWS provides an order-of-magnitude assessment of different COAs for comparison, helps identify decision points and risks, and provides broad operational insights for a COAs suitability, acceptability, feasibility, and completeness. Recently, due to dynamic changes in the operating environment, client organizations have requested wargaming support with short or no notice to CAA. In response to this demand, CAA has identified the capability requirements for Rapid Response Wargaming (R2W) and outlined the prerequisites, personnel requirements, and material requirements to execute R2W in support of corps, theater army, and geographic combatant commands. Location: TH341 Classification: UNCLASSIFIED Working Group: WG30 Wargaming		

66790 - Clever Briefers and Clever Courses of Action: How to Create a Smart Enemy in Wargames

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr. Yuna Huh Wong		
Abstract: Courses of action (COAs), particularly enemy COAs (ECOAs), are important inputs into wargames. While wargaming is an important tool for exploring potential conflicts and challenging assumptions, they can inadvertently reinforce conventional wisdom and institutional blind spots if used only on consensus scenarios and expected ECOAs. This paper outlines two methods, “Worst Possible Idea” and “Clever Briefer,” which work well in combination to create intelligent ECOAs for wargames. The paper explains the combination of the methods and proposes a social science explanation for its effectiveness. It also discusses the subsequent use of the ECOAs in matrix games. Its intent is to add to the body of structured analytic techniques (SATs) often employed in the defense and intelligence community but also to tie its use to the emerging body of social science on wargaming and SATs. Location: TH353 Classified Classification: SECRET NOFORN Working Group: WG30 Wargaming		

66408 - The Center for Army Analysis Accelerated Wargaming System (CAAAWS) Aerial Refueling Model.

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Mr. Daniel Mahoney		
Abstract: One of the shortcomings common to theater-level (operational) wargaming systems is a failure to account for each combatant side’s aerial refueling capability. If aerial refueling constraints are not taken into account, it is easy to overestimate a combatant’s air-sortie generation rate, thus overstating the impact of air power on its operations. The Center for Army Analysis Accelerated		

Wargaming System (CAAAWS) addresses the effect of flight distances and aerial refueling capabilities on air operations through the CAAAWS Aerial Refueling Model (ARM). The CAAAWS ARM does not seek to replicate the detailed scheduling and logistical complexity inherent in real-world, theater aerial refueling operations. Instead, the model uses approximate flight distances, standardized fuel consumptions rates, and generalized tanker capacity (and availability) data to generate both an estimated, theater-wide, air-tanking requirement and air-tanking capacity. It then uses the difference between these two figures to determine if, and to what degree, a force must curtail its air sortie generation due to aerial refueling constraints.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66235 - How the CNA Team Beat the CAA Team in Dunnigan's Drive on Metz Wargame

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr. Michael W. Garrambone, FS; Mr. Mark L Axtell; Ms. Tara A. Garrambone; Dr. Thomas Calvan Hughes; Dr. Clayton D. Rothwell

Abstract: With battlelines drawn, the "CNA" Team (German) faced the "CAA" Team (US) in the Lorraine Region of Metz—there will be no blood, only reputation. Teams received Dunnigan's game rules, umpires were positioned, computer consoles were ready, observers were pen-up. From two separate rooms the battle began. It was an astounding fight among the wargame masters, but you have to attend this briefing to see the strategies, hear what happened, and relive the smack. This MORS sponsored event drew crowds of 60 to see who could beat who and how they would earn the honors among champions.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

65435 - Integrating M&S Analysis in Adjudication of Maritime Wargames

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Christopher Kona

Abstract: Simulation is an attractive addition to naval wargames, especially the promise of being able to simulate explicit actions live during the conduct of a wargame. However, its use must be able to serve the wargame purpose and design. There are a number of pitfalls that need to be considered when simulation results are used to inform wargame adjudication. First, models and simulations are only approximations of the real world, and the extent to which they address questions in a relevant manner to the wargame needs to be considered. Second, the context in which the simulations are analyzed may be different than the context employed by the players. Lastly, accurate simulations require careful verification, and late changes to inputs or tactics used in simulation may result in unpredictable behaviors. For these reasons, the way modeling and simulation is integrated with wargame design requires careful contemplation.

Under certain circumstances, the addition of modeling and simulation-based analysis can improve the ability for a wargame to inform a particular research question. It can help to shape the spread of likely outcomes in a particular interaction, which is useful in educational wargames or those where the

audience may have a bias about interaction results. When applied carefully, it can also act as a tool to resolve common interactions that occur under contexts similar to those used in the models. This talk will illustrate a successful example of using modeling and simulation within an operational-level wargame conducted in 2021. The talk will present the design approach and describe how the team managed the associated contexts to ensure consistency between the model outputs and the wargame interactions.

Location: TH353 Classified
Classification: SECRET NOFORN
Working Group: WG30 Wargaming

66386 - Enhancing Analytical Results through the Integration of Wargaming and Mathematical Modeling

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Wayne O. Nitzschner

Abstract: Principal Author: MAJ Phuoc Nguyen
Briefer: MAJ Phuoc Nguyen (Phil)
Classification of Presentation: CUI
Distribution Statement: DISTRIBUTION D
Working Group: WG 28 - Advances in Modeling and Simulation Techniques; WG 30 - Wargaming

Enhancing Analytical Results through the Integration of Wargaming and Mathematical Modeling

Analytical wargaming is a technique intended to simulate and analyze military scenarios to inform decision-making. The adjudication process, which is responsible for resolving the outcomes of simulated events, can be complex and time-consuming. The process can be streamlined and more efficient using mathematical models and programming languages. The method involves creating a set of simple equations or algorithms that represent the key factors influencing the outcome of simulation events.

A formal methodology is needed to develop combat power estimates using the various elements doctrinally associated with combat power. TRAC is developing a structure and method for Analysts, Educators, and Trainers to use within wargames to estimate combat power and attrition and adjudicate other related effects. The structure and method will be transparent; readily understood; and facilitate rapid, structured changes to unit values and flexible inclusion of effects supported by pedigreed data (friendly and threat).

This presentation shows one such technique that improves the accuracy and speed of the adjudication process, facilitates the exploration of different scenarios, and facilitates rapid analysis of the results. This approach can also be a cost-effective alternative for those who do not have access to state-of-the-art wargaming simulators that require specialized hardware, software, or training.

Keywords: wargaming, simulation, adjudication, mathematical model, methodology

Location: TH342

Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66693 - Wargames and Wargame-Like Events: When to choose which.

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:30 PM

Authors: CDR Phillip E. Pournelle, USN Retired

Abstract: A wargame is a dynamic representation of conflict or competition in a synthetic environment, in which people make decisions and respond to the consequences of those decisions. Best practice for a full wargame is a conflict between at least two competing sides, but there are times when concepts, teams, systems, etc. are not ready for a full competition between opposing teams but instead need wargame like events to assist in maturing them. Wargame-like events include Rehearsals of Concept (RoC) Drill, Headquarters Exercise (HQex), Staff Exercise (StaffEx), etc. These events are extremely valuable but the results from these events is not as rigorous as a full wargame and the results and insights of such events should not be misconstrued as what comes from a fully mature wargame design. In this seminar the author will spell out the arguments for a dialectic with members of the working group.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66172 - Game Design for Critical Infrastructure Resilience: Game Engine Integration with Geospatial Technology

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: David I. Schwartz; Dr. Aldo David Abitbol; Emily Nack; Steven M. Whitham; CM Wilkinson; Brian Tomaszewski; Jessica D Bayliss; Chao Peng

Abstract: Wargames and tabletop exercises have long sought methods to address kinetic and non-kinetic warfare interactions. With the continuing and increasing cybersecurity attacks, governments, and other organizations have expressed a need for a scalable, non-kinetic platform handling multi-domain operations.

To address these challenges, a team from the Rochester Institute of Technology, the Army Education Outreach Program, and the Army Cyber Institute (ACI) at West Point developed a proof of concept "resilience game" and game engine for further development. Our team leveraged the ACI's Jack Voltaic cyber exercise for the game and framework to protect the sixteen critical infrastructure sectors (www.cisa.gov/critical-infrastructure-sectors). The sectors involve an enormous number of complex interactions. Our team sought to abstract and present visually via a real-world map with a game overlay.

The resilience game framework (RGF) leverages Homeland Infrastructure Foundation-Level Data (HIFLD) (hifld-geoplatform.opendata.arcgis.com) data layers, which the RGF reads into Esri's ArcGIS and the Unity game engine via a relatively new SDK. In the above figure, we show a hex map containing several elements of Georgia according to the HIFLD layers. Unity provides a user interface that represents various infrastructure elements summarized on the left side of the screenshot.

The gameplay involves four turns of randomly selected events from a database of pre-generated scenarios (top right). RGF offers each player a role to fund and expend resources controlled by that player during a single turn (bottom right corner). For example, a player representing energy might need to supply power for an emergency in a part of the state. Ideally, the players realize that balancing expenses and funding will likely yield a favorable (or less disastrous) outcome as the game issues harsher events. Players are not physically located near each other using a networked architecture and may need help communicating. This design introduces more variability and competition.

The proposed presentation will further explain the architecture and data flow of RGF. Given the one-semester development, this work provided a proof of concept. The presentation will explain the challenges of working with geospatial technology and data sets such as Geographic Information Systems (GIS), remote sensing imagery, spatial data assets, and game engine technologies and the future directions. The project has continued funding with the ACI–we will discuss ways to improve the scalability, abstraction of more CISA sectors, enhanced gameplay, and testing methodologies.

Location: TH342
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

66126 - Professional Development and Wargaming at the United States Naval Academy

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: CDR Kenneth Maroon; Franklin Kenter

Abstract: We present an overview of the current and future state of wargaming efforts at the United States Naval Academy. This is a multidisiplinary effort among many disciplines including professional development, operations research, and history, among others.

We hope the wargaming initiative at USNA will become a larger and enduring component of the midshipmen experience and curriculum with the ultimate goal of developing leaders to synthesize the combination of their professional knowledge, analytical expertise and their personal experience to make decisions.

There are many challenges of introducing wargaming at the pre-commissioning/undergraduate level and how to integrate wargaming within the current training schedule and tight requirements on midshipmen time.

We discuss past, current, and future projects at USNA, including the following:

* Developing STEM-focused wargaming courses and modules for implementation at service academies and even universities at-large.

* Implementing wargaming into past courses within operations research, core science, and history.

* Establishing programs to train and equip facilitators at USNA for more common, yet complex, wargames. Among these facilitators would be midshipmen, officers and civilians.

* Building the foundations of digital wargaming capabilities at USNA via equipment and software.

* Expanding programs and collaboration for wargaming across the Navy-education enterprise and with other service academies.

We hope to spawn discussion of this endeavor.

Location: TH342
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

65798 - Space Wargaming Analysis Tool (SWAT) Overview

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr Steven Toler		

Abstract: Wargaming, Map Exercises (MAPEXs), and Tabletop Exercises (TTXs) are important tools in an analyst's tool kit. The Space Wargaming Analysis Tool (SWAT) is is a quick scenario generation and execution model to provide high-level analysis that includes space-based concepts.

SWAT enables rapid and dynamic creation and execution of multiple platforms for wargaming courses of action. SWAT generates critical data that can be used to inform commanders and decision makers regarding space concepts, capabilities, concept of operations, and tactics, techniques and procedures in environments with and without space-based capabilities.

SWAT supports space, air and ground maneuver (red and blue) forces in a wargaming environment, while providing data collection and reduction in real time; allowing the user to get an understanding of the impacts of planned and injected events and platforms.

SWAT is not focused on system engineering of detailed operational analysis but for quick looks. SWAT trades off fidelity for ease of use. It is tailorable for future capabilities, without the need of full system definition to run. The 3D map gives commanders and leaders a unique understanding of the contributions, benefits and limitations of space - both red and blue.

Location: TH341
Classification: UNCLASSIFIED
Working Group: WG30 Wargaming

WG31 Operational Environments

65487 - Systems Thinking; A Force Multiplier of Analytics

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Michael Woudenberg; Mr. Carl J. Unis		

Abstract: No matter how advanced, how novel, or how tech-enabled, compartmentalized analytics cannot solve increasingly complex and emergent wicked problems. Join us as we explore the roots of systems thinking underpinning Operations Research through a combination of insatiable curiosity, humility, and an intentional reframing of the problem to ensure perspective. We'll demonstrate a simple, yet powerful framework we use to decompose problems based on the systems views of physical, logical, and persona applied to case studies on cyber, autonomy, and supply chain resilience.

Systems thinking is the force multiplier of analytics and when properly aligned provides the keys to innovation, wicked problem reduction, and complex systems solutions.

Location: TH376
Classification: UNCLASSIFIED
Working Group: WG31 Operational Environments

66715 - Understanding the Urban Operational Environment through Urban Morphometric Analysis

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Mr. Matthew Hiett

Abstract: Cities are intractably difficult places for military operations and the dense urban operational environment is arguably the most complex in which the U.S. Army will be called to operate. As a result of ongoing trends in population growth, urbanization, littoralization, and connectedness, the places where people live are becoming increasingly crowded, urbanized, coastal, and networked. Therefore, it is expected that future military operations will exhibit similar attributes, and as these trends continue, such operations are likely to become even more complex and challenging. Despite its complexity and significant challenges, the U.S. Army and Joint Services must be prepared to operate in dense urban terrain in the future.

Urban morphology is the study of urban form – of the physical/built "fabric" of cities and the people and processes that shape it. At a general level, all cities are composed of a set of elements: streets, street blocks, plots, and buildings. These constituent elements combine in varied and complex ways which often create identifiable tissue patterns that provide a way of understanding the character of a city or district. They also change over time and create a "palimpsest" in which previous urban forms can be "read" in the fabric of the current city though many features of the prior form may have been altered. Urban morphometrics is the quantitative analysis of urban form.

I use open data (Open Street Map) and open-source tools (the Python library Momepy) to quantify the physical form of representative urban core areas across the world. Using Momepy's analytical tools, I quantify morphometric characters encompassing dimensions, shapes, spatial distributions, density/intensity characteristics, diversity, connectivity, and plot-scale "morphological tessellation" cells. I then present comparisons of the metro areas via graphics and summary statistics of each morphometric character to observe whether the presence of 1) a river or 2) significant topographical features have any consistent impact on morphological urban tissue and in what manner physical geography might be used to make inferences about more complex urban characteristics.

This research is an early step toward using urban morphometric analysis to understand and predict components of urban operational environments. Such analysis is applicable across the operational spectrum including shaping missions, humanitarian assistance and disaster relief (HADR), the transition from deterrence to kinetic operations, and ultimately enabling civil authority. This and future work will provide an understanding of the operational environment that otherwise would require time-intensive and costly data procurement and analysis or even dangerous field operations. By identifying quantitative patterns and correlations in the data, this research aims to enhance military operations in dense urban terrain and contribute to the broader discussion on the evolving nature of warfare.

Location: TH376

Classification: UNCLASSIFIED Working Group: WG31 Operational Environments

66075 - Robotics for Engineer Operation (REO)

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Israel Josue Lopez-Toledo; Ahmet Soylemezoglu		
Abstract: The Robotics for Engineer Operations project is a Science and Technology (S&T) effort led by the U.S. Army Engineer Research and Development Center to provide increased survivability of U.S. Army Engineers by removing Soldiers out of high-risk operations and providing expanded capacity and capability to support Construction Engineering Operations. All capabilities will operate in undefined and uncontrolled environments without reliance on Global Navigation Satellite System (GNSS) positioning information. REO delivers standoff capabilities through Beyond Visual Line-of-Sight (BVLOS) teleoperation and semi-autonomous tool operations of commercial off-the-shelf heavy construction equipment, as well as Army Small Multipurpose Equipment Transport (S-MET) platforms. Both, the construction equipment and the S-MET platforms, are outfitted with a variety of sensor modalities, computational systems, and military-grade radios. This combination of equipment on the vehicles allows for standoff operations without the need for a well-established infrastructure. Additionally, REO delivers autonomous site characterization capabilities with mission planning and a task execution controller. The REO site characterization capability provides an Engineer specific 3D model and understanding of the environment through a multi-modal sensing approach to remotely characterize, identify, and semantically label site features using robotic and autonomous systems (RAS). A mission planner consolidates a priori information (such as satellite imagery), the detailed site model created by the site characterization platform, available assets/resources, and current mission requirements. The mission planner interface will be an interactive and semantic 3D environment allowing an operator to view and explore the area of interest. More specifically, this interface will be provided through the Android Tactical Assault Kit (ATAK), which is a program of record. REO will support the Army now with the previously described capacities and capabilities, but it has the potential to expand into other future areas like Civil Works such as disaster response, infrastructure construction, etc. Location: TH376 Classification: UNCLASSIFIED Working Group: WG31 Operational Environments		

65667 - Demography and Security in Saudi Arabia

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:30 PM
Authors: Dr. Brian Nichiporuk		
Abstract: Saudi Arabia is an important strategic partner of the US. Riyadh is a major global oil producer, a leading purchaser of US arms, a significant influencer of Sunni Muslim religious ideology around the world, and a large counterweight to Iran in the Persian Gulf region. One of the factors that will affect Saudi Arabia's future trajectory is demography. This presentation will seek to assess how demography will influence the security environment in and around Saudi Arabia. Specifically, this briefing will unfold in three parts. First, it will lay out the main demographic trends in Saudi Arabia today, including trends in areas like population growth rates, fertility rates, population age composition, tribal and sectarian composition, and migratory flows.		

Secondly, the briefing will present the main implications of these trends in terms of how Riyadh generates its military power, how it develops its military strategy, and what the major sources of conflict in and around Saudi Arabia are.

Third and finally, this briefing will conclude by laying out some preliminary policy recommendations as to how the US government can best protect American interests in the Persian Gulf region in light of Saudi demographic trends.

