89th MORS Symposium: "Analytics to Enhance Decision Making"

21 - 25 June 2021 - Virtual

Contents

Demo

56986 - JMP 16® Software for Data Visualization, Exploration and Discovery

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 4:50 PM ET
Authors: Dr. Thomas A. Donnelly		

Abstract: This is the 32nd 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 16. 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 new in JMP 15 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.

Classification: UNCLASSIFIED
Working Group:Demo

56689 - MLOps

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 5:00 PM ET
Authors: Joseph Troy Morgan; Sam Goldstein		

Abstract: DataRobot MLOps. Your Center of Excellence for Production AI. One place to deploy, maintain, and govern all your production models, regardless of how they were created and where they are deployed.

The market has matured to a point that machine learning models have to start showing and proving value by monitoring for performance and accuracy in order to eliminate business risk. The path to realizing this value is achieved by implementing a scalable solution to manage production machine learning.

Classification: UNCLASSIFIED
Working Group:Demo

57109 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 4:30 PM ET
Authors: Dr. Benjamin G. Thengvall; Dr. Michael Deskevich; Shane N Hall, PhD		

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), BMD I-Sim (Ballistic Missile Defense International Simulation, KIDD (Kinetic Impact Debris Distribution Model), G6, and a number of other custom 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 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.

Classification: UNCLASSIFIED
Working Group:Demo

56936 - Cloud Native Data Analytics: Speed, Capability, Scale

Start Date: 6/22/2021	Start Time: 4:30 PM ET	End Time: 5:30 PM ET
Authors: Chad Cravens		

Abstract: Cloud-native is the next frontier for highly scalable data management and analytics. Due to the rapid advancement of this emerging field, there is often confusion of what it means to be "cloud-native" and how these emerging technologies can be leveraged to accelerate decision making. Open source technologies, such as Kubernetes, serve as the foundation for much of the cloud-native concepts such as distributed storage, software-defined networks, multi-tenancy, zero trust security models, and distributed service meshes. These technologies work in concert to deliver a seamless experience to analysts and decision-makers and provide virtually unlimited compute, storage, and analytics capabilities at speeds not seen before. However, this often requires highly skilled engineers to work in a rapidly evolving ecosystem to develop and maintain the various components, which can be very expensive and time-consuming to successfully stand up and manage.

The Cloud Native Compute Foundation (CNCF) is an emerging open source ecosystem of hundreds of technologies with an estimated market cap of $15T and funding of over $15B (https://landscape.cncf.io/). Open Source Systems (OSSYS) specializes in this open source ecosystem and its emerging technologies. OSSYS will present Analytics HQ, a fully automated, cloud-native analytics environment with the mission of enabling an analytics value stream that automatically integrates dozens of leading analytics tools from this ecosystem to drive decision-making capabilities

at greater scale, faster speeds, and enhanced security. We will present what factors represent true "cloud-native" compute capabilities and the associated challenges of standing up these various tools.

We will demonstrate how Analytics HQ can, in minutes, standup a cloud-native ecosystem leveraging concepts such as Infrastructure as Code (IaC), automated secrets management, distributed storage, and automated ETL processes that work in concert to ultimately provide a web-based environment that gives analysts the tools they need to store, query and present data that would otherwise take months, or even years, to develop. We will present our approach with automation such as containerization to enable secure secrets management, how Analytics HQ interfaces directly with Kubernetes, and the security that is managed behind the scenes to provide these necessary features. We will present why abstracting these infrastructure details to ultimately enable analysts is so important.

By automating the deployment and management of a true cloud-native environment, Analytics HQ can drive unprecedented capability, speed, and scale that ultimately enables better analytics and decision-making within agencies. Analytics HQ can truly disrupt the analytics space by invalidating legacy assumptions about what it takes to stand up and manage various analytics tools and systems such as clustered databases, big data systems, and artificial intelligence/machine learning models.

Classification: UNCLASSIFIED
Working Group:Demo

58457 - Moving from a Compliance to Risk based approach to Cyber Security.

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 4:00 PM ET
Authors: Tom Faraday		

Abstract: The twin pressures of today's challenging cyber threat landscape and resource constraints means that a compliance-driven approach to cybersecurity is no longer fit for purpose. Organizations wishing to have confidence in their methodology as well as the ability to demonstrate an effective and resilient cybersecurity posture must adopt a rigorous approach to cyber risk mgmt. that

Prioritizes the most critical information assets.
Identifies relevant threats and the most effective controls to mitigate them.
Utilizes data and analytics to model threats and continuously monitor the effectiveness of key controls.
Provides relevant, real-time reporting for operational and executive audiences.

Classification: UNCLASSIFIED
Working Group:Demo

56808 - eSports Data Analysis Modeling - Rainbow Six Siege eSports Tournament

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:00 PM ET
Authors: Mr. Walt DeGrange		

Abstract: CANA eSports held a Rainbow Six Siege tournament in April 2021. The event's goal was to collect data on team tactics, determine critical skillsets, and team makeup using the data that is provided through First Person Shooters (FPS) games such as Rainbow Six Siege. This demo will review the mechanics of holding an eSports tournament event, using the event as an experiment to collect

data, and the post-tournament data analysis results. An overview of the game and actual game play video is provided for context.

Classification: UNCLASSIFIED
Working Group:Demo

56985 - Moving from Data to Decision FASTER with JMP Pro 16 – Machine Learning for NON-Coders

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 4:50 PM ET
Authors: Dr. Thomas A. Donnelly		

Abstract: This demo will show how to quickly and robustly create and test Machine Learning models using JMP Pro 16. 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 sensitivies 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 16 - 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 16's new action recorder, 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 16 can help your organization move from data to decision faster.

Classification: UNCLASSIFIED
Working Group:Demo

56691 - AutoML

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:00 PM ET
Authors: Joseph Troy Morgan; Sam Goldstein		

Abstract: In 2013, DataRobot invented automated machine learning — and an entirely new category of software as a result. Since then we've incorporated over 1.4 million hours of engineering innovation and data science best practices into this market-leading product. Unlike other tools that provide limited automation for the complex journey from raw data to return on investment, our

Automated Machine Learning product supports all of the steps needed to prepare, build, deploy, monitor, and maintain powerful AI applications at enterprise scale.

DataRobot's Automated Machine Learning product accelerates the productivity of your data science team, while increasing your capacity for AI by empowering existing analysts to become citizen data scientists. This enables your organization to open the floodgates to innovation and start your intelligence revolution today.

Classification: UNCLASSIFIED
Working Group:Demo

57350 - Investment Value Management: Post-Investment ROI-Based Performance Management

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:00 PM ET

Authors: Kevin Buck

Abstract: Title: Investment Value Management: Post-Investment ROI-Based Performance Management Demo

Abstract Text: The MITRE Corporation has created a Return-on-Investment (ROI) -Based Post - Investment Value Management Capability to optimize the selection, potential elimination, and on-going balancing of investments based on priorities, costs, benefits, uncertainties, and risks. A demo lasting 1 hr of the underlying ROI analysis model will be demonstrated. The idea is to apply the very same techniques leveraged for selecting investments in the first place to then manage those selected investments on an enduring basis throughout the investment lifecycle. The capability answers the questions "are we continuing to realize our initial value expectations from a government investment on a continual basis? If not, why?"

The Investment Value Management Capability includes:

(1) A detailed 5-step ROI management process guideline for training purposes and to maximize benefits from the techniques and tools that are intrinsic to this capability.

(2) An intuitive ROI Analysis Model (RAM) for selecting and monitoring selected investments over time (based on comparisons of actual performance relative to initial ROI expectations).

(3) An early warning system to automatically trigger course correction recommendations for investment decision-makers and metrics owners based on degree and duration of performance variance between initial investment expectations and actual results.

While the academic underpinnings of this capability derive from commercial industry ROI techniques, they have been significantly tailored to address the unique circumstances for government agencies. The creation of this capability is the culmination of over two decades of government-funded research and experience supporting DoD sponsors. This capability has been prototyped for DoD, civilian, and Intelligence Community government enterprises.

Investment decision-makers often define ROI quite differently, and the RAM incorporates four different ROI metrics that address various aspects of investment attractiveness, including Net Present Value (NPV), Benefit/Cost Ratio (BCR), Internal Rate of Return (IRR), and Discounted Payback Period (DPP). These directly monetizable calculations can be prioritized and are reported separately from other investment implication assessments. Non-monetizable implications are also reported separately, along with a series of DoD-compliant risk matrices that illustrate risk vulnerability for various investment assessments. Decision makers control which, and how significantly, investment implications will affect their decisions regarding initial investment selection and, subsequently, how to most effectively manage investments if selected.