Location: TH376
Classification: UNCLASSIFIED
Working Group: WG31 Operational Environments

65681 - Numerical Weather Prediction Modeling for Decision Support at Smart Military Installations

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Hyeyon Yi Bastian; Mr. Brendon Hoch; Dr. Ifezue Obiako; Dr. Randy Buchanan; Dr. John Richards; Christina Rinaudo; Natalie Myers

Abstract: United States military installations serve as crucial logistical, command, and control hubs supporting the strategic needs of armed force planning, projection, and sustainment of operations globally. Severe weather events introduce uncertainty and may hinder the installations' capabilities of supporting the needs of warfighters and civilian personnel. Incorporating weather forecasting capabilities within their operational processes may support effective planning of daily installation operations. However, the resolution of standard weather forecast products is often unable to capture specific geographic and environmental factors influencing small-scale meteorological phenomena, which in turn introduces uncertainties potentially affecting mission-critical decisions.

This presentation introduces a numerical weather prediction (NWP) modeling framework as a component of decision support at smart military installations as well as share initial results for use cases at Fort Carson, Colorado and Fort Benning, Georgia. Due the climate differences between Fort Carson and Fort Benning, each installation presents differing meteorological concerns. Fort Carson weather challenges include snow and icy conditions during the winter months, while Fort Benning requires higher-fidelity forecasts for heat, wind, tornado, and thunderstorm conditions during summer months. The framework utilizes the open-source Weather Research and Forecasting (WRF) model to increase forecast fidelity through the usage of nested domains and implementing distinct parameterization configurations for representing sub-grid scale processes (i.e., cloud physics and radiative transfer) at each location of interest. The custom meteorological simulations will support systemic improvements to installation operations and procedures impacted by weather.

Location: TH376
Classification: UNCLASSIFIED
Working Group: WG31 Operational Environments

66070 - Accelerating in Germany as a Government Technical Integrator (GTI)

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Youssef Ashraf Abubaker

Abstract: The National Reconnaissance Office (NRO) has begun to position Government Technical Integrators (GTI) across the globe to provide analytical support to the different military theatres. GTIs are capable of rapidly creating and improving upon the tools intelligence professionals rely on to perform their daily ISR analysis gathering (e.g. THRESHER, BODHI, FADE). This presentation will focus

on the recent success of the first-ever GTI. The presentation will highlight the different customers and needs encountered in EUCOM, code that the GTI deployed in a big data environment to get NRO capabilities embedded into the Army and Air Force's workflows, and the substantial effort the NRO is undertaking to improve the user feedback loop in order to better deliver products to the warfighter.

Location: TH356 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG31 Operational Environments

WG32 Special Operations and Irregular Warfare

66206 - UPDATE: Information Warfare, Religious Messaging and the "Kremlin Playbook"

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Dr. Douglas A. Samuelson		
Abstract: Much communication and control have become increasingly driven by images, memes and social media messaging rather than policy statements. We review the recent CSIS updates on Kremlin economic information warfare and expansions into religious messaging and political campaigns and discuss how confusing and disruptive content was used. Statistics, Operations Research, and Machine Learning helped to develop targeting strategies and detect opponents' attempts to disrupt. We note how these methods have also used to disrupt defense and intelligence networks and misdirect lethal force, especially in the Ukraine conflict, and draw some lessons learned about how to increase national and international security. Location: TH378 Classification: UNCLASSIFIED Working Group: WG32 Special Operations and Irregular Warfare		

65679 - The Application of Alliances and Coalition Militaries from the American Perspective

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Mr. Corey Addison Shiver		
Abstract: Coalition warfare will be the future of how the United States will fight its future wars. In order to be successful in an operation, it is imperative for American military and political leaders to understand the importance of fighting alongside our allies effectively. America was born in war. From our nation's inception, we have built, fought, and led coalitions, and we must understand the successes and failures of these past operations in order to better prepare for any future conflicts. If we are to be successful in the future, we must not fight alone. In the words of General Fox Conner, "Never fight unless you have to. Never fight alone. Never fight for long." By effectively fighting alongside our allies, I argue that these three principles will be much more easily achieved. In this paper, I will create a guideline for future and current American military and political leaders on how to successfully establish and operate a coalition within an alliance. My foundation for this study will be set by multiple qualitative interviews with active duty and retired military members, from both America and other countries participating in an alliance and military coalition with America. I also will refer to primary texts, academic studies, and auto-biographies. Through these interviews and texts, this study will aim to benefit the education of future leaders on how coalitions should be established and operated, and will hopefully help cause stronger relationships between America and her allies. Location: TH378		

Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65600 - Sensemaking-Decision making (SM-DM) via a System's Thinking approach; Building the SOF system III thinker.

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Dr John Rand Black

Abstract: Today's asymmetric and VUCA world is, to some degree, synonymous with the SOF environment. SOF operators, analysts, support, and those supported deal with complex problems and complex situations, often occurring in volatile, uncertain, complex, and ambiguous societies in dynamically shifting landscapes. Yet, are we trained on how to understand and think about this changing reality?

Throughout the SOF profession, we have been rewarded based on outcomes and our ability to solve problems. But these problems were often linear in nature, predictable in their outcomes, and respond to a certain type of thinking. More recently, we've been introduced to thinking fast and thinking slow by Kahneman and the idea of type I & type II systems thinkers. But today's complexity requires additional perspectives and additional types of thinking.

This presentation is about what a type III systems thinker might look like. What would they possess in the way of skills and perspectives? How would they combine the best of type I and type II? What would their focus be in contrast to a solution-centric culture? How does a sensemaking-decision making (SM-DM) paradigm fit and assist us?

Dr. Black has studied these questions extensively and offers a glimpse into the evolution of thinking about a future systems III type thinker. Sensemaking, a systems thinking approach, and a change in focus to becoming understanding-centric in contrast to solution-centric is offered as a way ahead and a necessity. The SOF community recognizes the value of thinking. After all, the SOF truth that humans are more important than hardware is found in how we make sense of and act in this world. The SOF system III thinker lives and excels in the VUCA world.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65281 - Developing a Country-Level CBRN Readiness Metric

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr Joseph L Stallings, Jr

Abstract: The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to support plans and operations that counter development and exploitation of Weapons of Mass Destruction (WMD) and emerging threats. As Combatant Commands assess their Areas of Responsibility (AOR), it is important to understand where vulnerabilities exist. A Country-level CBRN Readiness Metric will enable Commands to visualize regions of the Command that may be less prepared for WMD, or WMD-like, events and to prioritize resources to improve readiness and reduce vulnerability.

The CBRN Readiness Metric develops information from about 100 indicators into several categories and then into 3 capability sectors; Recognize, React, and Recover, which ultimately contribute to the overall Readiness metric. The indicators that form the foundation of the metric are captured from open source data sets which enables collaboration with security partners to address country vulnerabilities. The discussion will introduce the data hierarchy and compilation methodology.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65757 - Developing a Southern Asia CBRN Decisional "Wind Sock" Tool and Methodology

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Colonel (Retired) Scott Henry

Abstract: The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to support decision-making, plans and operations that counter development and exploitation of Weapons of Mass Destruction (WMD) and emerging threats. As the INDOPACOM Combatant Command monitors and conducts regular assessments of their Southern Asia Area of Responsibility (AOR), it is important to understand where the potential operational and strategic vulnerabilities and opportunities exist. A Country-level CBRN decisional tool (aka the CBRN Wind Sock) and methodology will enhance the Command's ability to visualize this region of their AOR that may be less prepared for WMD, or WMD-like, events and to prioritize resources to improve readiness and reduce vulnerability.

The CBRN Decisional Tool (CBRN Wind Sock) is derived from information from numerous open-source data sets, indices and indicators, which ultimately orients to a vulnerability scale. The socio-economic and defense indicators that form the foundation of the "CBRN Wind Sock" are captured from diverse open-source data sets which enables collaboration with security partners to address country vulnerabilities. The discussion will include thoughts on the data hierarchy and compilation methodology along with potential emerging vulnerabilities and opportunities.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65450 - The Impossibility of Successful Western Counterinsurgency

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: William Buppert

Abstract: The recent departure from Afghanistan has certainly started some much-needed conversations on conducting irregular warfare by the western powers.

This presentation will make the firm case that despite the false triumphalism in the West in the past one hundred years, the track record for successful prosecution of counterinsurgency (COIN) [a sub-component of Irregular Warfare] conflict amounts to many more losses to even the paper-thin evidence of winning any victories. This project will confine itself to Western conflicts and not pretend to any authority in most Eastern attempts at COIN.

It will examine the reasons for this and the possible repercussions of ending the entire notion of tilting at COIN windmills that result in no value added for Western political capital or regional/national security.

Most fundamentally, I want to explain that Western beliefs about the processes of COIN and their efficacy have been manufactured out of whole cloth rather than based on the historical record.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65388 - Markov Model of Country-Level Nuclear Latency and Nuclear Weapons Capability

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Gabrielle LaRosa

Abstract: Nuclear latency – the ability to quickly proliferate without currently holding any nuclear weapons – is an important consideration for combatant commands as they plan to mitigate nuclear proliferation in their AOR. This is also an important consideration for the Defense Threat Reduction Agency (DTRA), as our mission is to deter strategic attacks against the United States and its allies, prevent, reduce, and counter WMD and emerging threats, and prevail against WMD-armed adversaries in crisis and conflict.

We consider a Markov chain to model country transitions between 3 states: (1) non-nuclear, (2) nuclear latent, and (3) nuclear capable. The transition probabilities are estimated as a function of both time and country-level covariates, such as access to fissile material, number of uranium enrichment/reprocessing facilities, number of enemy states, and economic/political stability.

From this Markov model, we can answer questions such as: What is the probability that a given country moves from non-nuclear to nuclear latency? On average, how long do we expect a given country to remain in the nuclear latent state before transitioning to nuclear weapon capability? What covariates are the strongest indicators of a country moving to nuclear latency and/or nuclear capability?

The model results will provide insight to combatant commands on where, and how, to prioritize resources when seeking to deter nuclear weapon proliferation in their AOR.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65451 - Prometheus' Gift: Decanting Smaller Conflicts from Larger Wars

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: William Buppert

Abstract: Campaign planning and analysis requires the examination of all the possible branches and sequels that emerge when war commences and wargaming requires the extrapolation of probable and possible excursion and departures from the plans for initial conflict.

This presentation will make the case to make the acceptance and examination of potential flashpoints and second and third order effects a necessary part of war planning.

It will examine the reasons for this, historical cases from the European conflicts from 1939-1950, the case study of the Iraq invasion of 2003 and the complete absence of necessary planning to tackle the post-conflict scenarios that emerge.

I will conclude by offering possible solution sets to ameliorate what has become a perennial operational shortfall in contemporary war planning.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65486 - Systems Thinking; A Force Multiplier of Analytics

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Michael Woudenberg; Mr. Carl J. Unis

Abstract: No matter how advanced, how novel, or how tech-enabled, compartmentalized analytics cannot solve increasingly complex and emergent wicked problems. Join us as we explore the roots of systems thinking underpinning Operations Research through a combination of insatiable curiosity, humility, and an intentional reframing of the problem to ensure perspective. We'll demonstrate a simple, yet powerful framework we use to decompose problems based on the systems views of physical, logical, and persona applied to case studies on cyber, autonomy, and supply chain resilience. Systems thinking is the force multiplier of analytics and when properly aligned provides the keys to innovation, wicked problem reduction, and complex systems solutions.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

65848 - General Agent Theory of Mind: Preliminary Investigations and Vision

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Prabhat Kumar

Abstract: A Theory of Mind (ToM) is a mental representation one agent has of another's emotion, desires, beliefs, and intentions formed through their interactions which help the agent predict the other's behaviors. In other words, a ToM is a mental map one individual forms of another individual; (a theory of ``their'' mind). The concept hails from work in cognitive science which addresses questions about the mechanism for inferring motivations behind human behavior. We aim to apply this concept to understand the degree to which we can impart ToM capabilities to artificial agents. We want to investigate whether it is possible for a machine to form a ToM of agents it observes and eventually make predictions of future agent behavior. While we do not aim to resolve the depths of human emotions, desires, and beliefs, we hope to first recreate a proof-of-concept from a recent machine learning application and later scale to more realistic and Army-relevant contexts.

In this paper, we lay a foundation for exploring machine learned ToM and summarize our preliminary findings and thoughts from initial literature reviews and developing the simulations, models, and

experimental tools. We briefly introduce ToM and a few early works before going into more recent studies involving modeling ToM and explorations with machine learning. We dive into how existing ideas will guide our explorations, including a few details about the technologies we plan to leverage. Phase 1 of our work involves recreating an existing ToM machine learning model; so we provide a few details about the work done in developing the data-generation/model-input pipeline, as well as commentary on the first model components we are recreating and how they may evolve through our explorations. We next go into ideas on scaling to investigate our model's performance in more realistic situations, and present a preliminary vision for our work. Finally, we conclude with summarizing the potential contributions that our work will make in artificial reasoning.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

66220 - The Enemy's Gate is Down – Counterintuitive Insights from the War on Terror

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Michael Woudenberg		

Abstract: Warfare in the 21st century presents new and dynamic problems that are difficult to solve with traditional perspectives or paradigms of analysis yet too often fall victim to common pitfalls where the answers expected are more technology, more complexity, and the drive to do something new or different. Operations research is the profession best positioned to answer these challenging questions due to the natural breadth of analysis disciplines it encompasses, the analytical tools it leverages, and the diversity of experience that analysts hold. Leveraging this core strength of operations research in the 21st Century requires stepping back and reframing the problem sets from different perspectives, applying lessons learned and established methods, and focusing on simplicity. This presentation will investigate a series of personal case studies the author has experienced in his career that demonstrate the power of reframing a problem. In this way, any operations research practitioner can arm themselves with analysis techniques and mindsets that challenge the established paradigm, narrative, or conceptualization of the problem and in doing so, identify elegant solutions to complex problems.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

67856 - Game Theory for Defense and Military Operations Past, Present, and Future

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Daniel O Rice		

Abstract: This presentation will address increasing adoption and use of game theory to model defense operations and decision-making. The use of game theory has exploded in a various disciplines including business, economics, computer science, human behavior modeling, and military operations just to name a few. In the upcoming era of strong general artificial intelligence (e.g., Chatbot-GBT), will usher in an age in which intelligent agents will reason, plan, and behave like humans. AI agents will strive to achieve their objectives by making decisions influence by the incentives that have been programmed into the systems (e.g., reward functions) and AI algorithms will most likely anticipate the decision-making of other AI agents and humans. This presentation will introduce how game theory

has been used to model defense/military decision-making to date by reviewing relevant publications. Additionally, we will discuss the evolution of game theory applications to defense/military operations in the future.

Location: TH378
Classification: UNCLASSIFIED
Working Group: WG32 Special Operations and Irregular Warfare

WG33 Social Science Methods and Applications

66324 - A Data Processing Pipeline for Socio-Technical Network Analysis

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr. Gabriel A. Weaver; Daniel A Eisenberg		

Abstract: With the rapid adoption of emerging technologies, there is a need to catalog and model sociotechnical interdependencies that have been historically used to influence the operation of Critical Infrastructure networks including the impacts of mergers and acquisitions, hostile takeovers, and foreign investment. Our research intends to address this need with two primary contributions. First, we have developed a data curation and processing pipeline to generate sociotechnical networks extracted from a variety of data sources including SEC filings and infrastructure asset databases. The pipeline, implemented in Apache Airflow, extracts and normalizes the representation of entities and relations, specified within ontologies. Our intent is to provide an extensible, machine-actionable approach to quickly communicate such models, reproduce previous results, and adapt them to new, unanticipated situations.

Second, networks produced by our pipeline enable the development of graph-theoretic metrics that consider the properties of network components in addition to its topology. Metadata associated with network components---whether semantic, temporal, or geospatial---affects the alignment of generated networks with assumptions underlying complexity metrics. Validation of generated networks relative to component types defined by an ontology, may allow the research community to adapt metrics to the semantics of the domains being studied. Generated networks may be processed as knowledge, dynamic, or spatial graphs and enables a variety of analyses including automated reasoning and measures of network complexity. Automated reasoning views extracted entities and relations as a knowledge graph; this enables application of inference rules that represent historically-attested adversarial business methods and applies that behavior to a specific geographic context. Measures of network complexity, including degree distribution, reachability analyses, temporal analysis, and community detection can be adapted to indicate adversarial organizational influence.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

65619 - Evaluating Writing Style Bias in Open Source Intelligence Analysis

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: MAJ Iain Cruickshank		

Abstract: Information Advantage has become a key component of future war fighting concepts. A critical first step in achieving Information Advantage is to understand the information environment. In

particular, there is a need to better understand source biases, especially from media sources, when collecting open source intelligence in support of achieving Information Advantage. Evaluating sources biases, especially at scale and independent of analyst biases is a difficult problem, however. For one, there are many ways in which media can be biased in their reporting. In this work, we focus on the concept of writing style bias. Writing style bias includes techniques like carefully selecting the words used in describing an event or framing certain events or persons in a particular fashion. To date, analyzing writing style bias in media texts remains a challenge due to the subtle ways in which word choice and framing can be manipulated to present a certain bias as well as the high amount of text reuse in the media ecosystem.
In our work, we present a new method based on text embeddings and network representations to analyze writing style bias between different articles and different media sources without any a priori knowledge of the bias existing in the articles and the article sources. Our proposed method first analyzes texts at the sentence-level for content reuse between articles using pre-trained transformer deep neural network models. We find near-duplicate sentence matches between articles based upon these sentence embeddings. From these matches, we then represent each article by mapping unique sentences to an alphabet so that each article becomes a string of characters, which both preserves the order of sentences within articles and explicitly represents the overlap between articles (i.e. articles share the same character for their matching sentences). Having produced article representations as a string of unique characters, we can then compute the similarity between articles using a number of known metrics, like the edit distance. With these similarities, we can then construct article-to-article and article source-to-article source networks that allow for analysis of the writing style bias.
With our proposed method we analyzed the websites shared in the politically charged conversation around military vaccine mandates. The analysis revealed distinct clusters of writing style bias present in the data, that vary by events and sub-topics within the broader military vaccine mandate reporting. We also find that commonly used bias labels, such as the overall bias of a media source typically reported in online bias and fact-checking sources, are only weakly correlated to the writing style bias present in its respective articles.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

65742 - Orchestrating Inspiration: A Framework for Enabling Better Decisions from Information Theory and Live Performance

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: SGM Denver D Dill; Brandon Michael Podojil

Abstract: In an era of abundant statistics, AI, and interactive dashboards, why do leaders and decision-makers still rely on their gut? To what end do performers move audiences to tears and cheers? We submit that the under-explored intersection between the performing arts and data analytics offers insights into shared commonalities between these endeavors. Having sifted through numerous examples to curate a select collection, we offer a ”Feel, Know, Do” framework to create exceptional experiences that inspire decision-makers to act.