Authors: Kevin Buck (primary), Matt Griesbach
Classification: UNCLASSIFIED
Distribution Statement: Both Contractor and GOV UNCLASS
Classification: UNCLASSIFIED Working Group:Demo

57110 - OptDef – Optimization, Design of Experiments & Analytics for Simulation Models

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 4:30 PM ET
Authors: Dr. Benjamin G. Thengvall; Dr. Michael Deskevich; Shane N Hall, PhD		
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), BMD I-Sim (Ballistic Missile Defense International Simulation, KIDD (Kinetic Impact Debris Distribution Model), G6, and a number of other custom 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 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 tradespace. 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. Classification: UNCLASSIFIED Working Group:Demo		

DWG 01 Emerging Operations Research

55327 - Quantifying Army Band Mission Effects Using a Weighted Scoring Model

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Jonathan Lee Crane		
Abstract: In 2017 Government Accountability Office report 17-657 recommended military bands enhance efforts to measure performance. The Army Music Analytics Team developed a weighted scoring model which uses performance indicators to measure performance for three strategic goals. Raw data is first normalized then run through two levels of weighting based on stakeholder input. The		

output is then compared to baseline data to determine effectiveness. This model allows for the quantification Army Bands' intangible effects. The intent is to support band decision making from the unit to the strategic level.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56760 - The Koopman Operator, Disjunctive Programming, and Multi-Level Optimization: Complementary Computational Methods for Modeling Critical Infrastructure

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Craig Bakker; Arnab Bhattacharya; Dr. Samrat Chatterjee; Ethan King; Matthew Oster; Feng Pan; Casey Perkins		
Abstract: Cyber-Physical Systems (CPSs) consist of computing and communication devices integrated with physical components. Critical infrastructure, such as the power grid, provides key examples of CPSs. Solvability (predicting future behavior), operability (meeting performance goals), and security (anticipating and mitigating threats) are then three core challenges in running these systems, and mathematical modeling has been widely used to address those challenges. However, critical infrastructure systems are often too complex for closed-form, bottom-up modeling approaches. To produce computationally tractable representations, it has historically been necessary to make simplifying assumptions. One type of simplifying assumption has been to consider only the continuous dynamics of systems that are actually mixtures of continuous and discrete components. Another type of simplification has been to ignore any adversarial activities present in the CPS; control strategies and consequence scenarios have not considered adversaries that could be strategic and adaptive in their behavior. The nonlinearity and nonconvexity of CPSs have also often created an optimization dilemma. Convex approximations of the original system (and linear approximations in particular) can be solved rapidly and provide guaranteed optimal solutions. Those approximations, however, may neglect key properties and behaviors of the actual system. General nonlinear optimization solvers, on the other hand, may suffer from convergence issues and cannot, in general, guarantee global optimality for any solution they return. Here, we use examples from the power grid to show how analytical and computational advances in disjunctive programming, the Koopman operator, and multi-level optimization can be leveraged to produce tractable and scalable computational methods that do not rely on those simplifying assumptions. Together, these methods provide a set of disparate but complementary tools for dealing with solvability, operability, and security challenges for CPSs in general and critical infrastructure in particular. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

56804 - Recipe for Using R Products to Produce Ad-Hoc Reports from Ad-Hoc Data

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Joseph Olah		
Abstract: During the discovery phase of an analysis of alternatives (AoA), alternatives and data describing them are in flux, yet the customer wants reports, whose content frequently changes as what is important continues to emerge. This paper provides a recipe for using R tools to automate the generation of these ad-hoc reports based on ad-hoc data collection. In particular, the paper explores the case of storing data of dozens		

of alternatives in multiple spreadsheets and creating tables summarizing certain qualities of each alternative by category. Also explored is using the same data set to produce a synopsis of each alternative. The technique uses an R Markdown (RMD) page that includes R scripts to read, join, and filter data; and then create formatted tables and documents.

The advantage of this technique is that it allows the creation of these dozens of products to be automated by only changing several portions of the RMarkdown page and R scripts. The paper then suggests how one might facilitate those changes from a spreadsheet leaving the RMarkdown page and R scripts untouched.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56951 - Analysis of COVID-19 transmissions, effects, and mitigations in the workplace

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Michael Taberski; sean p carey; Keith Hattes; Dr. Christopher E. Marks		

Abstract: We make use of our access to individual-level locational data to analyze COVID-19 transmission rates and propose a model for predicting
community transmissions. First, we employ state of the art pandemic modeling and publicly available data to understand and predict COVID prevalence in our work locality. Next, we employ a network model to represent the interpersonal interactions over time within a specific work campus. To build this model, we rely on "badge" data; employees on this campus are required to use security badges to log facility entrances and exits.
We use the resulting log data to track individual movements and locations over time and infer likely interactions.
Finally, we overlay known COVID-19 cases onto this network model to determine probable workplace transmissions.   We use this information, combined with our local prevalence model, to infer future prevalence and transmissions in the workplace. By altering the interaction model to represent different mitigation strategies, we gain insights into their probable effects. These outputs are useful in informing decisions on the timing and nature of pandemic mitigation measures.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56838 - Synthetic Training Environment—Next Generation Constructive (STE-NGC) Framing Analysis (FA)

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: MAJ Marshall Bartee		

Abstract: Synthetic Training Environment—Next Generation Constructive (STE-NGC)
Framing Analysis (FA)

The Army often leverages constructive training capabilities to train Commanders and their staffs from tactical through operational level. During constructive training, Commanders and their staffs are given command of virtual forces to accomplish a mission while facing a virtual opposing force. The current constructive training capabilities are a mix of systems within an ad hoc federation that contain many documented capability gaps which will increase and amplify as we continue the transition to Multi-

Domain Operations (MDO). Given this reality, the training community has begun looking towards a holistic solution designed to meet near term and projected training requirements.

At the request of the Combined Arms Center-Training, TRAC began executing a framing analysis to support the development of an Abbreviated Capability Development Document and refinement of a strategy for initial acquisition of elements to improve constructive training. The framing analysis is focused on informing three main areas of interest. First, the team was asked to identify and prioritize projected capability gaps for the current constructive training capability to support MDO training for a peer/near-peer adversary in the 2030 and beyond timeframe. Then, with those identified gaps, the team will assess the efficacy of the proposed next generation concept to mitigate those gaps. Second, the team was asked to consider multiple categorical acquisition approaches, and lead efforts to identify key technologies, identify maturity of those key technologies, and estimate likely fielding timelines as well as explore some of the development timeline sensitivities (system requirements, RDT&E funding, etc.). Third, the team was requested to identify likely cost drivers within each of the acquisition approaches. This analysis must be completed to inform senior Army leaders for near and long term decisions that will occur over the next year.

Constructive training using virtual forces needs improvement. TRAC is supporting needed change. This presentation will provide an overview of the design of the methodology, initial insights of the ongoing efforts, and any emergent lessons learned from the analysis.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56678 - Strategic Fires Study Table Top Exercise (TTX)

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Danielle Monique Aldrich		

Abstract: To develop a sound strategic fires acquisition strategy, the Army G-8 directed Army Futures Command (AFC) to conduct the Fiscal Year 2020 (FY20) Strategic Fires Study (SFS). AFC tasked The Research and Analysis Center (TRAC) to complete the 4-month study to inform the 2020 Program Objective Memorandum. The SFS is a comprehensive analysis that explores the trade space between cost, schedule, and performance of various Strategic Fires capable systems. Additionally, the study assessed their respective sustainment, logistical, mobility, and survivability challenges. To support the study, TRAC executed two back-to-back TTX events. The purpose of these TTX events was to obtain operational feedback on these strategic fires systems and to gain insight into how well they support the forces of the United States, allies, and partner nations against near-peer Threats.