We began this journey as an unlikely tag team of a military data analyst and a Juilliard-trained professional musician who shared a passion for understanding exceptional experiences. Undaunted by our disparate backgrounds we developed a shared approach, language, and

understanding grounded in the tenants of information theory. As we describe our journey, a framework begins to emerge. To this, we add the panache of performance, sharing insights garnered from live experiences, such as theme park design, comedy routines, magic arts, poker playing, and improvisational music. Studying world-class live experiences enables advisors to consider the psychosocial and environmental variables that enhance an experience and get decision-makers to ”yes.”

We all know that good analysis does not always win the day and that compelling arguments are rarely alone sufficient to shape decision-making. Humbly, we believe that others who share our passion for exceptional engagement - but have not yet charted our path, will feel empowered to build their own experiences. For analysts: to reach beyond their comfort zone and find their inner performer. For artists: to continue inspiring but toward the result of purposeful action. Drawing upon the best elements of extraordinary live experiences lights a path along the journey to ”Feel, Know, Do.”

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

65666 - Choose Your Own Adventure: A Flexible Geospatial Infrastructure and Contextual Engineering Assessment Framework for Decision Making

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Dr. Jessica Lyons; Ms. Rebekah Jackson; Elle Williams		

Abstract: DOD engineers and scientists are often asked to solve problems with unique and challenging factors in a restricted timeline. This project proposes a framework for decision making that combines weighted geospatial infrastructure maps with contextual engineering, a concept that creates a modality for the inclusion of societal and cultural factors into technological development. In the proposed framework, geospatial infrastructure map layers based on a weighted risk analysis are created for as many factors as needed, e.g. land cover, roadways, flood zones, air zones, etc. Using a weighted risk assessment for each factor, a multicriteria decision analysis composite map is created to visually identify areas that prioritize the identified mission objective – accessibility, resilience, etc. These weighted composite maps can assist in quick decision making that must take into account multiple factors, some of which may take priority over one another. This geospatial information is then framed within the sociocultural conditions of the region in order to contextualize the quantified geospatial data. This framework can be used to provide information to support planning operations and decision making for a variety of purposes, from providing recommendations for improving resilience and emergency management, to recommendations for site construction and route planning.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

66107 - Narrative Analytics: A Human-in-the-Loop Machine Learning Algorithm

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM
Authors: Nick V. Flor		

Abstract: There is a long history of behaviors by foreign adversaries using narratives to shape US population perceptions in directions that are counter to policy interests of the US and our allies. This ability has greatly increased with the widespread use of online news and social media. As discussed before the US Senate Select Committee on Intelligence, “the failure to detect and disrupt the … weaponization of online platforms against the United States and our allies is of great concern.”

The problem of extracting narratives from social media requires a shift in how we conceptualize narratives. A narrative is not a thing on social media that can be extracted, but rather a psychological construct that is created over time by adversaries deliberately pushing facts, factoids, disinformation, and misinformation—collectively “narrative elements”—on social media across an extended period. If successful, these narrative elements have the effect of framing our beliefs in ways that can compel mass action when triggered by news of an event.

As a narrative is a psychological construct that is constrained by social and cultural beliefs, it is difficult if not impossible for machine learning algorithms to reconstruct narratives from social media text alone. Expert human analysts are needed to reconstruct the narrative based on knowledge of social media posts, along with an in-depth understanding of social and cultural factors within the various subgroups that make up a targeted population.

To solve the problem of extracting narratives from social media platforms, Sandia National Laboratories developed a human-in-the-loop, machine learning algorithm for various department of defense customers. The algorithm uses a combination of statistical techniques from the social sciences, and computational methods, to extract narrative elements and to suggest groupings of narrative elements. An expert human analyst using our algorithm then refines the narratives and the groupings. We present the application of our narrative-extraction algorithm on a year’s worth of NATO-collected social media data on the Russia-Ukraine war. The findings show multiple narratives that would be missed by an expert-analyst unaided by our algorithm. We end by discussing the challenges of fully-automating narrative extraction using the latest deep-learning models.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

65697 - Demography and Security in Saudi Arabia

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Dr. Brian Nichiporuk		

Abstract: Saudi Arabia is an important strategic partner of the US. Riyadh is a major global oil producer, a leading purchaser of US arms, a significant influencer of Sunni Muslim religious ideology around the world, and a large counterweight to Iran in the Persian Gulf region. One of the factors that will affect Saudi Arabia's future trajectory is demography. This presentation will seek to assess how demography will influence the security environment in and around Saudi Arabia.

Specifically, this briefing will unfold in three parts. First, it will lay out the main demographic trends in Saudi Arabia today, including trends in areas like population growth rates, fertility rates, population age composition, tribal and sectarian composition, and migratory flows.

Secondly, the briefing will present the main implications of these trends in terms of how Riyadh generates its military power, how it develops its military strategy, and what the major sources of conflict in and around Saudi Arabia are.

Third and finally, this briefing will conclude by laying out some preliminary policy recommendations as to how the US government can best protect American interests in the Persian Gulf region in light of Saudi demographic trends.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

66010 - Strategic Influence: What it is, how to generate it, and measure it.

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr Pat Blannin

Abstract: The Indo-Pacific is undergoing significant strategic realignment. Strategic competition, military modernisation, technological disruption, the risk of state-on-state conflict and an increasing range of non-traditional security challenges are complicating Australia's strategic circumstances. This realignment demands the Australian Government revisit how it competes for influence through regional engagement. Whilst meeting the Department of Defence's (Defence) regional security objectives, Defence international engagement and Australian Defence Force (ADF) operations, actions and activities (OAA) with Australia's allies and other key partners must also complement whole-of-government efforts to influence favourably the Indo-Pacific.

The paper posits that in strategic competition, influence is a product of actualised power relative to a competitor in a particular context (country or target audience). Grounded on the premise that enhanced horizontal and vertical integration creates a robust, resilient yet agile system (anti-fragile), this paper presents a novel influence pathways framework. Through application of this framework, it can show how 'Influential' states effectively deploy their absolute national power potential (a portfolio of instruments-of-influence) along available pathways to modify the beliefs and behaviours of other actors. The paper demonstrates that a framework based on absolute, relative and comparative power is an appropriate decision support methodology to identify influence potential, and to plan, monitor and assess strategic influence.

Based upon the observations and findings from recent research this paper contributes to building a deeper understanding of the various aspects of strategic competition, strategic influence and whole-of-government integration. This research supports ongoing efforts to identify and implement adaptation mechanisms that enable Defence policy, strategy and force elements to manage strategic risk and assure strategic outcomes. The strategic influence framework discussed in this paper is a step towards a decision support methodology (technique and tools) that situates, contextualises and informs planning and evaluations of influence and information-based advantage gained through a strategy-driven influence campaign.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

64889 - The Social Return on Investment of Workplace Diversity, Equity, Inclusion, and Accessibility

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Matthew Griesbach

Abstract: Government workplace Diversity, Equity, Inclusion, and Accessibility (DEIA) initiatives promote diversity as a national strategic imperative and greater opportunities for historically underserved communities. While Executive Order 14035 seeks to innovate the government through increased employee engagement, more capabilities are needed to analyze, prioitize, and justify workforce investments. Monetizing government investment costs and benefits is a perrenial focus, but what about investment implications that cannot be readily translated into dollars? MITRE applies Social Return on Investment (SROI) principles to inform government workplace DEIA investment decisions. An Investment Value Management Framework (IVMF) compares DEIA solutions and identifies optimal solutions. The extensible framework offers performance management guidelines and includes an SROI model to estimate cost, benefit, uncertainty, and risk. The model translates metrics to benefits, and an early warning system manages lifecycle DEIA investment performance, comparing projected to actual SROI. IVMF calculations leverage historical DEIA costs from such sources as USASpending.gov and correlations of employee satisfaction and DEIA initiatives drawn from recent Office of Personnel Management (OPM) Federal Employee Viewpoint Survey (FEVS) data. Our presentation includes an IVMF demonstration, and a descriptive technical report is available upon request. The IVMF was built by economist, social-behavioral scientists, and data analysts.

Workforce diversity involves modifications in recruiting and hiring to ensure that the workforce composition more accurately reflects the variety of race, gender, and sexual orientation that exists within the population. Workplace inclusion involves actions to embrace the unique strengths and facets of identity for all individuals so that they feel welcomed, valued, and supported. Workplace equity refers to fairness of access, opportunity, and resources available to all employees. Agencies now seek ways to assess DEIA investment value and inform decisions regarding allocation planning, regulatory compliance, employee engagement, customer experience, and mission outcomes. While expected benefits of DEIA investment are significant, so too are the costs, risks, and uncertainties. While the White House indicates that costs of implementing President Biden's Executive Orders 13985 and 14035 will be too minimal for consideration, the list of on-going requirements for technology, process, and people would suggest otherwise.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

65460 - Forecasting Small Subgraph Events in Temporal Networks

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Matthew J. Hoffman

Abstract: We pursue forecasting of discrete events involving small subgraphs within a network, such as raiding parties by a clique of players in an online game. We search for hypothesized, plausibly causal relationships between data elements (e.g., prior player behaviors and future raiding party occurrences) and then build multilabel Bayesian Network (BN) classifiers by encoding those relationships in the BN structure. This approach enables forecasting on small/wide data through a fusion of weak indicators, and results in relatively interpretable models whose results can be explained using Bayesian calculations. Results to date are promising; we investigate further performance and/or scalability improvements via fusing models of multiple phenomena, data-driven BN structure augmentation, and more sophisticated problem/feature identification methods such as neural subgraph learning, two-mode generalized blockmodeling and persistent homological data encodings.

SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525.

Location: TH308
Classification: UNCLASSIFIED // FOUO
Working Group: WG33 Social Science Methods and Applications

66177 - Measuring transparency and trust in an airspace deconfliction engine

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dar-Wei Chen, Ph.D.; Craig Doescher

Abstract: Air Space Total Awareness for Rapid Tactical Execution (ASTARTE) is a collaborative effort between MITRE Corporation and Raytheon that aims to use AI-driven decision algorithms and sensor networks to provide warfighters with dynamically-updated 4D airspace pictures, the ability to anticipate and solve airspace conflicts, recommended courses of action (COAs) based on varying priorities (much like Google Maps can recommend routes based on speed or tolls), and situation awareness of adversary airspace. Deconflicted airspace will enable warfighters to safely, efficiently, and quickly conduct simultaneous long-range fire missions as well as operate manned and unmanned aircrafts within and between airspaces.

ASTARTE, as with any automation, will be most useful to warfighters when they can appropriately calibrate their trust in the technology. Accurate trust calibration by warfighters requires that the automation is transparent enough regarding its limitations and technical processes. Both over- and under-trusting of automation can lead to sub-optimal automation use and decision-making: Over-trusting automation can lead to warfighter complacency, which could cause operator skill degradation (e.g., because the operators do not sufficiently practice the automated tasks) and loss of situation awareness (e.g., operators might not pay close attention if they believe that the automation is perfect); under-trusting automation can lead to operators undertaking unnecessarily high workload and not fully utilizing the benefits of automation.

To maximize the effectiveness of ASTARTE, MITRE will be assessing operator trust and automation transparency during upcoming ASTARTE exercises. MITRE is proposing that the following topics be covered in these assessments:
> Degree of trust in the development of ASTARTE and its recommendations
> Degree to which ASTARTE performs like a similar technology would and fits well into the rest of your operations
> Clarity of ASTARTE's presentation of information
> Degree to which operators understand how ASTARTE produces recommendations and how to evaluate those recommendations
> Degree to which operators under- or over-trust ASTARTE

This presentation will provide a brief overview of the ASTARTE program, define trust and transparency in the context of ASTARTE and airspace deconfliction, propose survey questions that can be administered to operators for the purpose of measuring trust and transparency, and highlight potential avenues for future work on ASTARTE to improve operator trust and automation transparency.

Location: TH308

Classification: UNCLASSIFIED Working Group: WG33 Social Science Methods and Applications

66157 - Modeling Qualitative and Quantitative Data in Campaign Analysis Models: A Mixed-Methods Study

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Dr. Donald Williams, Jr.		
Abstract: This abstract describes an ongoing unclassified, three-phase, 12-month study that examines how to effectively model qualitative inputs in campaign analysis. The study explores the research question, “How can an operations research model best represent qualitative inputs in predominantly quantitative campaign analyses?” Qualitative inputs impact quantitative, campaign analysis because some inputs are force multipliers. Joint force doctrine, such as Joint Publication 1-0, Joint Publication 3-0, and the Joint Warfighting Concept introduce qualitative effects into campaigns, including diplomacy, strategic deterrence, risk calculation and mitigation, information operations, “perfect” command and control, signaling, and other government efforts that further military outcomes to achieve strategic objectives. However, it is unknown how military professionals account for specific qualitative actions and their effects because no model exists that draws relationships between tools with quantitative military outcomes and subjective, qualitative effects. This study has one of three phases complete. Phase one was the exploration of joint warfighting functions and identifying qualitative inputs into command and control, information, intelligence, fires, movement and maneuver, protection, and sustainment. The phase yielded a list of 302 qualitative inputs that related to joint warfighting functions. The researcher is using that list for phase two, which is ongoing, and involves finding ways that qualitative inputs relate to quantifiable outcomes. The researcher is using a combination of four qualitative methods to identify applicable relationships between quantitative and qualitative inputs: content analysis, narrative analysis, discourse analysis, and thematic analysis. Phase three is a list of relationships between quantitative military outcomes and qualitative inputs, as well as how operations research models may represent mixed-method data. This study is relevant to operations research because it potentially increases the confidence researchers place in campaign analysis. Models that include qualitative inputs allow analysts to account for all the contributions to joint warfighting functions, which conserves resources, and ultimately serves as force multipliers for planning and contingencies. This research is relevant to this year’s symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it integrates traditional operations research approaches with peer-reviewed, reputable qualitative data analysis. The presentation will include a detailed summary of phases one and two, as well as preliminary findings from phase three. The study will conclude in September 2023. Location: TH308 Classification: UNCLASSIFIED Working Group: WG33 Social Science Methods and Applications		

65875 - Using Computational Social Science Modeling to Assess the Effect of Information Warfare Behaviors on Populations and Governments

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Mr. Michael Lewis Bernard, PhD.; Nick V. Flor		
Abstract: Sandia National Laboratories is extending its geopolitical/sociocultural modeling and assessment capability, DYMATICA™, so that it can examine how current information warfare		

behaviors, such as hostile narratives coupled with disinformation, is likely to affect different population groups and ultimately governments. DYMATICA (Dynamic Multi-scale Assessment Tool for Integrated Cognitive-behavioral Actions) is a computational approach to help decision makers better understand and anticipate the decision calculus and likely responses of populations, groups, and governmental institutions to different situations and conditions. The intent of DYMATICA is to minimize the likelihood that different courses of action lead to undesirable consequences by providing a more systematic analysis of decisions within state and non-state entities. It uses a scientific and systems engineering approach to assess, among other topics, how different forms of communication affect the perceptions, motivations, and ultimately behaviors of people over time. To accomplish this, DYMATICA computationally instantiates the mathematics underlying empirically derived psychosocial theories reflecting the reality of interest. Here, the structure and process are based on a particular combination of well-established psychological, social, and economic theories of decision making as well as established techniques in knowledge elicitation, statistics, and system dynamics modeling. Data used to condition the model can originate from a large spectrum of sources including reports, surveys, observations, polling, social media postings, and website data such as from online news outlets. These data serve as cue inputs to the models to help strengthen, weaken, or modify the perceptions of the simulated entities regarding a given topic. These perceptions, in turn, affect represented motivations and behaviors of entities, which can affect the behaviors of other represented entities. This enables inputs such as current social media and polling data to affect associated modeled population and sub-population entity perceptions in a manner that is similar to social media influences currently being perceived within the actual information environment for a particular domain. For example, DYMATICA is being developed to ingest sentiment values associated with various daily social media trends along with online news and other data every 24 hours. This might include information that could affect a represented population's positive or negative sentiment towards their own government, other governments, or populations, or towards organizations such as NATO. In addition, various validation techniques are being used to determine and improve model accuracy, the efficacy of data inputs on model response, and intervention points with the greatest effect(s) on system results. This involves ongoing, collaborative assessment to ensure that the final product provides useful information for the desired application.