This presentation will cover the TTX approach employed by the TRAC study team, the method, models, and tools used during the event, and how the output aided in informing the overall FY20 SFS effort.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56497 - Spares Modeling with ARIMA Forecasting

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET

Authors: Erika Garcia-Boliou
Abstract: Spares modeling is sometimes left to Consumer off-the-shelf (COTS) software when it is better done in-house. An Auto-Regressive Integrated Moving Average (ARIMA) forecast was used to better calculate spares and the forecast was imported into an Excel dashboard for analysis. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research

56993 - Promotion Board Performance - Using Cohort Benchmarks to Improve Promotion Board Performance

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: David Hickman; Nicholas E Alvarez		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. In this discussion we propose how decision analysis and data visualization tools could be used to improve selection/promotion board performance. Using decision analysis techniques, the team has produced a value model of the desired officer characteristics at the next grade – and used that model to calculate a composite (whole person) score for each officer. The team used data visualization methods to illustrate the composite scores for the entire cohort of promotion-eligible officers. These products may be used to provide cohort benchmarks for selection/promotion board members, enabling improved board performance.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56655 - Project Convergence (PC): Longitudinal Data Analysis

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: MAJ Anthony Wrench		

Abstract: Project Convergence (PC) is the Army's new campaign of learning, designed to run on a year-by-year cycle, to aggressively advance and integrate our Army's contributions to the Joint force. It is the Army's contribution to Joint All Domain Command and Control, and it informs Joint All Domain Operations. PC ensures the Army, as part of a Joint and multinational force, can rapidly and continuously integrate or "converge" effects across all domains through intelligence gathering, data sharing, interoperable systems to decide and act more rapidly against adversaries in competition and conflict.

Approximately 2 months out from the execution of PC20, the Army Futures Command (AFC) tasked The Research and Analysis Center (TRAC) and the Data and Analysis Center (DAC) to lead the development and execution of an overarching analysis plan. PC20 provided the opportunity to develop an initial approach to integrating data collection and analysis under a single analytic framework and inform capability development stakeholder learning demands. Later, AFC tasked TRAC to lead, in collaboration with DAC, Joint Modernization Command, and the Army Evaluation Center, the development and execution of data collection and analysis (DC&A) for PC21. This will inform Army and Joint senior leader analytic questions and align PC21 stakeholder learning demands DC&A efforts with PC21 analytic questions. These require an integrated approach to data collection, data management, and data analysis executed by disparate DC&A teams across the analytic community.

This presentation will provide an overview of the original approach for PC20 data collection and analysis, lessons learned from PC20 and their application to PC21, and a description of the challenges and opportunities associated with informing the AFC's PC campaign of learning initiative.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

57123 - SWIFT Model for Wargame Visualization

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Mr. Kirill Sukhorukov		
Abstract: As the state of the art for operational wargaming progresses, it is desirable that the means of displaying and capturing operational activity should progress with it. This presentation will outline use of the Standard Wargame Integration and Facilitation Tool (SWIFT) at the Center for Army Analysis (CAA) as a new means of providing enhanced, computer-aided graphical visualization for its operational wargames. The presentation will begin with the initial development concept for the wargame visualization tool and then cover how CAA is currently using the SWIFT model to provide wargame visualization. The presentation will cover the process used to capture and display the operational data generated by the Center for Army Analysis Accelerated Wargame System (CAAAWS) and the paper map. It will also cover the additional uses of the SWIFT model in the area of support analysis (e.g., situational awareness, current unit strength, planning next turn actions, and visual record). The presentation will conclude with a discussion on the strategic direction for the improvements that will be essential for the future wargaming participants. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

56569 - Improving the Digital Aviation Readiness Technology Engine With Attention Mechanisms and Hyper-Deep Ensembles

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Benjamin Michlin		
Abstract: The Digital Aviation Readiness Technology Engine (DARTE) provides unprecedented predictive readiness capabilities for the Naval FA-18 fleet. DARTE focuses on discovering actionable insights in relation to predicting two key readiness metrics: the number of mission capable (MC) aircraft and flight hours. Recent DARTE improvements are particularly noteworthy, including the adoption of cutting edge AI and deep learning techniques such as temporal pattern attention mechanism enhanced long short-term memory (LSTMA) networks, hyper-deep ensembles for enhanced performance, and improved uncertainty estimation and robustness. Hyper-deep ensembles and attention mechanisms have been shown to provide state-of-the art results in industry and academia. Furthermore, their improved uncertainty estimation provides decision makers with an increased level of confidence that allows for better, smarter decisions. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

56496 - Spares Modeling with ARIMA Forecasting

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Erika Garcia-Boliou		
Abstract: Spares modeling is sometimes left to Consumer off-the-shelf (COTS) software when it is better done in-house. An Auto-Regressive Integrated Moving Average (ARIMA) forecast was used to better calculate spares and the forecast was imported into an Excel dashboard for analysis. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

56493 - Staff and Equipment Modeling with Process Simulator

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Erika Garcia-Boliou		
Abstract: There are many concerns when opening up a new site. Process Simulator was used to best guide Operations in how large their staff should be and how many pieces of equipment they should purchase in order to handle their desired throughput. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

57153 - Aircraft Mission Capable Rates Generally Do Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varies Widely

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Christopher Watson; Nicole Volchko		
Abstract: This presentation provides observations on mission capable rates and costs to operate and sustain 46 fixed- and rotary-wing aircraft in the Departments of the Army, Navy, and Air Force. The Department of Defense (DOD) spends tens of billions of dollars annually to sustain its weapon systems in an effort to ensure that these systems are available to simultaneously support today's military operations and maintain the capability to meet future defense requirements. One measure of the health and readiness of a military aircraft fleet is the mission capable rate—the percentage of total time aircraft can fly and perform at least one mission. GAO examined whether 46 types of aircraft met their annual mission capable goals for FYs 2011-2019, and we found: 3 met their goals in a majority of the years 24 did not meet their goals in any year GAO also reviewed annual operating and support costs for these aircraft, such as maintenance costs. These costs totaled over $49 billion in FY 2018, ranging from $118 million for the Navy's KC-130T Hercules to $4.2 billion for the Air Force's KC-135 Stratotanker. Classification: UNCLASSIFIED Working Group:DWG 01 Emerging Operations Research		

57242 - Stochastic Preemptive Goal Programming of Air Force Weapon Systems Mix

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: zach butcher; Dr. Mark A. Gallagher, FS		

Abstract: We demonstrate a new approach to conducting a military force structure study. We apply the stochastic preemptive goal program approach, described by Ledwit et al (2020), to balance probabilistic goals for military force effectiveness and the force's cost. We use the Bayesian Enterprise Analytic Model (BEAM), as described in Gallagher et al (2021}, to evaluate effectiveness, expressed in terms of the probability of achieving campaign objectives, in three hypothetical scenarios. We develop cost estimates along with their uncertainty to evaluate the force's research and development, production, and annual operating and support costs. Our summary depicts how the tradeoff between various prioritized goals influences the recommended force.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56517 - Using Safe Escape Methodology to Assess Fragmentation Impact Risk from Overpressurization of the ARRW Hypersonic Engine

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: Michaela Coughlin

Abstract: Safe escape analysis assesses the risk of self-fragmentation to the warfighter by modelling weapon, aircraft, and weapon fragment fly out. A safe separation time is calculated as the time in the weapons fly out where the aircraft is safe from fragmentation should the weapon detonate early. A Risk Assessment request was made for flight tests of the Air-Launched Rapid Response Weapon (ARRW) off a B-52. To assess the risk to the aircraft in the event of overpressurization of the SRM motor causing self-fragmentation, safe escape methodology was employed. Arena data was collected and used to create a fragmentation model, time space position information (TSPI) was provided for the flight of the warhead based on software simulations by the ARRW team, and aircraft trajectory models that are used in safe escape were utilized. This data was used to simulate the flight paths and relative positions of the aircraft and warhead. Analysis provided data on the distance between the aircraft and warhead at each time step and the probability of at least one fragment impacting the aircraft should an overpressurization event occur at each point in time. Safe escape provided useful tools to inform development and testing teams of the risks imposed by weapon failure. This methodology now has the proven utility to produce data on flight path, separation distance, and risk probabilities that can influence design and testing decisions beyond detonating warheads. Applying Safe Escape methodologies more robustly as more advanced weapons systems go through the aircraft/store certification process will continue to allow for safe employment of weapons in the hypersonic age and beyond.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

56979 - Gamifying Acquisitions for Assessing Impact on Military Strategy of Nation States

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET

Authors: Dr. Alicia Ruvinsky; Mr. James Richards; Mr. Joshua Church; Dr Megan E Gonzalez; Dr. Richard Cody Salter; Dr Maria Seale

Abstract: Complex Systems in which humans play a role, namely Human-Integrated Complex Systems (HICS), can be difficult to model or simulate due to the uncertainty introduced by the human component. Military acquisition often manifests as a multi-faceted and complex process, implemented by large enterprises, with the purpose of managing national investment towards a

national security strategy. As such, the military acquisition process can be characterized by (1) processes and protocols, (2) asset(s) being acquired (i.e., problem), and (3) national security characterization of a nation (i.e., context). The goal of this work is to build situational awareness and knowledge of how military acquisitions are executed by various nations, and understand how and when situational factors impact the probability of success of an acquisition strategy. We aim to evaluate military acquisitions in this way by building a game based on rigorous investigation into a historical perspective of the interaction of process, problem, and context of military acquisition initiatives undertaken by different countries. This historical perspective will be used to extrapolate a framework for evaluating the aspects of the 3-dimensional space that contribute or detract from successful acquisition initiatives.