Location: TH308
Classification: UNCLASSIFIED // FOUO
Working Group: WG33 Social Science Methods and Applications

66211 - Using Natural Understanding to Characterize the Evolution of Cable News Bias

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Seth Benson; MAJ Iain Cruickshank

Abstract: In recent times, much has been written about the trend toward political polarization in the United States. This phenomenon describes the increasing prevalence of partisan divides at both the national and local levels of our government. Currently, the literature has heavily documented voting trends that point towards partisan polarization as well as congressional behavior and media consumption patterns. However, one limitation of the current literature is a lack of mathematical-based computational analysis of statements made by political actors. Additionally, while extensive mathematical research has been done discerning differing sentiments towards issues, the application of cross-subject bias models has been limited.
In our work, we present an application of developed Natural Language Understanding techniques to characterize the partisan bias in cable news. Sentiment analysis is performed on individual statements

made in cable news transcripts and statements are sorted by topics discussed within each transcript. This allows for an understanding of the varying sentiment different speakers have towards each topic within the transcript. Then, using the words associated with each topic, the similarity between topics in different transcripts is graphed. As a result, we are able to compare how different channels, programs, or speakers vary in sentiment towards topics and whether that sentiment changes over time. Speakers that are part of divided groups of sentiment across topics represent more partisan voices while speakers whose sentiment matches a varying group of other speakers depending on the topic likely hold less of a partisan bias.
The method presented in our work allows for a more versatile approach to characterizing bias than much of the previous work in the field. Because our method does not rely on controlling for the subject being discussed in the text studied, it can be easily applied to a broad range of political content. Additionally, as Information Advantage has become a key component of future war fighting concepts, versatile methods like the one we present are necessary to understand a broad and diverse information environment.

Location: TH308
Classification: UNCLASSIFIED
Working Group: WG33 Social Science Methods and Applications

WG34 Data Science and Analytics

66227 - The Risk Evaluation for Command Operating Networks (RECON) System

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Ashley Ulricson		
Abstract: The mission set of the United States Special Operations Command (USASOC) is to coordinate and support special operations forces domestically and internationally. One point of friction that the organization faces is assembling a concise collection of data that informs traveling soldiers of relevant and important factors pertaining to their destination. The Risk Evaluation for Command Operating Networks or RECON System collects open-source data, aggregates it, and then evaluates it to produce a risk assessment for commanders to interpret. The output will not just be tailored to that specific country but will also consider individual factors such as appearance, social media presence, and the security measures of the airport. The scope of the product will range from the moment a DoD member is informed of their travel plans, to the time they pass through customs. A list of threats that travelers will face will be created and depend on the country's ability to detect abnormalities in data signatures and their will to investigate these abnormalities. The compiled information will then be presented to the commander of the unit traveling overseas and allow them to make a more risk-informed decision. Location: TH348 Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

66016 - Using CNNs to detect munition manufacturing defects.

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: MAJ Thomas Frederick Mussmann		
Abstract: We use Convolutional Neural Networks (CNN) to identify defects in military manufacturing processes. We explore the concepts of transfer learning using the munition images the U.S.		

Armament center has provided for training with a goal of finding a process that can compare the munitions to MILSPEC requirements categorize defect munitions. We start with background subtraction using a recursive algorithm to identify areas that are not of interest. We then use the cleaned data and parameters transferred from a network built to identify welding defects to train the network to identify defects.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65445 - Using Machine Learning (ML) to Train Threat Kill-Chains Models for Warfighter Support (a.k.a. AIrborne GreMLin)

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. June Rodriguez; David Gohlich; Jeffrey Hay

Abstract: Critical asymmetric warfare questions often involve complex kill-webs for peer and near-peer adversaries that can be effectively captured through simulation. Running these simulations faster would enable a fuller options evaluation for the warfighter/planner. The objective of this study is to develop a repeatable process using Machine Learning (ML) models to replicate large scale kill-web simulations. The process will be developed through testing different classes of ML techniques on kill-webs using Integrated Threat Analysis and Simulation Environment (ITASE) as the simulation environment. The outcome is a framework for the Intelligence Community (IC) to identify advantages against integrated threats by running fast surrogate models that allow for real-time exploration of options. Using this blueprint, the IC will be able to rapidly create IC-informed, higher-fidelity, light weight models of threat kill-chains, allowing DoD planners to build threat kill-webs in hours instead of weeks/months. A full surrogate modeling and analysis capability will be transitioned to the government sponsor and used to support real-world military planning against adversarial threats. The use of the proposed framework will contribute to saving lives, saving time and money, and preparing the warfighter.

The vision of the study is to Improve military planning on adversary kill-web threats with authoritative threat models by developing a process to produce fast running and shareable models through machine learning. Our government sponsors have named this idea “AIrborne GreMLin”.

These models are built and run in the Defense Intelligence Agency’s (DIA) Integrated Threat Analysis and Simulation Environment, or ITASE. ITASE is the Intelligence Community’s M&S environment for supporting integrated forces analysis and is a common framework for the Intelligence Community to develop, test, validate, and conduct analysis with the authoritative threat representation (i.e., models, laydown, CONOPS, tactics, etc.) in an integrated system-of-systems context. Unlike many of the models in AFSIM, NGTS and other simulation frameworks, all ITASE models are verified and validated by the Intelligence Community both as individual threat systems and as an integrated kill-web.

This study involves developing a repeatable process for building machine learning models that capture the input-output relationships of pre-built IC models to generate light weight surrogate models that enable real-time exploration Critical to the effort is creating models that are not only useable by U.S. and allies/partner planners, but trusted, so that IC system level analysts have confidence that the metamodels faithfully represent the authoritative models in an integrated kill-web and planners can understand the expected threat kill-web response in a way that improves planning.

Location: TH357 Classified
Classification: SECRET//REL TO FVEY
Working Group: WG34 Data Science and Analytics

66063 - Double Crossed: Cross Organizational and Cross Domain Development of Readiness Analytical Applications in Advana

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Dr. John Richards; Mr. Blaine W Fulton; Jaylen Hopson; Mr. Jed Richards

Abstract: The United States Strategic Command (USSTRATCOM) Readiness Division's analytics team utilizes data pulled from the Defense Readiness Reporting System (DRRS) to inform decision makers on the readiness of the force. Previous research built a proof of concept application within the Air Force Visible, Accessible, Understandable, Linked and Trusted (VALUT) platform to generate analytic insights from DRRS data queries for key decision makers. However, recent changes in their analytical workflow to implement the Department of Defense Advana data analytics platform necessitated the transition the analytics process and products from VAULT to Advana.

This research, collaboratively conducted between the US Army Engineer Research and Development Center and the USSTRATCOM Readiness Division, is utilizing the CRoss Industry Standard Process for Data Mining (CRISP-DM) methodology to both transition the previously custom-built analytic products that utilize unstructured data to enable data-driven decision making as well as adding additional functionality to the analytic processes. The CRISP-DM methodology supports: 1) developing an understanding of the Advana data analytics environment; 2) understanding how the existing tools and methods can be transitioned to Advana and what, if any, limitations occur due to the transition; 3) identifying improvements to existing tools; and 4) developing new analytic software tools to support emerging use-cases.

This presentation provides an overview of the utilization of the CRISP-DM framework used for architecting the products for deployment and usability, challenges of integrating research and development across various data platforms and network classifications, and lessons learned from Advana novices in working in this data analytics platform.

Location: TH357 Classified
Classification: SECRET NOFORN
Working Group: WG34 Data Science and Analytics

66485 - An Interactive R Shiny Dashboard for Viewing Combat Hammer Weapons Data

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Joshua Rackham

Abstract: Combat Hammer is a crucial program that collects air-to-ground weapon performance data for war planners, program offices, and other stakeholders. Over the past 37 years, the 86 FWS has accumulated data for 8500 weapons worth upwards of $940M. However, until recently, the data was only accessible via static tables and individual email queries. To address this challenge, Combat Hammer analysts have developed an innovative R Shiny dashboard that provides a dynamic and user-friendly interface for interacting with the Combat Hammer database.

The CAF weapons dashboard allows users with SIPR Net access to filter and interact with the data by weapon, year(s), aircraft, target type, and Shot Kill compliance. Weapon-specific filters enable users to view WSEP data according to various test profiles evaluated by Combat Hammer. The dashboard

reports the total number of shots, a calculated CE 50/90 distance, weapon success rate, and the likelihood a weapon hits within a user-defined distance for the selected data. Additionally, a plot generates to show the cross range and down range impacts, enabling users to gain insights into weapon performance. Users can click on each point on the graph for additional data about the individual mission/weapon, and all the data can be downloaded to a CSV file. For analytically-minded stakeholders, statistical tests for circularity, correlation, and bias can also be viewed for the data.

The R Shiny dashboard offers greater transparency to the data informing CE 50/90 numbers that are posted in 3-1 Shot Kill and provides a user-friendly interface for WSEP data. Leveraging Air Combat Command's first interactive tool to visualize weapon accuracy, over three decades of weapons performance data is now downloadable at the click of a button. Furthermore, the dashboard allows for external stakeholders to share WSEP data and better collaborate, improves weapon accuracy/reliability knowledge, and increases robustness to 3-1 Shot Kill updates.

In conclusion, the Combat Hammer R Shiny dashboard is an innovative tool that provides a dynamic and user-friendly interface for interacting with WSEP data. The dashboard offers greater transparency to the data informing CE 50/90 numbers that are posted in 3-1 Shot Kill, and it enables users to gain insights into weapon performance. This presentation includes the technical aspects of developing the dashboard, the benefits of using R Shiny for data visualization and analysis, and the potential future applications of this tool. Additionally, there is a focus on how the dashboard enables stakeholders to access Combat Hammer weapons data easily and how it can be used to support enhanced mission planning. Lastly, this dashboard is a valuable addition to the Combat Hammer program and has the potential to improve weapon accuracy/reliability knowledge and mission outcomes.

Location: TH357 Classified
Classification: SECRET NOFORN
Working Group: WG34 Data Science and Analytics

66125 - Designing the Soft Recoil Cannon Artillery Armament System using Design of Experiment Techniques

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM
Authors: Ms. Sarah J. Longo; Melissa Jablonski; Katherine Murphy		

Abstract: This presentation will focus on the novel application of a design of experiments (DOE) approach applied to the design of a Cannon/Ammunition Interface which considers the relationships between the propelling charge system and the cannon system. The interdisciplinary design effort includes contributions from subject matter experts in statistics, propulsion charge design, gun design, computational physics, and experimentation. The methodology being employed incorporates data from several interior ballistic models ranging from lumped parameter to two phase-Lagrangian 2D. In parallel, additional data is being gathered through testing using a ballistic simulator (BSIM) and live firing. Several iterative loops in the design-analyze cycle have been completed, involving extensive planning and strategizing, identifying relevant design factors and their bounds, creating a design, simulating using models and/or testing in the BSIM, and analyzing the data. Each iteration has accomplished one or more of the following: diagnosing our models' stability, identifying where outliers exist, creating preliminary surrogate models, and generating factor importance rankings. These findings feed into refining the plan/ strategy of the next iteration. The result of the effort will be the creation of surrogate models for each output of interest that will be exercised to identify

optimum chamber designs for both existing propelling charge systems as well as propelling charges currently in development.

Location: TH348
Classification: UNCLASSIFIED // FOUO
Working Group: WG34 Data Science and Analytics

66719 - System Vulnerability Performance Data Recommendation System

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Spencer Potter; Ryan Barker

Abstract: The Modeling and Simulation Community (M&S) depends on the vulnerability data of materiel systems to accurately represent battlefield effects in models and simulations. The U.S. Army DEVCOM Analysis Center (DAC) provides standard vulnerability data to the M&S community. DAC's vulnerability file contains data for the probability of kill given a hit for an incoming munition against a ground target. In many cases, vulnerability data does not exist for certain specific interactions between munitions and targets. In order to represent these interactions, one common approach analysts take would be to use the closest or most similar dataset that we have on-hand. The process for choosing a suitable vulnerability dataset requires knowledge of what datasets already exist and for certain munitions against targets, the optimal selection is not always obvious.
DEVCOM DAC has developed a recommendation system using machine learning that produces the top recommendations for munitions and targets for a new munition and target pairing. There have been multiple models developed to tackle this problem including independent munition and target models along with a feed-forward model that takes the output from the target model and produces munition recommendations. These models take munition and target characteristics as inputs and output the top recommended munitions and targets to use as representatives. The models are decision trees that were developed in python leveraging common packages and libraries such as sklearn, pandas, and numpy. These recommendations will help guide analysts to decisions on choosing representative vulnerability datasets. This capability will increase the efficiency of data fulfillment process for new munition/target interactions as well as enable quality assurance practices for identifying data issues based on model outputs. This briefing will cover the work that has been completed along with future plans for additional work.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65956 - Integrating Modeling & Simulation, Design of Experiments, and Machine Learning to Advance the State-of-the-art in Artillery Munition Fuze Performance

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Sharise N Dantzler; Victoria Gerardi; Michael J Greco, Jr; Melissa Jablonski; Ms. Sarah J. Longo

Abstract: Insights leading to technological breakthroughs can be driven earlier in the systems engineering lifecycle through the use of 'digital engineering' enabling competencies. Data science and analytics methods were paired with computational systems modeling and simulation (M&S) to rapidly assess artillery fuze munition performance metrics relative to a variety of diverse target sets. This paper details a methodology to implement dynamic triggering to determine when a munition should

fragment against a target. Historically, static M&S studies have determined the “optimal” height of burst for a munition for all terminal conditions against any target. Improving upon this one-size-fits-all approach is the goal of this effort. With the evolution of munition technologies (guidance, sensors, fuzing), heights of burst that maximize effects on target can be realized. The Combat Capabilities Development Command - Armament Center (DEVCOM-AC) is proving this concept out. Using high fidelity physics-based models to represent lethal effects and simulating the model using systematic sampling by way of design of experiment techniques, a robust data set of lethality was built across several munitions, targets, and terminal conditions. The data set includes munitions and target sets relevant to the U.S. Army, Navy and Air Force reflecting the joint nature of this JEMTP-funded effort. Neural networks were then built using these large data sets to create a lethality surrogate model that can be used to determine the optimal height of burst for any engagement i using real-time data on-board smart munitions or input at time of firing for legacy munitions. The improvements to the baseline effectiveness are then measured and a level of improvement is captured, which demonstrated promising results. Future work will include collaborating with software engineers to deploy this methodology.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65593 - NAVSUP's Journey to Collaborative Self-Service Analytics

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Mr. Christopher David Ferrarini

Abstract: The fleet relies on working parts to fulfill its mission and stay ready across the world. The Naval Supply Systems Command (NAVSUP) manages billions of dollars' worth of wholesale parts for the fleet. During these uncertain times, never before has it been more important to make accurate decisions based on a plethora of data to ensure that the fleet quickly gets their orders fulfilled. As such, the pure magnitude of NAVSUP's supply chain necessitates a collaborative self-service technology stack for data and analytics.

Much of NAVSUP, let alone the Department of Defense, is full of analysts learning cutting-edge analytic tools and techniques in academia, only to enter the workforce and have access to a severely limited toolkit. Complex requirements for maintaining Navy Marine Corps Intranet (NMCI)-supplied Science and Technology (S&T) Developer computers are unsustainable, heavy reliance on IT support to engineer data & canned web-based analytic products reduces agility, limited North Star collaborative analytics creates stovepipes & increases the chance of duplicative/contradicting work, and limited publishing capability exists to share & consume analytic products. In addition, there are key capabilities that are required for an advanced Operations Research Analyst or Data Scientist in any organization to be successful: data engineering, data visualization, optimization, simulation, machine learning, and statistics.

For the past two years, NAVSUP's Lead Operations Research Analyst in its Business Process Analytics and Integration Division has conducted a gap analysis and shaped the requirements for an analytic architecture that will enable it to more agilely support the Navy. Heavy coordination and communication with NAVSUP's Information Technology (IT) arm have made significant strides possible, moving NAVSUP away from passing spreadsheets around and toward web-based self-service analytics. Having this architecture in place will enable the command to respond to initiatives faster

and increase data-driven decision making. One use case is on what to buy & repair into the Navy's wholesale system to increase readiness while preserving fiscal solvency of the Navy's Working Capital Fund (NWCF).

This presentation will illustrate an example of an analytic architecture, the initiatives underway to improve analytics, and the vision for the future. At the end of the presentation, a demo will be shown on how to engineer data inside of the Navy Data Platform (NDP) data warehouse, create a quick Tableau dashboard connected to it, publish this dashboard on Tableau Server, and consume the results of the dashboard...all within 10 minutes!

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66669 - Modeling Spectral Data using Functional Data Analysis

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: Dr. Thomas A. Donnelly

Abstract: Curves and spectra are fundamental to understanding many scientific and engineering applications. As a result, curves or spectral data are created by many types of analytical, test, and manufacturing equipment. When these data are used as part of a designed experiment or a machine learning application, most software requires the practitioner to extract “landmark” features from the data prior to modeling. This leads to models that are more difficult to interpret and are less accurate than models that treat spectral/curve data as first-class citizens.
This talk will present an overview of functional data analysis applied to spectral data. It will feature a case study showing a reanalysis of published NMR spectra for 231 blends of three alcohols - propanol, butanol, and pentanol. Small subsets of the full data set are modeled and used to predict either the spectra or the composition of blends not used in the analysis.
Functional data analysis was performed using wavelets as the basis functions to break the spectra into Shape Functions and Shape Weights (Functional Principal Components scores). A prediction profiler can now be used to predict spectral shape as functions of the shape weights and shape functions. Predicting as a function of the Shape Weights is difficult to use practically as the Shape Weights are not components in the mixture. However, by modeling the Shape Weights as functions of the proportions of the mixture components, a prediction profiler can be used to predict the shape of any blend of these three alcohols as confirmed using the checkpoint formulations.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65675 - Playing Clue in the Digital World: Attribution in the Information Dimension

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM

Authors: David Beskow; Elijah Bellamy

Abstract: Conducting a measured response to cyber or information attack is predicated on attribution. When these operations are conducted covertly or through proxies, uncertainty in attribution limits response options. To increase attribution certainty in the information dimension, the authors have developed a suite of supervised deep learning models that predict correlation between emerging

non-attributed narratives and historical overt national propaganda. These models are language agnostic and offer binary or multi-class options. These models can be integrated into existing data workflows to assist analysts in determining attribution in emerging narratives and information warfare campaigns.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66044 - A Transfer Learning Based Approach to Sentiment Analysis – Using Indonesian Bidirectional Encoding Representations from Transformers

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Connor Shaw

Abstract: This research presents a transfer learning based emotion classification model to be used on Indonesian Twitter data with the goal of understanding the attitude, motivations, and emotions of a population of interest. The vast quantity of self-disclosed information on social media makes building an emotion classification model extremely useful for a decision maker, especially if they may not speak the native language. Three variations of Indonesian Bidirectional Encoder Representations from Transformers (IndoBERT) are tested with hyperparameters tuned via a designed experiment. The top IndoBERT model, tested on an open source corpus of 4,403 labeled Indonesian Tweets, outperforms all known prior studies with an F1 score of approximately 0.791 for five emotion classes. Additionally, this research explores the relationship between training set size and model validity for fine tuning the transfer learning models; datasets ranging from 300 to 3900 observations are trained and then validated on five unique test sets. Results indicate that as few as 1000 observations can obtain results comparable to using the full training corpus. Finally, this research proposes a self-supervised approach using embedded emojis for sentiment labeling to alleviate the need for translation and labels. Initial results are encouraging, with an F1 score of 0.454 on a five-emotion dataset and 0.746 on a two-sentiment dataset.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66111 - Extracting Pricing Information from Raw Text Data with a Machine-Learning Pipeline

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dennis Robertson; Robert Murphy; Clark Van Lieshout

Abstract: Data-driven decisions are crucial to an effective cost negation process. Assessing if proposal costs are fair and reasonable relies on reference data sources, which may not have sufficient samples to form a persuasive position on proposed costs. In some cases, additional data is available, but difficult to incorporate into the cost analysis without substantial manual effort. The extraction of information in this way is an enabler to Digital Transformation efforts, driving improved efficiency and effectiveness.
In this work, an automated pipeline was built to process ten thousand GSA eLibrary multiple award schedule (MAS) documents. Over half a million labor categories (LCATs) and key cost-related details were extracted. Currently, less than 20% of this data is in an accessible, structured format within GSA

CALC. While the focus is on GSA MAS documents, this work serves as a case study for the potential of AI/ML-powered text extraction to reveal and structure data that is otherwise inaccessible.
Text extraction is particularly challenging for MAS documents as there is no set format or structure to the documents. Advanced techniques including named-entity recognition (NER) as well as other artificial intelligence/machine learning (AI/ML) techniques were applied to extract key information. Labor categories, minimum education requirements, minimum years of experience, and price were among the fields extracted from the documents.
The ensemble of models extracted 80% of available content, with an accuracy of about 90%. This automated process can potentially save GSA over ten thousand hours of manual extraction across ten thousand contracts. Additionally, these results enable tens of thousands of new LCATs (and their prices) to be extracted, and the number of samples for already structured LCATs was expanded. This larger sample size will yield cost analyses with higher statistical weight, even among already common LCATs.
These results represent a substantial increase in the amount of information compared to GSA CALC, providing a pathway to expand the publicly available pricing data. The techniques presented in this work can be applied to other Digital Transformation and data extraction efforts as well.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66199 - Adversarial Forecasting: A Bayesian decision theoretic approach

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Dr Tahir Ekin; Dr. William Nicholas Caballero; Roi Naveiro		
Abstract: Forecasting methods typically assume clean and legitimate data streams. However, adversaries may attempt to influence data and alter forecasts, which in turn may impact decisions. In order to improve defenses, it is crucial to consider the adversaries' goals, knowledge and capabilities; and the uncertainty therein. This manuscript presents the adversary's poisoning decision problem where he manipulates batch data inputted into forecasting methods. Proposed adversarial risk analysis based decision theoretic framework allows incomplete information and adversarial perturbations on the data inputs. In particular, adversarial auto-regressive and hidden Markov models are presented and demonstrated with examples. The findings show the vulnerability of forecasting models under adversarial perturbations. We also briefly discuss defender strategies that could improve forecast quality under attacks. Location: TH348 Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

65749 - Using the Person Event Data Environment to Understand Suicide Clusters

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Carrie Donoho		
Abstract: The Person-event Data Environment (PDE) which is a very large database containing longitudinal records of over 40 million government employees (both military and civilian), with statistical and visual display packages such as Stata, SAS, R Studio, MPlus, and Tableau. We give an overview of the PDE and present a project using the PDE to examine suicide contagion and suicide		

clustering using survival analysis, multilevel models, and marginal structural models. Specifically, we examine how battalion-level suicide exposure is associated with increased risk of suicide over the course of one's career, whether there is a dose-response relationship between exposure and outcome, as well as how long Soldiers are at risk after exposure to a suicide in their battalion. Findings suggest there is a strong association between exposure to suicide and subsequent deaths by suicide, and that there is a dose-response relationship between suicide exposure and subsequent suicide risk.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66051 - Extracting structured information from contract documents

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ryan Trottier; Ojustwin Naik

Abstract: Immense value can be gathered by having current and historical contract information available in digital form. This value comes in the form of aggregations, comparisons and various other analysis that can be performed at scale only if important contract elements are available in structured, or at least semi-structured form. These elements exist in the contract document in various formats: including fillable forms, line items, sections of text and more. While "structured" for human inspection these elements are not easily machine interpretable. Currently, an important transition is underway where this contract data is being digitalized and structured immediately upon contract creation. Adopting this approach is important, as it is perhaps the most reliable way to capture this type of data. However, this approach unfortunately fails to capture historical data, and even some portion current contract data which does not correctly upload data to the appropriate systems.

To remedy this, the DART team has developed various contract element extraction techniques to make available both current and historical contract data within the same data set. The common thread of these techniques is their dependence on the original contract .pdf document, not an external supplement or database. Even with a common .pdf source, the different layouts, formats, etc. of these disparate contract elements necessitate different tools and techniques for reliable extraction. In this presentation we will detail how various techniques from simple regex, to computer vision, and machine learning are used by the DART team's extraction pipelines to identify and extract various contract elements in a structured format amenable to analysis. We will demonstrate the benefits and pitfalls of instantiating these data pipelines in two different environments, including a high-performance computing (HPC) environment and in a cloud environment hosted on Amazon web services (AWS).

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66284 - Predicting MICAPs with Machine Learning

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Mr. Edgar James Scott, II

Abstract: The Air Force requires that all parts required for a weapon system to fulfill its mission to be tracked. A Mission Impaired Capability Awaiting Parts (MICAP) incident is recorded for a required

part when it is not available, resulting in that weapon system being incapable of fulfilling its mission. One way to sustain the readiness of the Air Force is to begin instituting predictive analytics to anticipate when parts may experience a MICAP incident, followed by a supply chain decision to eliminate an oncoming MICAP before it happens. The 418 SCMS/GUBB Data Sciences and Analysis Flight has created a Machine Learning (ML) model that predicts if a part is expected to MICAP within 30, 60, or 90 day periods based on historical data of parts that have become a MICAP. This ML model was built using python and depends upon the centralized data ingestion and management system that uses the open source software Pentaho for data ingestion and PostgreSQL for data management. Improvements to the model will soon identify the downstream affected parts of the parts predicted to MICAP utilizing part indenture data.

Location: TH344
Classification: UNCLASSIFIED // FOUO
Working Group: WG34 Data Science and Analytics

66092 - Integrated Nuclear Detonation Detection

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Tracy E.L. Light		

Abstract: The United States employs systems both in ground and in space for remote sensing in service of nuclear treaty monitoring. Traditionally, both the space- and ground-based systems assess data individually across sensing domains (e.g., radio frequency, optical, seismic, etc.), and rely heavily on subject matter expert interrogation of the data. Additionally, all domains generally use domain-specific waveform analysis to reject background events (for example, to discriminate an earthquake from an explosion). This talk will first describe a novel statistical method for rejecting lightning, a prevalent background signature in the space-based detection program. The talk will then outline a data fusion technique that can bring together all the space- and ground-based detection domains for joint analysis, despite a disparity in signal timescales that spans over six orders of magnitude. The intent is to design a processing pipeline that maximizes whole system (space + ground) sensitivity while lowering throughput of false alarms, and without requiring costly improvements to individual sensor technologies.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66714 - Modeling Information Fusion for Military Operational Planning and Decision Support Systems as a Neural Network

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Dr. Jeff Durst		

Abstract: Multi-domain Operations (MDO) are at the center of modern military operations planning. Military missions today require juggling a disparate set of systems and resources operating across complex environments. For example, even a simple resupply operation requires coordination and optimization across MDO assets and environments, including logistic supply points, vehicles, manpower, weather, and geography. It has become impossible for a team of human analysts to effectively process this amount of data and make fully-informed operational decisions. As a result,

mission planners are often tasked with making life-or-death decisions with limited options for timely data processing.

To be successful in MDO, military planners need new decision support system (DSS) algorithms capable of synthesizing these data into operational actions. These DSS need to fuse information from across MDO assets to make robust, data-driven decisions about operations, both in the planning and execution phases. Fortunately, modern machine learning and artificial intelligence techniques, and neural networks (NN) in particular, have brought about tools capable of processing and synthesizing massive amounts of data. Moreover, AI/ML algorithms can process these data much faster and more robustly than a human analyst. Military planners now need an Information Fusion (IF) framework capable of taking in MDO information, fusing it into human-interpretable results, and recommending optimal decisions.

Conceptually, a NN is a ML construct containing input nodes with associated weights, computational nodes, and an output layer. Each input is mapped through the computational network according to its weight, or importance, and ultimately combined with other nodes to form an output; similarly, IF is the combination of information from multiple disparate sources to provide a single output with less uncertainty than each individual information source.

The presented research proposes a new DSS for military operations by conceptualizing an IF framework as a NN. Data about each asset (vehicles, supplies, etc.) can be thought of as pieces of "information." At the same time, each source of information can be thought of as a neuron inside a neural network. The value of each neuron is its encoded information, and that piece of information's relevance to the mission is its associated weight within the network. Using this framework, each asset's "information" can be fused into operational decisions.

Using historical mission performance data, these decisions can then be optimized through training and backpropagation. In much the same way traditional ML uses backpropagation to compare expected and actual outputs and update neuron weights, here backpropagation can compare expected and actual mission success metrics and update the relative value of each information source. This framework will result in an optimized DSS that can be trained to support any given mission.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65405 - Assessing the Overlap between DoD Responsible AI Initiatives and the NIST AI Risk Management Framework

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Daniel Grahn		
Abstract: In January of 2023, the National Institute of Standards and Technology (NIST) released the first edition of the Artificial Intelligence (AI) Risk Management Framework (RMF) 1.0. Along with the associated resources, NIST AI RMF 1.0 represents the United States most focused engagement with the ethics and risks associated with AI within the civilian realm. Similarly, the Department of Defense (DoD) has been implementing it's Responsible AI (RAI) Strategy and Implementation (S&I) Pathway. While these efforts are uniquely tailored to their respective sectors, their intersection and difference		

offers valuable insight into how the US is approaching AI ethics. In this presentation, we provide an overview of each effort, a comparison between them, and an evaluation of their work. We maintain a clear focus on ways that the DoD can develop RAI alongside NIST and offer recommendations for successful implementation of RAI.

Location: TH348
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65520 - Topological Data Analysis for Condition-Based Maintenance

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Mr. Dean Lee		

Abstract: Condition-based maintenance (CBM+) is an important tool to help maintainers create action plans that optimize uptime and minimize cost. Moreover, modern military platforms are instrumented with sensors which collect data that can be leveraged by CBM+ algorithms to provide insights. To the best of our knowledge, however, existing CBM+ algorithms are developed with the presumption of the availability of high fidelity data. Our observation is that the data collected from modern military platforms are often sparse, event-driven time series data, which are characterized by non-uniform sampling frequency with large gaps between sampling events. In this presentation, we describe a novel topological data analysis-based method that extracts salient features from this class of data for machine learning. We demonstrate the effectiveness of this method for CBM+ by using real-world data.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65680 - Automated Scoring of Officer Evaluation Reports

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM
Authors: Thomas Malejko		

Abstract: In late 2021, Army senior leaders inquired as to the feasibility of using natural language processing and machine learning to reduce the manpower burden associated with the Army's Centralized Selection List Board. This time-consuming, annual process consists of a series of boards—which combined with the outputs from the Command Assessment Program—select high-quality individuals for command and key developmental positions at, or above, the battalion-level (organizations consisting of at least 500 soldiers, noncommissioned officers, and officers). While members of the Centralized Selection List Board consider a variety of information about each officer when generating the total board score, officer evaluation reports explain a large portion of final board scores. Consequently, developing an algorithm that effectively scores officer evaluation reports is fundamental to the creation of a broader algorithm that scores an officer's entire board file. This paper explores the development of a machine learning model that uses the officer evaluation report's rater block check, senior rater block check, and senior rater narrative to generate a score for each individual officer evaluation report. The most effective model developed uses a random forest algorithm, combined with bag-of-words featurization for the free text field, to score 96.0% of combat arms officer evaluation reports to within a half-point of the human-generated (career-manager-assigned) score and 99.5% to within a full point of that value.

Keywords: Machine learning (ML/AI), natural language processing (NLP), officer evaluation report (OER), centralized selection list (CSL), human resource management, Shapley values

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65583 - EloRater: Quantifying Subjective Peer Evaluations

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Ian Paul Kloo

Abstract: Peer evaluations are a critical component of personnel assessment, but the common methodologies used in military settings are often plagued with unproven collection modalities and indefensible math. This presentation will present an alternative method for peer evaluation based on a popular chess ranking metric: Elo scoring. The Elo method allows for improved data collection (pairwise comparisons) and mathematically sound quantitative results. This methodology was first presented at MORS in 2017 and has since been developed and tested in Special Operations training pipelines as well as USMA's summer training (CFT and CLDT). The presentation will provide an update on the refined methodology, demonstrate the (Government-off-the-shelf) application that was developed to implement it, and describe the roadmap for future research in this space.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65621 - Walter W. Hollis Award Research Project

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Luke Timothy Braun; Mary Bell; Thomas Lake; Chaney Lieberman; Ruganzu Mulisa; William Schreck; Matthew McClary; COL Ricardo O. Morales; COL Brandon Thompson

Abstract: The Center for Army Analysis (CAA) developed the Strategic Competition and Crisis (SC2) Wargame to address shortcomings in the U.S. Army's strategic planning during competition and crisis. This capstone enhanced the SC2 Wargame over the course of two years. Last year, the capstone developed a dynamic, perspective-based reputation model designed for integration into SC2. This year, the capstone integrated the model to produce a more efficient, objective-focused wargame that optimizes strategic learning for senior military leaders. Building off the work from the previous year, this capstone combined tools from the Systems Decision Process with the theoretical framework within the Defense and Strategic Studies Department to create and implement an improved product. Analysis of the original framework of the game uncovered three improvement areas that address each component of gameplay: strategy-focused player guidebooks, a realistic negotiations-pairing process, and real-time feedback through a Player Dashboard.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65503 - Natural Language Processing-Informed Identification of Person in the Water Search and Rescue (PIW-SAR) Case Summaries

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Dr Zachary Kudlak; Justin Paris Sherman		
Abstract: The Marine Information for Safety and Law Enforcement (MISLE) database system is used and managed by the United States Coast Guard (USCG) to store search and rescue (SAR) case after-action reports (hereafter referred to as summaries) as semi-structured text files. These summaries contain simple data fields for categorical and numeric information such as incident type and latitude/longitude position, but the summaries also contain abundant data in the form of narrative and other unpatterned strings (e.g., weather conditions). The USCG seeks to extract and leverage the data contained in these narratives and strings. A pipeline for converting the semi-structured SAR case summaries into tabular data was developed. Next, machine learning and natural language processing models were employed to classify and cluster messages according to content. Specifically, models were trained to identify text describing a living person (or persons) in the water (PIW); a deceased person(s) in the water; or a false alert. Clustering these documents will inform and improve understanding of the impact of environmental actors on PIW survivability. Location: TH344 Classification: UNCLASSIFIED Working Group: WG34 Data Science and Analytics		

66190 - Responsible AI for Predictive Maintenance: A Case Study in Delivering Trustworthy Component Failure Forecasts

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: CPT John T McCormick		
Abstract: Despite the promise of military analytics as a force multiplier, integrating AI/ML solutions at the tactical edge of logistics and maintenance operations remains a significant challenge. In addition to the technical process of developing and deploying performant AI/ML models, an established procedure for implementing these solutions in accordance with the DOD's Responsible AI (RAI) guidelines is sorely needed. We present a case study of building an RAI-based framework for delivering probabilistic forecasts of rotary-wing aircraft component failures to tactical maintenance managers in Army Aviation units. The proposed implementation was designed and deployed within a prototype predictive maintenance application, Griffin-Analytics, currently being tested by multiple Army Combat Aviation Brigades. User engagement directed our development away from traditional Reliability-Centered Maintenance tasks and towards predicting the conditional hazard of the next 100 flight hours, informing the selection of aircraft for specific missions and pre-emptive ordering of parts. This application called for deliberate RAI processes and techniques, given the requirement to generate and govern over a thousand survival models for all independent serialized components in the three primary rotary-wing aircraft. Model reliability was supported through both standard test and evaluation procedures as well as a technical review from outside the development team. Temporal and grouped cross validation was used to assess candidate models across time and military formations with dynamic AUC_ROC as the primary performance metric. The external technical review was primarily performed to validate the model training and selection for appropriate evaluation and correct interpretation, though the process additionally allowed for recommendations regarding modelling techniques		

In order to provide traceability, the delivery of predictions was augmented with procedurally generated model cards. These model cards were designed to explain the intended use of the predictions, elaborate on the data used for training, and provide clear descriptions of model performance in domain relevant language. Engagement with aviation maintainers and battalion staff provided additional evidence and feedback on the efficacy of these explanations.