Classification: UNCLASSIFIED
Working Group:DWG 01 Emerging Operations Research

DWG 02 Unmanned Systems

56780 - Modeling Robots in Force on Force Structure Clearing to Shape Emerging Technologies

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Jason L. Pusey; Mr. Jeremy Collins; Dr. Chad Kessens; Mr. Zachary Steelman		

Abstract: Modeling Robots in Force on Force Structure Clearing to Shape Emerging Technologies

Future integration of autonomous robotic teammates with dismounted Soldier squads offers a significant opportunity to reduce Soldier risk. However, numerous technological advancements are still required before this future can be fully realized. This paper describes an initial effort to understand how to prioritize resource investments by assessing which performance parameters will produce the largest impact on mission effectiveness. In particular, this collaboration between the Science and Technology (S&T) and Analysis communities examines the addition of a notional legged robot to a structure clearing mission utilizing Infantry Warrior Simulation (IWARS), a simulation tool to aid in the system performance analysis of weapons and equipment as employed by the dismounted infantry Soldier. The effort required methodology enhancements in order to represent the capabilities of a legged robot and how to represent this in an operational environment. The simulation enhancements and scenario development focused on representing a squad tasked with clearing four rooms in a multi-level structure, either with or without an additional robotic teammate. The robot's abilities vary across parameters such as vulnerability, lethality (including inability to engage), movement speed, and target acquisition. The analysis compared the mean and standard deviations of the loss ratios between the red and blue teams across these variations for multiple replications. The results provide both a comparison of the relative importance of the parameters as well as an identification of critical capability levels within each parameter. By prioritizing mission effectiveness early on in the development cycle, the S&T community can target technology development resources and efforts to those that will deliver the greatest impact. This effort provided insights that will shape additional methodology enhancements to enable rapid representation of S&T in an operational context and gain an understanding of the operational impact of emerging technologies.

Classification: UNCLASSIFIED
Working Group:DWG 02 Unmanned Systems

56899 - Modeling Autonomous UAV Swarms in AFSIM

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Joseph Limber		

Abstract: An SPA team is developing an Advanced Framework for Simulation, Integration, and Modeling (AFSIM) model to evaluate heterogeneous and homogenous swarms of UxVs. Our SESU model takes an innovative approach to model low-level swarming and autonomous behaviors by leveraging concepts from biology and Artificial Intelligence (AI). This model leverages research on swarms in nature to provide low-level autonomy for members of the UxV swarms. In this type of model, each individual actor is guided by a limited set of rules that it can implement without explicit orders from another member of the group. These rules are inherently nonlinear; mixing them introduces chaotic behaviors. At the same time, they include negative feedback that keeps the group dynamics ordered. The result is life-like group behavior.

Our AFSIM model extends this concept, adding rules that enable the UxVs to exhibit coordinated behavior aligned to operational objectives without the need to control each member of the swarm directly. This approach diverges from a strongly hierarchical Command and Control (C2) approach often used for UxV control and enables evaluation of simple C2 structures to control complex architectures with many participants. It also creates a system that degrades gracefully in the face of individual losses and does not present critical nodes to be exploited by an adversary.

The inputs from these rules are integrated within this model in a manner that is analogous to a vector implementation of neuron activation in a Deep Neural Net. Different behaviors, appropriate for different mission phases, can be developed by tuning the parameters of the potential fields and activation functions instead of by writing new software. In the current model, these parameters are manually tuned, but in the future, we hope to be able to use Deep Reinforcement Learning techniques to tune them based on mission success criteria.

Classification: UNCLASSIFIED // FOUO
Working Group:DWG 02 Unmanned Systems

56656 - Counter – Small Unmanned Aerial Systems (C-sUAS) Basis of Issue Sprint

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Kristofer Dean Fosmoe		

Abstract: Friendly forces and installations are under threat from small unmanned aerial systems, which have increased drastically in their capabilities and proliferated widely due to decreasing costs. Consequently, the Department of Defense established the Joint Counter – small Unmanned Aerial Systems Office (JCO) to provide oversight and acquisition of capabilities to overmatch this emerging threat.

Following a JCO selection of eight initiatives from across the Services, Army leaders directed The Research and Analysis Center (TRAC) to conduct a rapid analysis to inform programming and budget decisions for an optimal set of capabilities. The study team was given 4 weeks to conduct this sprint analysis. Consequently, the analysis was focused at the United States Army Division echelon.

The study team engaged intelligence analysts, warfighters, observer/trainers, and program managers to analyze the attributes of each C-sUAS initiative in large scale combat operations. Warfighters and observer/trainers provided information on priority protection assets across both heavy and light divisions. The study team created 4 threat vignettes, and identified over 15 unique candidate protection assets that were combined into a generic Division template.

Ultimately, the study team synthesized this information to provide a range of procurement options of C-sUAS equipment.

This presentation discusses the study approach for identifying C-sUAS capability requirements and lessons learned.
Classification: UNCLASSIFIED Working Group:DWG 02 Unmanned Systems

FS 01 Analytic Capability Development

55122 - Analytic Capability Development Focus Session Overview and Introduction

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Christopher Santos; Chad Kimmel; Melissa Sayers		

Abstract: The MORS membership covers a diverse array of people and organizations with military and civilian backgrounds, the government and private sectors, and academia. 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.

This Analytic Capability Development (ACD) Focus Session represents a major milestone in addressing this gap within the greater MORS community. Given sufficient community interest through presentations submitted and attended at the 89th MORS Symposium, ideally ACD will become a permanent working group and a standing collaboration and information-sharing venue.

This ACD Focus 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.

Help us to formalize this "home" for capability development topics, whether by presenting, attending, or participating in the ACD sessions this week.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56640 - Saving Unicorns and Jedi Knights: Empowering Your Organization Through Data Literacy

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Melissa Sayers; Chad Kimmel; Christopher Santos		

Abstract: We agree improving data literacy has benefits but how do we do this in the government? What should people learn exactly? Who should learn? We have implemented a tiered training program that starts with fundamental data skills and concepts using Microsoft Excel that branches into a "Choose Your Own Adventure" style of training. Fundamental skills include but are not limited to (1) the VLookup function indicating the person understands the concept of joining two tables, (2) nested if statements indicating the person understands branching logic, (3) pivot tables indicating the

person understands aggregating data to answer a question, and (4) creating a bar or line chart indicating the person can create a more natural way for the human mind to interpret the data. After this foundational instruction, students can choose their own adventure to pursue more advanced Excel, pursue a coding course in Python or R programming, or learn to use a tool like Contour in Army Vantage or similar cloud computing analytic platforms. Students have attended as civilians (GS-7 to GS-14), contractors, and military (ranges include O-1 to O-5, W-1 to W-5, and E-1 to E-9) and from a range of job specialties (ORSAs and non-ORSAs, logistics, maintenance, Human Resources, intelligence, operations, and finance to name a few.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56960 - For the Jedi Master: an Overview of Software Acquisition and Best Practices Tailored for the Air Force

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Chad Kimmel; Christopher Santos; Melissa Sayers		
Abstract: A Jedi Master Air Force analyst needs the necessary software tools to efficiently perform his/her role within the Department of Defense. In the Air Force, the barriers to software acquisition are particularly challenging given the installation and download limitations placed on the NIPR and SIPR networks, especially for free, open source platforms such as R or Python. This presentation will provide a brief overview on how to obtain software acquisition approval for any installation in the Air Force along with the available, quick work-arounds for common issues. The presentation will then provide a brief overview of the various cloud-based software solutions and educational resources throughout the DoD – some of which are open access to all branches. The presentation will finish with a discussion of common best practices which detail the optimal software to use for a given analytical/data need within the DoD. These best practices cover the analytical gambit from basic data mining, simulation, optimization, probabilistic modeling, applied statistics and visualization tools. Audience participation is encouraged for any new knowledge and/or best practices. Classification: UNCLASSIFIED Working Group:FS 01 Analytic Capability Development		

56908 - A Blueprint for Building a Data Driven Organization

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: MAJ Brian Harris; Jeremy Blaney		
Abstract: The 2020 DoD Data strategy outlines a vision for a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency. Similar visions are shared across government and the commercial sector, however McKinsey estimates that 92% fail to scale their analytics. This presentation will outline practical steps organizations can take to meet the essential capabilities outlined in the DoD strategy while increasing governance, agility, proficiency, and community. Classification: UNCLASSIFIED Working Group:FS 01 Analytic Capability Development		

56839 - Developing an Artificial Intelligence Certification Program for DoD Analysts and Practitioners

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: John Sedlock		

Abstract: On January 1, 2021, the U.S. Congress finalized and approved the WILLIAM M. (MAC) THORNBERRY NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2021 (FY21 NDAA). Numerous provisions of consequence related to artificial intelligence (AI) were included in the final conference report of the NDAA.