Finally, we explored the organizational mechanisms necessary for promoting equity and governance of AI/ML systems. Specifically we examined the process for an external ethics review, the considerations for assessing and accepting risk associated with the AI deployment, and the application design necessary for effective communication channels with end-users.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

65461 - Forecasting Small Subgraph Events in Temporal Networks

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Mr. Matthew J. Hoffman		
Abstract: We pursue forecasting of discrete events involving small subgraphs within a network, such as raiding parties by a clique of players in an online game. We search for hypothesized, plausibly causal relationships between data elements (e.g., prior player behaviors and future raiding party occurrences) and then build multilabel Bayesian Network (BN) classifiers by encoding those relationships in the BN structure. This approach enables forecasting on small/wide data through a fusion of weak indicators, and results in relatively interpretable models whose results can be explained using Bayesian calculations. Results to date are promising; we investigate further performance and/or scalability improvements via fusing models of multiple phenomena, data-driven BN structure augmentation, and more sophisticated problem/feature identification methods such as neural subgraph learning, two-mode generalized blockmodeling and persistent homological data encodings. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525. Location: TH344 Classification: UNCLASSIFIED // FOUO Working Group: WG34 Data Science and Analytics		

66094 - No more bargaining in the dark: Data Rights Digitization

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Ojustwin Naik		
Abstract: To fully drive impact from digital transformation and AI, DoD programs need to identify, negotiate, and acquire rights to technical data across weapon system acquisition lifecycle. The Air Force is taking a DoD leadership role in building a foundational Intellectual Property Rights Data Repository that leverages Text Mining, Machine Learning, and Natural Language Processing. This collection of explicit data rights and implicit contract relationships is derived from 4.2 M contract documents. The resulting analysis of the data can then be used by Program Managers, Contracting		

Officers, Engineers, and Attorneys to efficiently acquire technical data. This presentation will focus on the evolution of methodology used to digitize and automate the analysis of data rights. This will include a description of the various types of data rights artifacts being captured, as well as the opportunities and challenges in building a relationship dense repository from unstructured data.

Location: TH344
Classification: UNCLASSIFIED
Working Group: WG34 Data Science and Analytics

66059 - Integrating Data Analytics in the Robotics and Autonomous Systems (RAS) Domain Space for Military Applications

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM

Authors: Mr. Titus Rice; Jaylen Hopson; George Edward Gallarno; Mr. Jed Richards; Dr. Ifezue Obiako; Robert Hilborn

Abstract: As Robotics and Autonomous Systems (RAS) technology evolves, the U.S. Army must develop innovative solutions ahead of its adversaries to maintain a competitive advantage globally. In order to achieve economical and resilient solutions within the novel and competitive domain of RAS, RAS systems require simulation to explore system behavior in a wide variety of complex environments and scenarios. The U.S. Army Engineer Research and Development Center (ERDC) supports the enhancement of existing RAS capabilities through the technological maturation of the U.S. Army Ground Vehicle Systems Center's (GVSC) Combat Vehicle Robotics (CoVeR) program. The CoVeR program seeks to reduce capability gaps in robotic and autonomous combat platforms. Thus, CoVeR Engineering Evaluation Test (EET) events are conducted annually in the field, to technically assess the software performance of all participating vendors' solutions. The ERDC has developed a capability, the Virtual Engineering Evaluation Test (EET), which seeks to replicate the semi-to-fully autonomous performance conducted during the physical EET events via a complex, software-in-the-loop (SIL) modeling and simulation (M&S) solution. Ideally, the performance of the virtual EET should match the performance of the EET, to the point where no differences can be observed in the quantitative data produced by each test. Over the past two years, this research has focused on three primary tasks to support enhancing RAS capabilities: (1) defining the SIL's M&S system requirements, (2) performing data analytics and metrics analysis on low-level, Robot Operating System (ROS) data output, and (3) replicating RAS performance from the physical EET events to provide predictive analytics to improve physical EET events. Researchers have developed code infrastructure using multiple programming languages to conduct both one-to-one comparisons and predictive analysis between the physical EET and the virtual EET. Moreover, regression models have been applied to this domain space using explanatory variables and response variables relevant to RAS for military applications. This presentation will include an overview of current and ongoing research, including potential future work.

Location: TH344
Classification: UNCLASSIFIED // FOUO
Working Group: WG34 Data Science and Analytics

WG35 AI and Autonomous Systems

65987 - Computation of Adversarial Manipulations Under Physical Access

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM

Authors: Austin Van Dellen
Abstract: Neural networks are notoriously susceptible to adversarial perturbations, where small changes to an input cause drastic changes to the network's predictions. Previous work on adversarial perturbations assume that an adversary can manipulate inputs to the network directly. We shift this assumption to one where the adversary can manipulate an ambient physical environment which is measured with a physical sensor and then passed to a neural network for analysis. This assumption on an adversary's access more realistically models the threat adversarial perturbations pose in many DoD applications. For concreteness, in this talk we focus on an application to autonomous sensing for passive sonar. We discuss how to construct adversarial perturbations in this new setting and their impact on the predictive ability of a neural network. We conclude by providing general recommendations for implementing machine learning models in DoD systems based on our experiments. Location: TH364 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems

66368 - The Dangers of Generative AI via Reification of Historical Conflict Strategies

Start Date: 6/13/2023	Start Time: 1:00 PM	End Time: 1:30 PM
Authors: Dr. Ruby Booth		
Abstract: The role of Large Language Models in future conflict is, as yet, uncertain. Possible roles in armed conflict for such technology range from presumed positives such as improved imaging or faster and more accurate missile launch detection to the presumed negative including deepfakes of world leaders and the much-reviled possibility of “killer robots,” so concerning to many in the public. In general, these projected roles focus the mechanisms by which Generative Artificial Intelligence (AI) will change existing conflict dynamics. Those concerned argue that Generative AI will impact strategic stability and conflict escalation. However, there exists an additional, underappreciated danger posed by use of these models. It arises from their potential to reify existing historical patterns on future conflicts. The promise of Generative AI is that these large language models will, in time, be able to create new insights, solving problems presented to them in novel, unscripted ways. However, like all AI, these models, no matter how sophisticated, arise from existing data sets. Specifically, they are trained and grow from vast data repositories for pre-existing information. From information the AI derives categories and constructs it uses to structure future insights and creations. Herein lies the danger. In the field of armed conflict, we are likely to train our Large Language Models on historical conflict data – real world examples that we have scoped and labeled, theoretical articles that express our biases and assumptions, cultural records that capture our perspectives in that historical, game theoretic models built with parameters we defined, etc. How, then, do we assess the AI that emerges? What test will allow us to distinguish between accurate insights from that AI versus insights that align with our expectations? This session will highlight a few areas of particular concern then move to an open discussion of how we might manage such potential impacts while still benefitting from these promising technologies. Audience participation is encouraged. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525 Location: TH366		

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66162 - Artificial Intelligence Algorithmic Requirements to Evaluate National Statecraft

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes an ongoing unclassified, 18-month experiment that examines how an artificial intelligence algorithm could describe the effectiveness of national statecraft instruments. Strategic competition is a relationship between two or more states in which one states seeks a competitive advantage over other states, hoping to maximize aspects of its national instruments of power and minimize those of its competitors. Assumptions between nation-states guide each other's use of their national instruments of power within strategic competition; that is, a state makes assumptions as it determines how it engages in statecraft. However, these assumptions result from the information a state has about another state. Governments may not have the required information to make informed assumptions that subsequently guide their statecraft. Once a state develops assumptions, it faces uncertainty about how its instruments of national power will demonstrate its resolve and deter a competing state or how its statecraft decisions will embolden its competitors. This study explores how artificial intelligence may assist a state in developing assumptions so that governments may effectively use statecraft to reach desired objectives and avoid strengthening the resolve of its competitors. This study's research problem addresses if strategically competing nation-states can use artificial intelligence technologies to develop better assumptions for statecraft decision-making, as well as the requirements for an operations research model that outputs the point at which strategic competition is counterproductive to a state's national interests. The study has two hypotheses:
Hypothesis 1: Competing nations could use artificial intelligence within operations research models to reduce uncertainty for statecraft deterrence decisions.
Hypothesis 2: Competing nations could use artificial intelligence to balance statecraft deterrence strategies that demonstrate resolve and avoid statecraft decisions that instead embolden competing nation-states.

The researcher will test the hypotheses with existing literature on strategic competition from the United States, Japan, and China. Further, the research will use four existing quantitative operations research models to explore the analytical gaps in modeling diplomatic, informational, military, and economic national statecraft efforts. The study will conclude in September 2024.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65907 - Explore Machine Learning for ISR Flight Path Planning

Start Date: 6/13/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Ms. Emily Conway; Mr. Huaining Cheng; Justin Morgan

Abstract: The current airborne ISR collection planning is optimized for the employment of limited number of large ISR platforms with respect to a set of collection targets created through an assembly line-like manual process. This process is often very cumbersome and time-consuming, hence lacking planning efficiency and operation optimality and agility. These problems could be amplified

significantly in potential future conflicts with a near-peer adversary because the complexity, scale, and intensity of an airborne ISR operation could be several orders higher.
This presentation discusses our new research on exploring multi-agent reinforcement learning (MARL) to create AI-enabled virtual agents in assisting mission planners to best manage a group of heterogeneous ISR assets for fulfillment of collection requirements. A new cooperative multi-player ISR flight path planning board game – Intellection – was developed to simulate the mission environment representing a large geographical area. Using Intellection, AI agents, representing different air platforms, can be trained with reinforcement learning methods to discover and fly the best routes over randomly distributed targets for maximizing successful collections over prioritized targets. The AI agents are required to follow game rules and constraints such as platforms' collection footprints and mechanisms, fuel capacities, varying launch sites, and altitude deconfliction. We tried out different reinforcement learning algorithms. Initially we implemented a basic Q-learning algorithm to get a preliminary analysis which reveals some undesirable behaviors learned by the agents. This was followed by experimenting with the multi-agent evolutionary reinforcement learning algorithm (MERL). It is a hybrid deep reinforcement learning algorithm using gradient-based optimizers to maximize individual agent rewards and a gradient-free optimizer to maximize the team reward through neuroevolution. Our preliminary results show that we can train multiple heterogenous agents to work together to develop an optimized flight path to collect more than the 80% target threshold of all targets on the board within a matter of seconds. This work demonstrates the potential benefits of AI agents in assisting complicated flight planning over many targets and relieving manpower bottleneck in fast-paced operations.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65379 - AI Agent and Environment Design for Combat Simulation

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: MAJ Marc Eskew; Dr Elisabeth Pate-Cornell

Abstract: This research combines Lanchester combat models and the latest advances in artificial intelligence and reinforcement learning to develop an agent which applies sound tactics in a combat scenario. The agents are designed for a discrete time combat simulation modeled as a Partially Observable Markov Game (POMG) where an environment of competing heterogenous forces are arrayed across configurable terrain. In this POMG, opposing decision making agents determine solution methods for all subordinate units per time step which allows for intelligent maneuver. The decision agent featured is an online planning agent developed from a Monte-Carlo Tree Search (MCTS) algorithm as well as multi-armed bandit learning to improve sampling across a large action space. With intelligent sampling of individual unit actions, the MCTS algorithm can effectively search potential future states while balancing exploration and exploitation. By combining well researched combat functions and modern AI decision making algorithms, efficient and flexible combat simulation can be applied to diverse operational scenarios to better understand potential conflict results.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66241 - Using Multi-Agent Reinforcement Learning to and Metaheuristic Optimization to Enhance Unmanned Aerial System Defense

Start Date: 6/13/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: James Jablonski		
Abstract: The war in Ukraine continues to demonstrate the growing importance of unmanned aerial systems (UAS) on current and future battlefields. This project focuses on training a reinforcement learning (RL) agent to control multiple enemy UAS in a combat simulation for optimizing the blue countering small unmanned aerial systems (CsUAS). The simulation includes both the enemy UAS, which will be trained using multi-agent RL, and the friendly defensive emplacements, which will be optimized through metaheuristic simulation optimization techniques. This adversarial approach will yield a deeper understanding of UAS tactics, and the defensive capabilities required to effectively counter them. The outcome of the simulation will provide valuable insights for the design and development of future CsUAS defense systems. Location: TH366 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

66239 - Augmenting Wargaming with AI Simulation: A Proof of Principle Study

Start Date: 6/13/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: MAJ Kurt Reynolds; Dr. Jefferey Appleget; LtCol Scotty Black; Dr. Christian Darken; LTC John R Morris; MAJ Brian T Pugh; Brian Wade		
Abstract: Analog wargaming and the adjudication of simulated combat scenarios are essential for military training and planning, but traditional methods can be time-consuming and lack real-time data for analysis. In this study, we present a proof of concept for using artificial intelligence (AI) and machine learning to augment wargaming and simulation efforts. Our team, made up of students and professors, developed and implemented a lightweight combat model known as Atlatl, incorporating basic agents to simulate multiple iterations of a battle in support of a larger analog campaign wargame. Atlatl is a Python and browser enabled framework for creating hex-based environments and agent simulations. It allows users to develop AI agents with different strategies, including aggressive, defensive, and passive-aggressive. The model also enables playing against basic agents or training custom agents with reinforcement learning (RL). The model provided data and visual playback for wargame umpires to interpret and provide feedback to players. The methodology included research, map creation, pre-packaging units, production runs of 100 replications per battle, and some light post processing to deliver the results to umpires. Improvements to the model included terrain effects, range restrictions, fog of war and a combat table for unit strength vs different types of defenders. Improved features result in a stronger force mix and more realistic behaviors in littoral battle simulations. The results demonstrate the potential for AI simulation to support wargaming in real-time and provide a foundation for further research. Ongoing work includes investigating and extending the use of hierarchical reinforcement learning to create intelligent agents capable of performing effectively in large scale and complex combat simulation environments. Location: TH364		

Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65446 - Cyber creative GAN for novel malicious packets

Start Date: 6/14/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: John Pavlik; dr. elie alhajjar; Dr. Nathaniel Bastian; Capt Marc Winczer Chale, PhD

Abstract: Machine learning (ML) requires both quantity and variety of examples in order to learn generalizable patterns. In cybersecurity, labeling network packets is a tedious and difficult task. This leads to insufficient labeled datasets of network packets for training ML-based Network Intrusion Detection Systems (NIDS) to detect malicious intrusions. Furthermore, benign network traffic and malicious cyber attacks are always evolving and changing, meaning that the existing datasets quickly become obsolete. We investigate generative ML modeling for network packet synthetic data generation/augmentation to improve NIDS detection of novel, but similar, cyber attacks by generating well-labeled synthetic network traffic. We develop a Cyber Creative Generative Adversarial Network (CCGAN) inspired by previous generative modeling to create new art styles from existing art images, which is trained on existing NIDS datasets in order to generate new synthetic network packets. The goal is to create network packets that appear malicious but from different distributions than the original cyber attack classes. We use those new synthetic malicious payloads to augment the training of a ML-based NIDS to evaluate whether it is better at correctly identifying whole classes of real malicious packets that were held-out during classifier training.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66143 - Designing an unmanned system to protect warfighters and civilians during WMD attacks

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Eva K. Lee

Abstract: During large-scale natural or intentional health security threats, rescue and emergency response operations and logistics, medical countermeasure dispensing, as well as supply and resupply of essential materials that sustain and save lives are often carried out under strained conditions and with limited resources. Damaged roads and dangerous terrain, with potentially hazardous contamination (chemical, biological, radiation plumes) greatly complicate emergency response capabilities.

Unmanned systems hold unique promise in transforming emergency response logistics and mass dispensing. UAVs can identify affected areas, examine the terrain and blocked paths, scout usable facility sites, explore transportation paths, and transmit critical on-the-ground information; while UGVs can traverse affected areas, perform critical on-the-ground logistics and carry out supply and resupply missions. They can deliver medical countermeasures to a much broader scope of demographics and landscapes more readily and safely than traditional human labor.

The crux of designing such a system involves determining the optimal deployment of fleets of unmanned vehicles (both aerial and ground) and system communication for effective response operations, mass dispensing logistics, and supply and resupply.

We describe a computational platform that can model unmanned aerial and ground fleets for effective emergency operations and supply/resupply in the face of uncertain road networks, conditions, and biological / radiological / chemical or hazardous conditions. The computational platform incorporates visualization, street networks, user-input location layout, mapping tools, and crowd-sourcing data. It enables users to explore a mix of autonomous, semi-autonomous, and interactive mode operations. The model will return optimal fleets, associated paths, communication protocols, and dynamic resource allocation plans. Recommendations can be re-computed on-the-fly to adapt to evolving situations. Most importantly, the system allows exploration of the scalability of fleets to determine requirements to effectively protect the affected population within a given time horizon. For a sustained operation, deep learning and machine learning can be applied to uncover patterns of on-the-ground events to predict evolving affected populations, associated demand, and required response resources.

This work is partially supported by a grant from the Department of Homeland Security.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66427 - Machine Learning and Network Management

Start Date: 6/14/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. Jayashree Harikumar; Dr. Oscar Antonio Perez

Abstract: DEVCOM Analysis Center (DAC) has built several collaborations with universities to analyze and develop methodologies and tools to assess systems that use Artificial Intelligence (AI) algorithms developed using Machine Learning (ML) techniques. One such effort is in intrusion and anomaly detection of AI enabled network systems. The current approach to detect intrusion and anomaly in AI-enabled network systems is done by analyzing the data used to train the network. This data is usually stored at a central logical location, the cloud, and consequently access to this data suffers from unacceptable latency, high communication overhead, and lack of consistent connectivity. A promising new approach, Federated Learning (FL), has been proposed in literature to address these challenges. While FL does largely address the above challenges its use of ML models makes it vulnerable to adversarial attacks, such as data/model poisoning and inference. If deceptive inputs are used for training local ML models or adversarial manipulation of the model weights are performed at the network devices, it becomes very difficult for the aggregator to identify such attacks both at node level and region level. Thus, it is critical that the FL framework used in the networking scenario be resilient to adversarial manipulation so that it can either adapt to thwart the attack or be robust enough to continue its operation despite the deceptive inputs. Working with the Universities, DAC is exploring (a) the use of FL to improve the network security by monitoring the network status to detect attacks and anomalies; and (b) an approach where systems on the network will share local ML model updates instead of training data with a central aggregator entity. In DAC's approach, at the aggregator entity level, the model parameters generated independently at the node/entity level are compared against those generated by co-located entities to identify entity compromise. At the same time, since no training data will be exchanged in the proposed FL framework, we provide a methodology to maintain data privacy for all the network devices and reduce load on the network.