SEC. 256. ARTIFICIAL INTELLIGENCE EDUCATION STRATEGY (a) STRATEGY REQUIRED.- (1) IN GENERAL- The Secretary of Defense shall develop a strategy for educating service members in relevant occupational fields on matters relating to artificial intelligence. (2) ELEMENTS- The strategy developed under subsection (a) shall include a curriculum designed to give service members a basic knowledge of artificial intelligence. The curriculum shall include instruction in- (A) artificial intelligence design; (B) software coding; (C) potential military applications for artificial intelligence; (D) the impact of artificial intelligence on military strategy and doctrine; (E) artificial intelligence decision making via machine learning and neural networks; (F) ethical issues relating to artificial intelligence; (G) the potential biases of artificial intelligence; (H) potential weakness in artificial intelligence technology; (I) opportunities and risks; and (J) any other matters the Secretary of Defense determines to be relevant.

In response to these NDAA provisions, the Joint Artificial Intelligence Center is tasked to develop and implement a DoD-wide certification program for AI developers, analysts, and practitioners. This presentation discusses the development of such a certification program and its implications for the military Operations Research community.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56481 - Air Force VAULT Platform: Enabling Distributed Analysis and Data Driven Decisions

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr Derek John Eichin		

Abstract: Before the VAULT Platform, building data analytic pipelines and creating data visualizations was a monumental 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. Fortunately for the AF enterprise, the VAULT Platform, hosted in AWS GovCloud up to the secret level, gives users access to over 50 authoritative AF data sources and the ability to extract, transform, and load their own data within a secure, cloud-based environment. The VAULT Platform equips airmen, space professionals, and civilians to execute an analytic use case through its lifecycle with industry leading tools and resources. Data munging and analysis tasks are made easy with Zeppelin, Databricks, and Trifacta which provide robust and scalable solutions at your fingertips. Combining the curated data sets and visualization tools already within the VAULT, tools which include Tableau, Plotly Dash, RShiny, and Neo4J, users are empowered to solve problems, create visualizations, and make solutions accessible to Senior Leaders and across the enterprise. With the help of the VAULT Platform, you and your teams are empowered to bring your data analysis into the 21st century. The VAULT Platform equips airmen, space professionals, and civilians to complete a full life-cycle analytic use case with industry leading tools and resources.

Classification: UNCLASSIFIED		
Working Group:FS 01 Analytic Capability Development		

56909 - A Novel Analytical Approach to Monitor Supervised Machine Learning Models with Natural Language Processing in Production

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Abhishek Paul; Christopher Lock; Joshua Mutugi		

Abstract: Over the past several years, there have been many advancements with machine learning (ML) and identifying the impact this new technology can have across industries. Through this process, supervised ML and natural language processing (NLP) have proven to be effective for automating tasks in research environments with problems such as multi-class text classification. As organizations move to productionizing ML models, they will have to identify methods to monitor and ensure quality of the ML model in production. A major underlying assumption with supervised ML models is that they work well in environments that are similar to the environment in which the model was trained and tested. If the environment changes while the machine learning model is in production, this could cause erroneous predictions from the model. To mitigate this risk, new tools will need to be created to monitor production environments. The purpose of this study is to propose and demonstrate a novel analytical approach to monitoring a supervised ML model with NLP in production; a notional aircraft maintenance dataset is applied. The effort produces a new metric that measures the textual environment in production to provide a signal that alerts of a potential environmental change for the model. This analytical monitoring approach can be tailored for use on supervised ML applications with NLP.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56784 - Machine Learning: DataRobot and Leveling Up Your Team!

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Joseph Troy Morgan; Marguerite Benson; Sam Goldstein		

Abstract: It's never been a more exciting time to be an analytical professional. With the rise of big data, the explosion of data analytics and data science jobs, and the vast amount of business problems that can now be solved with machine learning and artificial intelligence (AI), the time is ripe for data professionals to take the world by storm. The catch? It takes a lot of time to develop traditional data science expertise and the field continues to advance at a rapid pace – which is where automated machine learning technology comes in.

The DataRobot automated machine learning platform eliminates the barriers to machine learning for business analysts by automating many of the complex steps in machine learning model building that have traditionally required a trained data scientist. To start, DataRobot's runs a competition of machine learning algorithms on your data, building dozens of models in minutes and ranking them against each other by their predictive accuracy. Not only that, DataRobot's automation capabilities and visualization tools drastically reduce time-to-insight, allowing analysts to quickly and easily explain the results of the models built to their organizations. With DataRobot, analytical professionals evolve into Citizen Data Scientists – no coding necessary.

Unlike visualization tools with machine learning features that only work if your problem squares precisely with the technology, DataRobot is flexible, automatically testing hundreds of advanced algorithms until it finds the right options based on the business problem you seek to solve. Along the way, DataRobot's built-in guardrails help you identify questions or errors to help you feel more confident about your process.

DataRobot has a variety of built-in systems to help you explain and defend your use of machine learning, whether to leadership, data scientist collaborators, or even to regulators. For example, DataRobot automatically generates customized, model-specific documentation that captures the choices you've made and the findings uncovered. Model blueprints are downloadable and reflect the specific steps that a model takes on the dataset, providing full transparency. Importantly, the robust suite of documentation allows individuals to use the platform to continually improve their knowledge as they experiment and deliver results. With advanced options built-into the platform, as well as Python and R clients, DataRobot is ideally suited to serve the full-spectrum of analytic professionals.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56833 - How Much AI/ML do I need to Learn?

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr. Jerry L. Schlabach		

Abstract: Artificial Intelligence (AI) and Machine Learning (ML) are powerful new technologies that will disrupt and transform future combat operations. AI/ML and Operations Research (OR) are independent fields of academic study with limited historical overlap, which has led to a significant knowledge gap within the OR community regarding the newer technologies. However, in order to perform Analysis of Alternatives (AoA) studies and Military Utility Assessments (MUAs) of future AI/ML-enhanced systems, OR Analysts will require a basic understanding of capabilities and limitations. This presentation will outline a spectrum of 'AI/ML understanding required for OR Analysis' with respect to typical OR tasks. One implication is that a modest grounding in AI/ML fundamentals, well short of an advanced degree, is sufficient for a large percentage of future AI/ML-focused OR studies. This presentation will suggest some basic elements required for such a modest grounding. The author is a retired Army Military Intelligence Officer with an MS in Computer Science (AI) and twenty-five years of experience in AI-centric Army Acquisition. He is also a co-chair of MORS Working Group #35, "AI and Autonomy."

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56882 - How to use the Army Vantage Data Analytics Platform

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Melissa Sayers; Martin C Harris		

Abstract: Use R and Python, SQL, Excel-like tools, etc within Vantage to conduct analysis on numerous Army data feeds. Build your own dashboards and applications within the platform to help inform leader decisions. These dashboards can be self-updating where the data feed is already updating every day and feed into your report to automatically update it. These dashboards can be interactive with drop down menus and widgets to help a leader navigate your report. The analyses and reports

you create can be made without knowing how to code in R and Python. However, if you can code in these languages, you can do more advanced analytics within the platform up through optimization, predictive algorithms, machine learning, etc. These products can be exported from Vantage to Excel and PowerPoint or live and update within the platform. Both ORSAs and non-ORSAs are learning how to use this tool to conduct their own analysis and products. ORSAs are uniquely trained and skilled to take advantage of this tool to aide in their analyses. Come and learn how you can too.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56952 - The Data Value Chain - a Model for Enhancing Understanding and Increasing ROI in Systems and Processes

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: sean p carey; Keith Hattes; Michael Taberski; Dr. Christopher E. Marks		

Abstract: Many efforts aimed at improving the capture and use of DoD data focus on specific solutions, tools, or methods (e.g., machine learning) that are intended to either adjust a specific solution or have a broad impact across many application areas. We present an alternative approach to understanding data, systems, and processes for enhancing derived value from our data, in which we instead focus on a specific application or decision we intend to affect. We provide a simple model workflow, the "data value chain," that generalizes to many cases in which the objective is to turn raw input data into useful, decision-informing insights. We also walk through a recent effort in our organization in which we applied this model, and comment on resources and skills required to take a seemingly simple project from concept to deployment. Our data value chain, supported by the example case we provide, is a useful model for planning and executing organizational improvements related to data.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

57015 - Web Apps and Cloud: Programming Modern Data Solutions

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: MAJ Marc Eskew; Robert Smith		

Abstract: There is an emerging opportunity for the analytic community to revolutionize how data is created and utilized with a combination of cloud technologies, programming, and web applications. The capability is available today to allow a moderately experienced R programmer to create products that go beyond simple dashboards or reports. Army Futures Command (AFC) is using Shiny web applications, NoSQL databases, and Agile development processes to create and utilize enterprise accessible data in the cloud. Problems that would either be solved with the creation of either a new spreadsheet or a long and expensive contracting process can now be solved by an individual or small team with a flexible web app developed in weeks instead of years.

The signature effort proving this capability is a full stack developed application for the Army Cross Functional Teams (CFTs) to develop records for emerging efforts. CFTs access a Shiny application developed specifically to capture the data with a modern UI/UX. The application uses a mongoDB backend instead of a traditional SQL database many enterprise applications use. The advantages of this are simple use of the API through the R 'mongolite' package, the document structure is more

intuitive for individual CFT efforts, and the flexibility of the documents allows for easy changes to the schema as requirements change or develop. As a product of the AFC Data and Decision Science Directorate (DDSD), Agile methodologies can be employed to rapidly produce a minimum viable product and iterate improvements to the software. This application is now providing data informing senior leader decision making and powering the AFC Modernization COP.

The development of programmers organic to the DoD and adoption of cloud technologies are opening up new possibilities to innovate. This use-case is still being developed and refined, but it demonstrates that the combination of creative tech talent, availability of open source programming tools, and cloud resources can modernize business processes without prohibitive costs.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56720 - Human Capital Analytic Pyramid: A Structure for Assessing the Performance of our Manpower, Personnel, Training, and Force Development Enterprise

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Maj Joseph Hoecherl		

Abstract: Human capital challenges are robust, wicked problems. The overarching human capital challenge the USAF must meet is to field the human capital needed to execute our missions now and in the future. Solving this core problem requires solutions to a number of intermediary problems, spread over myriad institutions and chains of command across the Manpower, Personnel, Training, and Force Development Enterprise. As a complicating feature, many of the metrics commonly referenced across the USAF to inform solutions to these problems are misleading, misunderstood, or lack a meaningful basis. This presentation introduces the Human Capital Analytic Pyramid (HCAP), a structural framework for understanding current challenges. The HCAP seeks to enhance cogent, deliberate thinking about human capital management problems. Planned technical contributions for the author's Ph.D. dissertation -- in the form of operations research and artificial intelligence methods for solving some of these difficult human capital management problems -- will be discussed within the context of the HCAP.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

57009 - Stochastic Preemptive Goal Programming of Air Force Weapon Systems Mix

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: zach butcher; Dr. Mark A. Gallagher, FS		

Abstract: We demonstrate a new approach to conducting a military force structure study. We apply the stochastic preemptive goal program approach, described by Ledwit et al (2020), to balance probabilistic goals for military force effectiveness and the force's cost. We use the Bayesian Enterprise Analytic Model (BEAM), as described in Gallagher et al (2021}, to evaluate effectiveness, expressed in terms of the probability of achieving campaign objectives, in three hypothetical scenarios. We develop cost estimates along with their uncertainty to evaluate the force's research and development, production, and annual operating and support costs. Our summary depicts how the tradeoff between various prioritized goals influences the recommended force.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56923 - To Err is Human; To Error404 is Machine... Developing a Lessons Learned Ontology to Help Computer's Understand Context

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Maximilian Zocholl; Jacqueline Eaton		

Abstract: Being able to offer the right lesson in the right situation to the right decision maker is crucial for unlocking its benefits. However, the meaningful part of any lesson is the free text which is stored as unstructured data, which is difficult for computers to process. When a human reads lessons they can immediately connect them to their entire lifetime's worth of knowledge. Computers miss that background knowledge and make silly mistakes which mean we cannot rely on them to help us process lessons data.

In 2019, the NATO Joint Analysis and Lessons Learned Centre (JALLC) embarked on a journey to understand better how advanced analytics could support the Lessons Learned process. Two experimental projects were completed that focussed on the use of Natural Language Processing (NLP) to explore large unstructured text-based datasets for lessons. The initial results were simultaneously promising and disappointing. It was clear that without a domain ontology to help the computer to understand the context of the lessons, the results were unreliable. As a consequence, in 2021, JALLC partnered with the NATO Centre for Maritime Research and Experimentation (CMRE) to develop a Lessons Learned ontology. The Lessons Learned ontology project aims to enrich lessons semantically, hence upgrading keyword-based search to semantic search, enabling the use of context information and leveraging organisational learning.

This paper presents results from the first part of the Lessons Learned ontology project including potential use cases and requirements for a Lessons Learned ontology, scientific and organisational challenges for its development as well as an overview of advanced and promising methods and technologies for development and integration of a Lessons Learned ontology into NATO's Lessons Learned capability.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56835 - DoD Supercomputing Resource Centers: Data Analysis and Assessment

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Vincent Perry		

Abstract: The Department of Defense High Performance Computing Modernization Program provides high performance computational capabilities at 5 DoD Supercomputing Resource Centers (DSRCs) across the US. Collectively, these centers provide hundreds of thousands of cores, billions of processor hours per year, excess of a hundred petabytes of storage, high-speed networks, software maintenance, and domain expertise to support the DoD's science and technology (S&T) and test and evaluation (T&E) communities. In alignment with the DoD's modernization efforts, strides have been taken by the DSRCs to improve analytic capability development for its users. Containerization of software stacks, gitlab for HPC, and on-site support allow users to bring their test, development, and analytical workflows to the HPC environment. Traditionally a batch computing environment, more recent efforts focus on persistent application workflows and large-scale heterogenous data analysis

pipelines. This presentation discusses the HPC environment for the DoD and how to utilize the DoD's most powerful supercomputing resources for analytic capability development.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56724 - R Shiny: A Beginner's Introduction and Application for Mortality Estimate Collection

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Ranny Maurer; Tracy Negus		

Abstract: R Shiny is a package available in the free, open-source R-language that facilitates building quick and easy-to-use web applications for interactive data visualization, sharing of analyses, and data collection.
Updating the mortality models for the Joint Medical Planning Tool (JMPT) required data on situations that have not been recorded in recent history, thus requiring subject matter expert (SME) estimation. Using Shiny, we were able to quickly develop and deploy a web-based application for collecting time-based mortality estimates from our SMEs. The Shiny interface allowed us to provide ready access to reference materials so estimates could be collected using consistent assumptions, along with instant visualization of the estimates being entered. We were also able to chunk the data entry task to help make it more manageable for the SMEs. The ready availability of feature packages and user-community support made this a beginner-level Shiny project. This presentation will discuss the process of creating a Shiny app, some features that provide off-the-shelf enhanced capabilities, and demonstrate our simple Shiny application used to collect SME estimates of mortality.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

55354 - Army Operations Research International Programs: Opportunities for Analysts and Organizations

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Martin Dubbs		

Abstract: The U.S. Army operations research community has a long history of cooperation and analytic exchanges with allies around the world. However, many Soldiers and Army Civilians are unaware of the opportunities for professional development and collaboration available under the international exchange programs, do not know how to become involved, and have insufficient information about how the programs work. The purpose of this presentation is to provide the information required by U.S. Army operations research analysts to better understand how the international exchange programs work and how to become involved.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56837 - Virtual Wargaming Methodology via SIPR

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Claire Fisher		

Abstract: How does an analyst shift a massive, in-person wargame into a virtual, distributed event? What can an analyst do to maintain momentum on a series of wargames that started in person but must continue now online? Which previously unexpected factors does an analyst consider when designing and planning a virtual wargame? Since April 2020, the Center for Army Analysis has designed and run several wargames with a focus on balancing analytic returns and participant/analyst health and safety. This unclassified presentation will discuss the methodologies for three virtual wargames in a case study format, with the intention of sharing lessons learned and best practices developed. There will be a focus on the wargame design implications and considerations for different secure internet protocol router network (SIPRNET) platforms (Defense Collaboration Services (DCS), Global Video Service (GVS), and secure video teleconference (SVTC)/file sharing). The first case was a heavily adjudicated wargame originally designed as a large in-person event. The in-person event was canceled and the methodology modified to be a distributed event facilitated by SVTC and SharePoint. The second wargame utilized DCS as the platform to continue an in-progress wargame series. The third wargame was a standalone seminar-style table-top exercise held over GVS.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

57007 - Uncovering Hidden Structures Beneath the Data Lake

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Craig Nilson		

Abstract: As the analytics community constantly adapts new technologies to provide more robust data storage, and processing, older data and models are often lost within the depths of these new technologies. This is because proponents of new technologies often replace old paradigms with new ones instead of seeking to truly improve or build upon existing paradigms. Moreover, organizations are often limited in the resources they can dedicate to properly sustain, reengineer, or revive antiquated data and models while merging new and existing paradigms. This inevitably leads to the accumulation of stale and unused data and models within the data lake, which amass substantial costs for data and analytics proprietors. In order to save costs and ensure that older data and models are not wasted, it is important for data analysts to develop strategies for ensuring greater continuity between older and new technologies.