Location: TH364

Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems

65633 - Applications of Deep Reinforcement Learning in Ballistic Missile Defense Scenarios

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Trey Wager; Christian Carrico; Dr. David Ellsworth; Mr Caleb Wesley Hayes; Randy Shirts; Shawn Oliver Sloan; Dr. Daniel Westfall		
Abstract: Current blue force configurations, concepts of operation, and tactics, techniques, and procedures rely on legacy wargaming and operations research methods for development and optimization. These methods are challenged to keep pace as the battlespace expands and adversaries' capabilities advance. As the number of decisions, options, and adversary actions increase, it becomes difficult for warfighters to observe, orient, decide, and act on a course of action without the use of computer aids. This research aims to deliver warfighter decision aids using deep reinforcement learning (DRL). Recent advances in DRL have created powerful agents capable of quickly making decisions with imperfect information and complicated scenarios. DeepMind's AlphaStar agent has been able best top professional players in the game of StarCraft II while OpenAI Five's agent can take down Dota 2 world champions. These examples demonstrate the capacity of a well-trained agent to surpass the abilities of expert level human players. At the most basic level, wargaming simulations are highly analogous to video games like these; however, video games simplify key components like well-defined observation and action spaces required for simple network architectures. In the warfighting domain, assets and threats constantly evolve and modify the environment necessitating the use of a context aware model. This work applies graph convolutional neural networks (GCNN) and deep reinforcement learning algorithms to Missile Defense System (MDS) scenarios. GCNNs are a novel network architecture that excels in learning complicated relationships between nodes in a graph. To leverage this architecture, the MDS (including multiple sensors, interceptors, and command and control systems) and threats are represented as nodes in a graph. Each node encodes features of the platforms like type, position, velocity, and inventory, and edges of the graph represent relationships like tracking, intercepting, and communicating. This representation allows the agent to ingest the evolving environment and understand the intricate relationships between various MDS assets and threats. This model can then be trained by common RL algorithms to optimize blue force behaviors and can inform the warfighter in real-time. Location: TH366 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

65509 - Levarging Machine Learning to Accelerate Aircraft-Store Compatibility Analysis

Start Date: 6/14/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Regan Bernstein; Alexandra Straub		
Abstract: The mission of the Air Force SEEK EAGLE Office (AFSEO) is to deliver war-winning capability by expanding the compatibility of state-of-the-art stores on current and future generation aircraft, and by providing accurate combat weapon delivery software. Within AFSEO there are 8 unique engineering disciplines, each responsible for preventing one mode of catastrophic failure during flight		

and deployment of weapons. Due to the range of aircraft and stores AFSEO analyzes, combined with the unique perspective of each engineering discipline, data exists in inconsistent formats and locations across the organization. Data artifacts are saved in inaccessible data silos, which prevents other disciples from accessing existing models, simulations, and other critical data types. This stove pipe approach leads to decreased productivity and longer processing times. The Advanced Analytics and Artificial Intelligence (AAAI) initiative within AFSEO aims to centralize and leverage 30+ years of flight test data to improve delivery of products to the warfighter through two AI driven workflows.
Workflow 1: Data Catalogue
Each of the 8 engineering disciplines within AFSEO generate and analyze a variety of documentation over the lifetime of a project. There is not a standard file storage system across the disciplines, resulting in lost productivity searching for needed documentation. To solve this problem, AFSEO is leveraging natural language processing for metadata extraction and tagging to surface key references and connections buried within the documentation. The data tagging shifts the soiled data to a flat data lake that allows engineers and analysts to search specified tags across entire file trees, providing access to historical documentation which may have gone unnoticed using traditional search techniques.
Workflow 2: Certification by Analogy
The By Analogy tool aims to expedite the weapon certification process by utilizing historical weapon data. Up to 50% of the work that comes to AFSEO is modifications to existing weapons and aircraft stores which requires limited retesting. This workflow is designed to automatically calculate weapon limits and identify the relevant historical reference material. This effort will culminate into an interface that will indicate, in which specific engineering disciplines a certification effort can be worked with minimal engineer involvement. If no testing or additional analysis is required, a first draft engineering rationale will be generated to support certification of a store. This workflow has the potential to decrease processing time from upwards of two days, to a few hours in analogy projects.

This initiative has a combined estimated time saving potential of 2,100 hours annually across AFSEO. Engineers and analysts will have more time to work products in the backlog increasing fielding capabilities.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65512 - Autonomous Aircraft Identification (AACID)

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Raymond Scott Starsman; Aisha Chun; LCDR Robert Routely; Robert Gresham; Bradford Lott		
Abstract: This study examines the performance of a one-shot learning approach to identify 41 different classes of military aircraft as well as identifies a data pipeline to include additional classes. The proposed Autonomous Aircraft Identification (AACID) method, capable of multi-object detection and near-real-time predictions for video feed, achieves 78% test accuracy across the 41 classes which include military aircraft commonly used by the United States, Russian, Ukrainian, and Chinese Armed Forces as well as numerous defense partners of those nations. The U.S. Department of Defense's ability to collect data exceeds its ability to analyze that data and convert it to actionable information. In addition to near-real-time predictions, we consider a scenario in which a Processing Exploitation and Dissemination (PED) analyst maintains a backlog of image and video files requiring analysis. AACID may assist the analyst in determining which files to review first by creating a “file-tag”		

including potential aircraft classes and quantities. This has the potential to improve intel product creation time. This work is a direct result of the Department of Defense Chief Digital and Artificial Intelligence Office's (CDAO) first-ever Create AI training program. All data used in this study is captured from publicly available sources.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66151 - Recurrent Neural Networks to Streamline Data Interoperability

Start Date: 6/14/2023	Start Time: 11:00 AM	End Time: 11:30 AM

Authors: Dr. Donald Williams, Jr.

Abstract: This abstract describes a 12-month study that explored the use of artificial intelligence (AI) recurrent neural networks (RNNs) to streamline data interoperability between operations research models. The research question is: "How could RNNs improve statistical analysis, recognize data compatibility changes, and/or modify data sets to improve data compatibility between models?" This research is relevant to operations research methodology in three ways. First, it addresses how RNNs are especially suited for optimizing linear and non-linear statistical models. Second, it explores how RNNs may recognize data incompatibility between models and inform the researcher of the effects of this incompatibility. Third, it examines how an RNN may correct data incompatibility between models by converting data types and maintaining accuracy during the data transformation process. A neural network algorithm assigns weight to inputs and produces output based on the comparative weights of its inputs. Researchers may use the technology to recognize and correct situations in which data is lost or misrepresented as different models use a single data set. An RNN is uniquely suited for this research because it is agile enough to accommodate a wide range of modern optimization tools. It understands the context of its calculations, making it particularly useful for streamlining data interoperability between operations research models. This study used an RNN to model the structural components of three quantitative research models. Findings showed that an RNN was insufficient to capture all the differences between operations research models, but an algorithm exists that may allow analysts to modify data sets to improve data compatibility between models.
This study is relevant to operations research because it potentially increases the confidence researchers place in operations research models. If tools exist to help analysts recognize the limitations and differences between research models, then analysts may use this knowledge to account for all the contributions to joint warfighting functions, which conserves resources, and ultimately serves as force multipliers for planning and contingencies. This research is relevant to this year's symposium because it explores an innovative approach to analysis in an under-researched area. Finally, it applies artificial intelligence research to an emerging operations research challenge. The presentation will include a detailed review of the study's hypotheses and findings.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65871 - Physics-Based Synthetic Training Dataset Generation for Artificial Intelligence & Machine Learning Algorithms

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Mr Garrett Holden
Abstract: For decades, the Army has been conducting research and development in Artificial Intelligence & Machine Learning (AI&ML) algorithms and Unmanned Ground Vehicles (UGVs). The Defense Information System Agency recently recognized the ability to leverage data which requires integration with these AI&ML technologies, enabling improved capability for the warfighter. To be useful, AI&ML algorithms must be reliable even when input data is noisy. This reliability is achieved through plentiful realistic training data which includes examples of data spanning all situations the algorithms would be called on to interrogate. Effective AI&ML training datasets can number from the tens to hundreds of thousands of training images which can require great effort to collect and annotate. This is where synthetic training data begins to show consequential results. Instead of waiting weeks or months for a specific dataset, the lead time for a fully annotated image dataset is reduced to hours. These datasets can be generated in varied environments and meteorological conditions to support the training of the algorithm(s). The Environment Sensor Engine within the Virtual Autonomous Navigation Environment tool suite (VANE::ESE) provides the ability to generate high-fidelity data with physics-based sensor models, enabling the generation of synthetic data that is quantitatively representative of real sensor data. These datasets can be used to augment real data to train AI&ML algorithms for autonomy, intelligence, and reconnaissance missions. VANE::ESE supports LIDAR and Camera sensors, including the physics-based sensor interaction with varying meteorological and atmospheric conditions. High entropy datasets can also be generated by leveraging VANE's Virtual Environment Generation Automation Scripts (VEGAS) to generate complex and varying environments utilized in VANE::ESE. Currently, VANE::ESE is being used to generate training datasets for AI&ML algorithms used for object classification and detection and unmanned ground vehicle localization. Leveraging the power of High Performance Computing (HPC), VANE::ESE is able to rapidly produce data with multiple dynamic target objects in digital twin environments. With the capabilities of VANE::ESE, a high entropy and physics based synthetic dataset can be generated to support the effective and rapid training of AI&ML algorithms. This presentation will cover the benefits of synthetic data, VANE::ESE's capabilities in its creation, and the current applications that the data produced by VANE:ESE is used in. Location: TH364 Classification: UNCLASSIFIED // FOUO Working Group: WG35 AI and Autonomous Systems

66078 - Weapons of Precise Destruction: a case study at the intersection of law, targeting operations, and AI

Start Date: 6/14/2023	Start Time: 11:30 AM	End Time: 12:00 PM
Authors: Mr. Harris Heit; Eric Jensen; Emma Lamberton; Hitoshi Nasu		
Abstract: Currently the co-authors/presenters are working on USAF funded research (SBIR) to develop an AI tool that supports the selection, validation, and execution of military targets. This case explores		

the frontier at the intersection of law, targeting operations, and advanced technologies like Artificial Intelligence (AI). Discussed will be the complexities that arise when the speed of innovation in the development of autonomous weapons and targeting tools outpaces the ability of Judge Advocates to evaluate military targets to ensure the legality of planed operations. Some in the U.S. Armed Forces are advocating for the implementation of AI to supplement the legal review process, which they claim is a necessity to provide the proper checks and balances to autonomous weapons, surveillance systems, and other AI decision aids used in combat. Just as the absence of AI presents an operational risk, so too does the implementation of AI. This study presents the countervailing interests of targeting stakeholders and the inherent risk associated with both the presence and absence of AI.
In an age where the battlespace changes dynamically and continually, where military and civilian populations are often intermixed, and where advances in autonomous weaponry are accelerating the speed and tempo of warfighting, comprehensive and timely legal reviews for targeting decisions are even more important. The use of AI has become increasingly prominent in the warzone, and has advanced productivity, weapons systems, strategic decision making, maneuverability, and targeting. While the Department of Defense (DoD) has prioritized artificial intelligence, AI has not yet been implemented to support the role of judge advocates in targeting decisions. Integration of Artificial Intelligence/Machine Learning models will make the targeting process more accurate and efficient. Judge advocates are integrated into the decision-making process at all levels, and act as a resource for commanders to make informed combat decisions. In the current process, judge advocates are often present as real-time information comes into the war room. Because of the time-sensitive nature of targeting decisions, judge advocates will increasingly have limited time to thoroughly review all the appropriate information necessary to inform his or her advice to the commander. AI can assist them by checking for unreliable surveillance, flawed intelligence, human error, and technological issues that have contributed to significant targeting errors that have recently resulted in unnecessary civilian casualties (Khan, 2021).By assisting in the development of AI tools that will assist the JAG in the targeting process, Air Force research, working with companies like Visimo, can facilitate both legal and policy compliance on the fast paced and legally intensive modern battlefield.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66103 - Adapting Machine Learning Classifier Models to Unknown Environments through Open World Learning

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Todd Morehouse, Jr.; Charles Montes; Ruolin Zhou		

Abstract: In Electronic Warfare (EW) environments are difficult to predict and constantly changing. Adversaries are constantly attempting to overcome systems. Machine Learning (ML) has been widely pursued to extend and improve the ability of military operations, however current models struggle to generalize when the environment changes. Models often rely on large datasets to include diverse scenarios; this requires designing an environment around predictable scenarios. When factors are not included during training, the model will often completely fail to generalize. The nature of ML enables a unique ability to adapt, by continually incorporating new information post-deployment, called lifelong learning. For supervised learning, this requires labelled data, which is uncommon to encounter in the open world. Thus, in order to learn in the open world, we must be able to first autonomously label data, and then learn on this new data. In this research, we show how a

combination of novelty detection and incremental learning can adapt machine learning models to new environments.

Our research focuses on wireless communications, and thus we apply adaptive ML to this domain. Wireless communications must contend with constantly changing environments, in both civilian and military applications. New technologies such as 5G and 6G encounter unique channel conditions, that change by physical location. In EW, adversaries constantly change tactics in order to subvert surveillance and detection. Monitoring the RF space to identify adversaries is a challenging but imperative task. We apply adaptive ML to identify changes in the RF environment and learn to overcome them. The primary example we use is an adaptive automatic modulation classifier (AMC), where we introduce new classes and data sources in the field, post training. These new samples represent a change of environment, and adversaries changing tactics, which are not included in initial model development. Ordinarily, a model would fail when encountering them. Adaptive ML allows the AMC model to autonomously overcome these changes and continue to function in the field. We demonstrate our system over-the-air using software defined radio (SDR), which allows us to create changing real-world wireless environments that the model can adapt to.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65406 - Assessing the Overlap between DoD Responsible AI Initiatives and the NIST AI Risk Management Framework

Start Date: 6/14/2023	Start Time: 1:30 PM	End Time: 2:00 PM
Authors: Daniel Grahn		
Abstract: In January of 2023, the National Institute of Standards and Technology (NIST) released the first edition of the Artificial Intelligence (AI) Risk Management Framework (RMF) 1.0. Along with the associated resources, NIST AI RMF 1.0 represents the United States most focused engagement with the ethics and risks associated with AI within the civilian realm. Similarly, the Department of Defense (DoD) has been implementing it's Responsible AI (RAI) Strategy and Implementation (S&I) Pathway. While these efforts are uniquely tailored to their respective sectors, their intersection and difference offers valuable insight into how the US is approaching AI ethics. In this presentation, we provide an overview of each effort, a comparison between them, and an evaluation of their work. We maintain a clear focus on ways that the DoD can develop RAI alongside NIST and offer recommendations for successful implementation of RAI. Location: TH364 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

66113 - Simulation Experimentation of Swarms: Methodologies and Analyses

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Melissa Jablonski; Dr. Ross Arnold; CDT Shawn Mather; CDT Kayla Jones; Jonathan Jablonski; Michael McBride; Dr. Elizabeth Mezzacappa		
Abstract: Collections of autonomously behaving systems, or swarms, are predicted to be an important component of the US DoD strategy. Therefore, research into how to create swarms with suitable		

characteristics, behaviors, and function for these different purposes is in the interest of the US military. However, there are challenges in swarm research, including technical limitations of existing hardware, the need to address both individual drone level behavior as well as the complexities of the entire swarm behavior, and the sheer number of parameters that may be relevant to swarm performance in operations.
This presentation proposes methodologies for the computer simulation research and analyses for experimentation on swarm behavior. The work is a result of a collaboration between USMA Cadets and DEVCOM Armament Center. Swarm performance data from computer simulation experimentations using simulation software were analyzed through multiple steps to investigate how individual and entire swarm characteristics might affect how well the swarm performed a mission. The DroneLab Unmanned Aircraft System software used the operational scenario of rendering humanitarian aid after a natural disaster (e.g., earthquake, tsunami). The task for the drone swarm in the DroneLab simulation experiment was to locate survivors who were situated throughout the 2 X 2 km terrain. Inputs were both individual drone characteristics (i.e., types of search behaviors) and entire swarm characteristics (i.e., number of drones in the swarm, communication range, proportion of drones performing type of search behaviors). Output from the software included location of drones, inter-drone communication events, survivors found, and time to complete the mission, defined as locating 90% of the survivors. Data were from 2000 unique swarm configurations which were run with 10 repetitions.
Several methods were used to analyze the data output by the simulation. Each drone's location throughout the mission were graphed; this was used to gain an overall pattern of the swarm behavior. Visualization greatly aided identification of bugs in the programming. Next, computer design of experiments was used to examine the relationship of swarm parameters to performance, and to identify the best and worst performing configurations of swarms. Communication networks that emerged within the swarm were identified using social network analyses software. Social network parameters that described, for example, the densities of interconnections among the individual drone were derived. Then the best and worst configurations were compared on these social network parameters. Analyses are ongoing; however, these preliminary analyses identified characteristics of the well performing swarms versus poorly performing swarms. More importantly, the work demonstrates a general approach to experimentation for developmental engineering and optimization of swarms.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65690 - Verification, Validation, Assurance, and Trust of Machine Learning Models and Data for Safety Critical Application in Armament Systems