This presentation aims to propose strategies that data analysts could use to ensure this continuity. First, it will describe "digital archaeology" techniques for gathering data with the help of automated tools. Second, it will discuss the use of network graph analysis and visualization to reveal macro-level relationships among the data and model structures. The presentation will highlight the insights gleaned from using these strategies to aid in technology transitions and provide guidance on how to communicate these strategies effectively to senior decision makers.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56834 - Space Data Analysis Outreach

Start Date: 6/24/2021	Start Time: 11:00 PM ET	End Time: 11:30 PM ET
Authors: Lt Col Adam Messer; Benjamin Johnson; William McEntee; Lt Michelle McGee		

Abstract: The Analysis and Assessments division in Space Operations Command (SpOC/S9A) is pioneering an effort to solve problems within our subordinate units by utilizing data science techniques. This effort includes informing the units of the capabilities SpOC/S9A can provide, educating them about data science and its benefits, and consulting with them on their projects. Residing within the command allows us to leverage our "insider" position to be more responsive to the units. We will highlight our recent success of projecting the COVID pandemic using machine learning and discuss future plans.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56861 - Slow is Smooth and Smooth is Fast

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Michael Woudenberg		

Abstract: Operations research is challenged to answer complex problems in dynamic environments and under tight timeframes. Decision makers and analysts are pressured to demonstrate results and progress quickly yet often what is needed is to spend more time understanding the problem. This presentation will investigate the military adage "slow is smooth and smooth is fast", its parallels around the world and throughout history and how the operations research analyst can slow down to perform impactful analysis with reduced effort.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56661 - Best Practices in Decision Analytic Presentations to Influence Action

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Erika Garcia-Boliou		

Abstract: As a data professional, it is imperative that when we communicate our findings, we not only do it lucidly but also in a way that will influence action. Our analysis has more value when we can help organizations make decisions and more importantly, ACT on those decisions.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

57232 - DAF Operations Assessment Working Group: Education & Training Update

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Lt Col Allen Cohen; Linda Lee		

Abstract: The lack of structured education and training (E&T) for operations assessment (OA) creates capability deficiencies where Department of the Air Force (DAF) personnel must learn on-the-job through trial and error. OA practitioners require proper E&T, as any operator within their respective field, to successfully fulfill their roles supporting joint warfighting commanders. While some venues exist, there is no standard OA pipeline for DAF members.
The DAF's OA Working Group recently completed two 3-month Sprints within its Assessment E&T Line of Effort. Sprint 1 examined the current state of DAF OA E&T, proposed a future state for DAF assessors, identified enterprise-wide gaps, and recommended options to enhance institutional OA

proficiency. Sprint 2 refined the recommendations from Sprint 1, developed an Implementation Plan with prioritized options, and coordinated near- and far-term actions with DAF E&T organizations. This briefing presents findings from Sprints 1 and 2. It lays out immediate next-steps for the DAF to continue improving OA E&T. The goal of this presentation is not merely to convey information, but to advocate an ongoing path towards improving OA E&T, for the benefit of decision-makers and assessors at every Major Command, Air Operations Center, and Joint Task Force.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56998 - What is Your Research Verb? The Actions You Take Determine the Analytical Techniques You Will Use.

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Kenneth W. Lewis		

Abstract: What is your research verb? What is the action associated with your research question? What exactly are you observing from or acting upon the data you collect? Are you describing, counting, comparing, relating, predicting, explaining, simulating or costing behavior? While the vision of your research may be clear in your mind, if you don't clearly identify the correct research verbs then you may end up using an invalid or incorrect analytical method to get at the answers to your research questions. Each research verb you deal with has a descriptive or inferential technique associated with it. Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 35 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results.

Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56980 - Overcoming Analytic Friction to Streamline Decision Making

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Kierra Shay; SIDI ZEID CHLEUH; Jamie Conti		

Abstract: In the Department of Defense's endeavor to adopt data driven practices, analytic friction emerged as a side effect of disparate development efforts. Though the theory of friction in business is not new, we will focus on the reduction of analytic friction. We define analytic friction as difficulty in identifying and navigating available and validated analytical products. Analytical products include descriptive metrics and predictive models. Symptoms of analytic friction include duplicative datasets, incongruent products, and non-repeatable analysis.

Each analytical product is a well thought out story - a repository of domain specific use cases materialized. Developing an interface to navigate these well-defined products is analogous to connecting the use cases and processes they represent. Our interface is a roadmap for the user highlighting multiple paths to answers utilizing products with which they may not be familiar.

By developing with all users in mind, our interface reduces the friction of performing day-to-day and ad-hoc analysis while also introducing users to a wider toolset. The interface is customizable and scalable to meet fleet, program, and enterprise decision making needs in support of the DoD's transition to a data centric organization.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56777 - Finding the Story in Your Data

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
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.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

56969 - Analytic Capability Development Focus Session Hotwash and Strategy Session

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 3:00 PM ET
Authors: Christopher Santos; Melissa Sayers; Chad Kimmel		

Abstract: This is a 60-minute session hotwash for the 89th MORSS Analytic Capability Development (ACD) Focus Session. All persons interested in professional development, training opportunities, and hardware/software availability for the analyst are welcome to attend. Feedback on the conduct and content of the week's focus session presentations are welcome. We will also begin a roster of those willing to keep abreast of future ACD developments in the future, or who would like to participate in advancing ACD within the broader MORS community.

Classification: UNCLASSIFIED
Working Group:FS 01 Analytic Capability Development

Special Session

57388 - Rist Prize Classified Competition

Start Date: 6/21/2021	Start Time: 12:00 PM ET	End Time: 2:00 PM ET
Authors: Mr. James Richards		

Abstract: The Rist Prize recognizes the practical benefit sound operations research can have on "real life" decision-making and seeks the best implemented national security operations research study from those submitted in response to this 2020 Rist Prize Call for Entries.

The Rist Prize Schedule is below:
The Rist Prize schedule:
Monday 21 June (all times EASTERN)
1200 - Strategic Fires Study (classified)
1300 - Tactical Intelligence Targeting Access Node Analysis of Alternatives (classified)
***60 minute break for change over from SIPR to NIPR ***
1500 - An Operational Risk-Based Approach to Multi-Facility Staff Allocation for U.S. Customs and Border Protection (unclass)
1600 - COVID-19 Analysis Project (unclass)

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

56800 - Distributed Wargaming Workshop for Force Design, enabled by the Joint Analytical Wargaming Tool (JAWT)

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 2:00 PM ET
Authors: Chris Manning; Mr Lance Holden		

Abstract: The Land Capability Analysis Branch within Australia's Defence Science and Technology Group has developed and applied military experimentation, analytical wargaming, computational and judgement based red teaming analytical tools and methods to address Defence problems and shape the future of the Australian Army for over 25 years. These techniques analyse the effectiveness and robustness of future military systems, structures and concepts and thereby support evidence-based decision making. This workshop will apply a learn-by-doing approach to connect, coordinate and enhance the existing Defence Analytical Wargaming Network (DAWN) using the Joint Analytical Wargaming Tool (JAWT) immersing participants in a Joint and Land Force Design problem. By playing an existing distributed wargame participants will be exposed to a number of different Methods, Models and Tools (MMT) which can be used within an Analysis Campaign to represent kinetic and non-kinetic effects and address data capture requirements to meet analytical needs. These MMT include; wargame mechanics, causal modelling, red-teaming techniques, and operations research and systems analysis approaches. Participants will also contribute to the design and refinement of the distributed wargame and wargaming process as well as the improvement of JAWT and the DAWN for collaboration.