Start Date: 6/14/2023	Start Time: 2:00 PM	End Time: 2:30 PM
Authors: Jon Vigil; Mikel D Petty; Shane N Hall, PhD		
Abstract: As the use of machine learning (ML) models proliferates in commercial and defense applications, the United States Army (Army) faces significant challenges in evaluating the effectiveness, robustness, and safety of these ML models in armament systems. Relying on ML-informed recommendations and decisions in these systems requires very high confidence that any resultant behaviors will fall within intended operational and mission bounds. Ensuring reliable and safe behaviors involves both ensuring accurate and comprehensive data is used in the creation and training of these ML systems and that the ML models are robust, accurate, and appropriately		

behaviorally bounded when employed using real data in military operations. ML models come in many forms, and the technologies used to create them are rapidly evolving, and hence, the Army needs 1) a process and framework to assess and measure the quality of training data and identify shortcomings that may lead to poorly trained ML models, and 2) a process and tools for ML model exploration that can assure confidence of model behavior within defined data boundaries and can also identify unintended or poor behavior in ML models if they exist. This presentation outlines the existing literature on the metrics and measures used to verify and validate (V&V) ML training data and models and describes the process, framework, and tools to analyze these metrics and measures. Results that demonstrate these metrics, measures, framework, and tools are provided for an open-source classification ML model and an autonomous vehicle reinforcement learning (RL) model. This comprehensive methodology for ML training set and model V&V is meant to provide additional assurance and trust in Army ML systems and help determine the readiness for more formal operational test and evaluation (OT&E) of the Army armament systems that employ ML models.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66098 - MAST as a principled design framework for Trustworthy AI: Case Studies in Automated Face Verification and Document Summarization

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Michelle (Mickey) Mancenido; Dr. Erin Chiou; Myke C. Cohen		
Abstract: The Multi-AI Scorecard Table (MAST) was originally developed for assessing the potential of existing AI-embedded systems to comply with hypothesized determinants of trustworthiness and social responsibility. In this paper, we propose the utility of MAST as a holistic design framework (MAST-D) for trustworthy AI through the design, test, and evaluation of two mock AI-enabled systems. We describe a top-down, systems engineering approach that proceeds by determining customer requirements, translating those requirements to engineering features, and finally, mapping those features to MAST-compliant technical specifications. By following the MAST-D framework, it will be shown through empirical test data that MAST-designed AI systems are generally perceived to be more trustworthy, beneficial, and less risky compared to systems that were not purposely designed using MAST. This presentation would be of interest and significance to members of the MORS community who are involved in the conceptualization-development-TEVV-monitoring life cycle of AI-embedded systems. Location: TH364 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems		

66110 - Unsupervised SNR Estimation Using Prototype-Based Multi-Stage Deep Neural Network

Start Date: 6/14/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Charles Montes; Todd Morehouse, Jr.; Ruolin Zhou		
Abstract: This paper presents a novel unsupervised learning approach for signal to noise ratio (SNR) estimation combined with supervised modulation classification. Unsupervised learning consists of training a network while the input data labels are not provided. Previous work has shown that knowing the SNR or being within some range of SNR improves performance when performing		

modulation classification by using multiple networks trained separately. Existing methods are either supervised or have very specific requirements of a dataset that might not be possible to obtain in the implementation environment. Current modulation classification methods perform poorly at low or negative SNR values which previous works have shown is due to the difference in frames' SNR. Our proposed method is a frame-level SNR estimator which uses a custom prototype-based objective function that is minimized using a regression deep neural network. The estimator network partitions a dataset by estimating SNR ranges and each range is trained on a separate network for modulation classification. We explore multiple splits of a correlation-matrix-based method to evaluate the separability of the SNR and use analytical correlation of the dataset to determine an upper bound and feasibility of multi-network approaches. The performance of our method is evaluated using mean absolute error (MAE) on two datasets: DeepSig RadioML2016 and DeepSig RadioML2018, which consist of multiple modulation types and SNR values. Results show the ability to effectively estimate and separate multiple SNR ranges in a dataset.

Location: TH366
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66130 - Formal Verification of Autonomous Ground Robots Learning from Human Demonstrations

Start Date: 6/15/2023	Start Time: 8:30 AM	End Time: 9:00 AM

Authors: Christian Ellis

Abstract: Rather than wait to the test and evaluation stage of a given system to evaluate safety, this talk proposes a technique which explicitly considers safety constraints during the learning process while providing probabilistic guarantees on performance subject to the operational environment's stochasticity. We provide evidence that such an approach result in an overall safer system than their non-explicit counterparts in the context of wheeled robotic ground systems learning autonomous waypoint navigation from human demonstrations. Specifically, inverse reinforcement learning (IRL) provides a means by which humans can demonstrate desired behaviors for autonomous systems to learn environmental rewards (or inversely costs). The proposed presentation addresses two limitations of existing IRL techniques. First, previous algorithms require an excessive amount of data due to the information asymmetry between the expert and the learner. When a demonstrator avoids a state, it is not clear if it was because the state is sub-optimal or dangerous. The proposed talk explains how safety can be explicitly incorporated in IRL by using task specifications defined using linear temporal logic. Referred to as side information, this approach enables autonomous ground robots to avoid dangerous states both during training, and evaluation. Second, previous IRL techniques make the often unrealistic assumption that the agent has access to full information about the environment. We remove this assumption by developing an algorithm for IRL in partially observable Markov decision processes (POMDPs) which induces state uncertainty. The developed algorithm reduces the information asymmetry while increasing the data efficiency by incorporating task specifications expressed in temporal logic into IRL. The intrinsic nonconvexity of the underlying problem is managed in a scalable manner through a sequential linear programming scheme that guarantees local converge. In a series of examples, including experiments in a high-fidelity Unity simulator, we demonstrate that even with a limited amount of data and POMDPs with tens of thousands of states, our algorithm learns reward functions and policies that satisfy the safety specifications while inducing similar behavior to the expert by leveraging the provided side information.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65942 - Planning, Execution, and Analysis of Soldier Operational Experiments

Start Date: 6/15/2023	Start Time: 9:00 AM	End Time: 9:30 AM

Authors: Avery Nevling

Abstract: The Research and Analysis Center (TRAC) was the evaluation lead for the Next Generation Combat Vehicle (NGCV) Phase I Soldier Operational Experiment (SOE) conducted at Fort Carson, CO, in 2020, and the Human Machine Teaming (HMT) Phase II SOE held at Fort Hood, TX, in 2022. TRAC worked in conjunction with stakeholders of the Robotic Combat Vehicle (RCV) community (Ground Vehicle Systems Center, Army Test and Evaluation Command, Army Research Laboratory, Combat Capabilities Development Command (DEVCOM) Analysis Center, and NGCV Cross-Functional Team) to develop and implement plans associated with data collection, experiment execution, and analysis to inform operational and technical learning objectives. Data was collected through event observations, facilitation of after action reports (AAR), and digital data collection. The knowledge gained during these experiments has refined the Army's understanding of the HMT concept and how it could be applied within a reconnaissance and surveillance mission set. Soldier feedback captured during the events provided information on required capabilities, technical improvements, and possible tactics, techniques, and procedures (TTP) for use of HMT in accomplishing missions.
This presentation will cover specific data collection methods used during the experiment; processes and tools developed to capture and analyze the data; and general lessons learned from a data collection perspective. Additionally, the presentation will highlight the overall data collection methodology to include discussion of data sources and their associated limitations. A follow-on effort that aims to refine speech-to-text and natural language processing of AAR recordings so that these analysis techniques can be more efficiently leveraged in future events will also be discussed.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65518 - Estimating Impact of Vegetation Density on Ground Vehicle Autonomy Performance Using M&S

Start Date: 6/15/2023	Start Time: 9:30 AM	End Time: 10:00 AM

Authors: Dr. John Gabriel Monroe

Abstract: Modeling and simulation (M&S) tools play an important role in developing autonomous ground vehicles (AGVs). Physics-based, high-fidelity M&S tools enable software-in-the-loop (SIL) simulations where an autonomous algorithm processes synthetic sensor feeds and sends steering commands to a validated platform model as if it were controlling an actual vehicle in the real world. This capability sheds light on how the autonomy will react to various conditions or situations that might be too difficult (e.g., various weather conditions), dangerous (e.g., complex urban environments), or time-consuming (e.g., repeated cross-country missions) to test physically. Augmenting physical testing with simulations that explore edge-case behavior results in more robust autonomy and a better understanding of its capabilities or limitations. To support the development and evaluation of ground vehicle autonomy, the US Army Engineer Research and Development Center (ERDC) has developed the Virtual Autonomous Navigation Environment (VANE). VANE is a suite of

government-owned M&S tools that enable the analysis of environmental effects on autonomous vehicle systems, from the sensors and algorithm perception to the tire-soil interactions and the platform's mobility. As part of ERDC's ongoing Virtual Engineering Evaluation Tests (VEETs), the present study uses VANE to analyze the performance of an autonomy algorithm against parametrized vegetation density, grass height, road shape, etc., in virtual "challenge arenas." This presentation will outline the generation of the challenge arenas, the autonomy performance criteria, and the results of the VANE SIL simulations.

Location: TH364
Classification: UNCLASSIFIED // FOUO
Working Group: WG35 AI and Autonomous Systems

66236 - Large Language Models for Enhanced Analytics in Army Domains

Start Date: 6/15/2023	Start Time: 10:30 AM	End Time: 11:00 AM
Authors: Daniel Ruiz		

Abstract: This presentation advocates for the integration of large language models (LLMs) into the daily workflows of the Army analytical community. We argue it is crucial for the Army to adopt and fine-tune open source LLMs to maintain a technological edge over our adversaries investing in similar capabilities. We provide a brief overview of recent advancements in LLM development, offer a technical description of their functionality and architecture, and highlight the need for creating our own foundational language models that better understand military terminology. We then emphasize our utilization of open-source LLMs during Project Convergence 2022, demonstrating how they can be used to improve the efficiency of quick-turn analysis and knowledge discovery, even on classified networks. We conclude by brainstorming a future where Army analysts use specialized LLMs for everything from code writing to intelligence extraction, and describe the key milestones that need to be achieved to reach this vision.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65399 - Dispatches from the Field - Unique AI/ML System Engineering Challenges for DoD Deployments

Start Date: 6/15/2023	Start Time: 11:00 AM	End Time: 11:30 AM
Authors: Shannon Ellsworth		

Abstract: 2023 MORS Presentation: Dispatches from the Field – Unique AI/ML System Engineering Challenges for DoD Deployments by Shannon Ellsworth

If Artificial Intelligence and Machine Learning (AI/ML) are such exciting and emerging technologies, why aren't they fielded all over the defense department? One significant reason is the gap that exists between AI research and the system engineering expertise required to successfully and safely field AI. This system engineering work is complicated, tedious, unexciting, and therefore quite neglected but it must be addressed to improve the transition rate of AI to the field.

This presentation will discuss the importance of taking time to understand the system engineering challenges facing engineers as they push to transition prototypes of AI to the DoD field including

Education and Expectation Level Setting of Algorithm Capabilities, Requirements Development Challenges, Hardware Challenges, Challenges with User Trust in AI/ML Technology, User System Training and Maintenance Challenges, Training Data Challenges, Algorithm Fragility and establishing appropriate System Level Controls, Visualization Challenges, and Challenges with Developing Viable Success Metrics.

The hope is by sharing and discussing these challenges, the AI/ML community can begin to bridge the system engineering gap so more AI/ML research can move from the academic and lab spaces to the field when it can help the operators who need it.

Shannon Ellsworth is a Senior Principal Systems Engineer at Raytheon Missiles and Defense in Woburn, MA, who also co-chairs MORS Working Group (#35), "AI and Autonomous Systems. She will be completing her master's degree in Systems Engineering with a Focus on Applied AI from Worcester Polytechnic Institute (WPI) in June 2023. She also has a bachelor's degree in mechanical engineering and applied computer science from the University of Vermont. She has over 20 years' experience in architecting and fielding solutions with particular emphasis on multi-domain C4ISR.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65590 - War Elephants: Rethinking Combat AI and Human Oversight

Start Date: 6/15/2023	Start Time: 11:30 AM	End Time: 12:00 PM

Authors: Dr. Philip Gregory Feldman

Abstract: This presentation will explore the changes that AI is having on the nature of combat. We will first look at the current practice where AI substitutes for the human for most tasks, and the human provides a final check or veto. We show that this approach is brittle and tends to expose weaknesses of both AI and humans. We then explore an alternative approach where complementary human and machine abilities are blended. Using the historical example of War Elephants, used as a type of lethal autonomous weapons system for thousands of years, as well as more recent examples from the conflict in Ukraine, we show how autonomous weapons systems can be more effectively managed by specially trained AI Operators.

The AI Operators are responsible for watching over the AI system, and detecting when the AI fails to behave in accordance with the warfighter's intent. By blending the human capacity for social thought, context changing, and creativity with the AI's speed and precision, the AI operators can quickly and efficiently detect anomalies in the AI's behavior. When a potential problem appears, the AI operators can intervene in the system and take corrective action. The AI operators must be trained to recognize when the AI system is making decisions that are not in line with the warfighter's intent and understand how to intervene.

Next, we will discuss the need for diverse model ensembles and the training and equipping of AI Operators. We will discuss how these proposed human/machine teams will possess the capability to act outside of the domain that they were developed and trained for.

We discuss a path to achieve machine-speed/machine-scale combat where the AI is operated by diverse Operator teams that watch for patterns of behavior to assess the system's performance. This approach enables the development of combat systems that are inherently ethical, operate at machine

speed, and are capable of responding to a broader range of dynamic battlefield conditions than any AI system could achieve on its own.

In accordance with the recommendations of the National Security Commission on Artificial Intelligence, we conclude that a human-centered approach, in which the strengths of both humans and AI are balanced, ensures that AI models are always used in accordance with the principles of international humanitarian law, and that ethical behavior is an enhancement of performance, not a hindrance.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

66074 - Robotics for Engineer Operation (REO)

Start Date: 6/15/2023	Start Time: 1:30 PM	End Time: 2:00 PM

Authors: Israel Josue Lopez-Toledo; Ahmet Soylemezoglu

Abstract: The Robotics for Engineer Operations project is a Science and Technology (S&T) effort led by the U.S. Army Engineer Research and Development Center to provide increased survivability of U.S. Army Engineers by removing Soldiers out of high-risk operations and providing expanded capacity and capability to support Construction Engineering Operations. All capabilities will operate in undefined and uncontrolled environments without reliance on Global Navigation Satellite System (GNSS) positioning information. REO delivers standoff capabilities through Beyond Visual Line-of-Sight (BVLOS) teleoperation and semi-autonomous tool operations of commercial off-the-shelf heavy construction equipment, as well as Army Small Multipurpose Equipment Transport (S-MET) platforms. Both, the construction equipment and the S-MET platforms, are outfitted with a variety of sensor modalities, computational systems, and military-grade radios. This combination of equipment on the vehicles allows for standoff operations without the need for a well-established infrastructure. Additionally, REO delivers autonomous site characterization capabilities with mission planning and a task execution controller. The REO site characterization capability provides an Engineer specific 3D model and understanding of the environment through a multi-modal sensing approach to remotely characterize, identify, and semantically label site features using robotic and autonomous systems (RAS). A mission planner consolidates a priori information (such as satellite imagery), the detailed site model created by the site characterization platform, available assets/resources, and current mission requirements. The mission planner interface will be an interactive and semantic 3D environment allowing an operator to view and explore the area of interest. More specifically, this interface will be provided through the Android Tactical Assault Kit (ATAK), which is a program of record. REO will support the Army now with the previously described capacities and capabilities, but it has the potential to expand into other future areas like Civil Works such as disaster response, infrastructure construction, etc.

Location: TH364
Classification: UNCLASSIFIED
Working Group: WG35 AI and Autonomous Systems

65745 - A Saliency Map is Worth 1000 Words

Start Date: 6/15/2023	Start Time: 2:00 PM	End Time: 2:30 PM

Authors: Christine Krueger
Abstract: In February of 2020, the Department of Defense established the DoD AI Ethical Principles as a means to standardize how AI is assessed and deployed. One of these principles, that AI must be governable, specifically articulates that AI capabilities must possess the “ability to detect and avoid unintended consequences”. Given, the wide range of AI applications in DoD, the impact of these unintended consequences could, in some cases, be catastrophic. Therefore, during the acquisition process of new AI models, decision makers must be able to understand the potential failure modes of the models they are evaluating. The challenge is that the field currently does not communicate this information in such a way that decision maker without high levels of AI literacy can quickly comprehend. Rather, descriptions of model performance are most often given in its rate of accuracy, precision, and or recall. Our work seeks to determine whether there are visualizations that when provided to a layman improves their comprehension of the model’s behavior. To do this we are conducting a series of experiments that pit visualizations of the results of several image classifiers against each other to allow us to study the difference between their effectiveness. Ultimately, this work seeks to be part of a foundation for the standardization of how model effectiveness and behavior is communicated to decision-makers. Location: TH364 Classification: UNCLASSIFIED Working Group: WG35 AI and Autonomous Systems

65928 - Modeling Real-Time LiDAR Performance During Adverse Weather

Start Date: 6/15/2023	Start Time: 2:30 PM	End Time: 3:00 PM
Authors: Lowranche Garnett Phillips		
Abstract: Many autonomous vehicles rely heavily on Light Detection and Ranging (LiDAR) for obstacle perception and avoidance. This ability deteriorates during adverse weather such as rain, snowfall, and fog. Designing, developing, and evaluating autonomy algorithms to handle challenging adverse conditions is difficult due to limitations in replicating these environments. Naturally occurring weather is difficult to replicate in the laboratory, and field studies must be planned around fleeting ambient conditions. The U.S. Army Corps of Engineers Research and Development Center (ERDC) has developed a modeling and simulation tool to overcome these obstacles. ERDC’s Virtual Autonomous Navigation Environment (VANE) applies a variety of high-fidelity physics-based weather effects including rain, fog, and snowfall and enables interaction with a real-time LiDAR sensor simulation. This technique provides a low-cost and low-risk path to early insights into inclement weather effects on autonomy performance before committing equipment and personnel to field testing. Location: TH364 Classification: UNCLASSIFIED // FOUO Working Group: WG35 AI and Autonomous Systems		