Classification: UNCLASSIFIED
Working Group:Special Session

57327 - First Timer Orientation

Start Date: 6/21/2021	Start Time: 1:00 PM ET	End Time: 2:00 PM ET
Authors: Ms. Sarah E Stewart		
Abstract: Join members of the 89th Leadership Team to learn how to get the most out of the MORS Symposium. Review the Schedule of events, 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! Classification: UNCLASSIFIED Working Group:Special Session		

57451 - MORS Community of Practice (CoP) Special Meeting

Start Date: 6/21/2021	Start Time: 2:00 PM ET	End Time: 3:00 PM ET
Authors: Ms. Kristi Bane		
Abstract: MORS has 22 communities of practice (CoP) that meet throughout the year on various topics ranging from Women in MORS to Campaign Analysis. The CoPs were formed to continue discussions from the annual Symposium and Special Meetings. CoPs meet monthly for virtual sessions to discuss outstanding issues, share best practices and works in progress. CoP sessions often feature guest speakers addressing critical issues or important training, tips and techniques relevant to the community's focus. The MORS Communities of Practice are an excellent way to enhance your professional development and get involved in MORS with a limited time commitment. If you would like to learn more about the CoPs are get more involved, attend this informational session to learn more! Classification: UNCLASSIFIED Working Group:Special Session		

57389 - Rist Prize Unclassified Competition

Start Date: 6/21/2021	Start Time: 3:00 PM ET	End Time: 5:00 PM ET
Authors: Mr. James Richards		
Abstract: The Rist Prize recognizes the practical benefit sound operations research can have on "real life" decision-making and seeks the best implemented national security operations research study from those submitted in response to this 2020 Rist Prize Call for Entries. The Rist Prize Schedule is below: The Rist Prize schedule: Monday 21 June (all times EASTERN) 1200 - Strategic Fires Study (classified) 1300 - Tactical Intelligence Targeting Access Node Analysis of Alternatives (classified) ***60 minute break for change over from SIPR to NIPR *** 1500 - An Operational Risk-Based Approach to Multi-Facility Staff Allocation for U.S. Customs and Border Protection (unclass) 1600 - COVID-19 Analysis Project (unclass) Classification: UNCLASSIFIED Working Group:Special Session		

57372 - MORS 89th Symposium Plenary

Start Date: 6/22/2021	Start Time: 10:30 AM ET	End Time: 12:15 PM ET
Authors: Ms. Jennifer Ferat		
Abstract: Join us for the 89th Symposium opening session with the Keynote address from Dr. Julie Swann, A. Doug Allison Distinguished Professor and Department Head of the Fitts Department of Industrial and Systems Engineering at North Carolina State University. Following the keynote address will be the MORS sponsor panel: Panelists: Dr. Steven Stoddard, Army Sponsor Mr. Douglas Hoffman, Marine Corps Sponsor Ms. Mindy Montgomery, Navy Sponsor Ms. Virginia "Robbin" Beall, Navy Sponsor Mr. R. Chandler Swallow, Air Force Sponsor Mr. John Garskta, OSD Sponsor Mr. Jonathan McEntee, DHS Sponsor Moderator: Mr. David Saranchak, MORS President-Elect Please complete the secondary registration to participate: https://register.gotowebinar.com/register/3055565218604164363 Classification: UNCLASSIFIED Working Group:Special Session		

57120 - MORS Junior Analyst Program Information Session

Start Date: 6/22/2021	Start Time: 12:00 PM ET	End Time: 12:30 PM ET
Authors: Dr. Jonell N Samberson; David J. Myers, Ph.D.		
Abstract: Join us for a discussion focused on the MORS Junior Analyst Program! Junior Analysts are the next generation of operations researchers. Are you forty-years old or less? Do you have less than ten years of experience within the National Security Community? If yes, you are an ideal candidate to join MORS as a Junior Analyst Member! More information can be found on the MORS Website: https://www.mors.org/Member-Central/Become-a-Member/Junior-Analyst Classification: UNCLASSIFIED Working Group:Special Session		

56920 - Readiness Special Session – Senior Leader Perspectives on Analytics to Enhance Readiness-Related Decision-Making

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Shaun Doheney		
Abstract: "We need some fundamental changes in how we approach readiness, how we generate it, analyze it, measure it, integrate it, articulate what we need, and predict what the return on our		

readiness investment might be." – Commander, U.S. Fleet Forces Command, Admiral Christopher Grady, U.S. Navy

We will kick off the Readiness Working Group with this special session on readiness. Join us for this Special Session to hear from the perspective of senior leaders who rely on the MORS community for analytics to enhance decision-making. The National Security and National Defense Strategies place a renewed emphasis on readiness and the United States' ability to produce and sustain ready forces to compete, deter, and win in a complex security environment against any national security challenge. Further, the complexity of readiness generation and consumption increases significantly in the face of a global disrupters such as the COVID-19 pandemic. Keeping in mind the theme of the 89th MORS Symposium, Analytics to Enhance Decision-Making, Working Group 19 is committed to exploring evolutionary (gradual development grown from mature and proven techniques) and revolutionary (disruptive and dramatic shift in analytic processing) analytical techniques and tools that allow for real improvements in how we plan, manage, and assess the readiness of our organizations and individuals to meet real world missions. We look forward to having you join us in these important discussions.

Classification: UNCLASSIFIED
Working Group:Special Session

56652 - Data Science and Artificial Intelligence (DS&AI) Community of Practice Meeting

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Mr. David D. Saranchak		

Abstract: Come join the annual meeting of the Data Science and Artificial Intelligence (DS&AI) Community of Practice! The intent of this meeting is to connect DS&AI practitioners, researchers and leaders across the community to discuss best practices, insights, and lessons learned with a common goal of leveraging the unique tools, techniques and technologies of the field.

Classification: UNCLASSIFIED
Working Group:Special Session

58459 - Logistics Community of Practice Special Session

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 5:00 PM ET
Authors: Norm Reitter		

Abstract: The MORS Logistics Community of Practice is completing our third year. We focus on bringing together an eclectic group of logistics professionals across the National Security Community to discuss the hottest issues, review potential and applied solutions, and network whenever possible. This special session focuses on our 2020-2021 year in review along with discussions of where we want to take the Log COP for the 2021-2022 year. We will spend some time introducing participants and talking through current challenges. Logistics is very broad and touches many professions. Come join us for a candid talk, to meet others in the community, and to hear about where we are headed.

Classification: UNCLASSIFIED
Working Group:Special Session

56976 - Panel Discussion - Coast Guard Analytics in Support of National Security

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Michael R. Hieb, PhD		
Abstract: The US Coast Guard (USCG) faces unique challenges within DHS. This panel will consist of Senior USCG and Science and Technology (S&T) Directorate leaders to discuss the state of Analysis within the USCG to both support acquisitions and to address data readiness. S&T conducts extensive R&D and studies for the USCG. This panel will explore current challenges and future needs. Classification: UNCLASSIFIED Working Group:Special Session		

56540 - Women In MORS Community of Practice Special Session

Start Date: 6/22/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Ms. Renee G. Carlucci, FS; Ms. Brittlea S. Brown; Maggie Dozier; Ms Cherish Joostberns; Ms. Sarah E Stewart; Ms. Megan Wilton		
Abstract: According to research studies, critical career-enhancing opportunities are shared unevenly by people in positions of power and influence, often without realizing that certain groups are disproportionately excluded. Hard work and technical skill are the foundation of career progress, but without some access to formal and informal networking opportunities, that progress can be stalled. Are you often the only woman at the table in your meetings or do you have few women in your organization? The Women In MORS Community of Practice invites you to a Special Session for their June COP Meeting featuring a panel presentation on effective networking strategies, as well as an interview segment with a contemporary female trailblazer in our field. Classification: UNCLASSIFIED Working Group:Special Session		

56830 - Becoming a MORS Author

Start Date: 6/22/2021	Start Time: 4:30 PM ET	End Time: 5:30 PM ET
Authors: Mr. Terrance J. McKearney, FS		
Abstract: Promoting the professionalism and advancement of operations analysis in the support of national security through publishing is a primary mission of MORS. The Society offers several publishing platforms for analysts to share their work: the journal Military Operations Research (MOR) is a peer reviewed academic periodical that provides authors the opportunity to publish their work in a highly regarded, formal forum. The Phalanx is the Society's quarterly magazine that shares information about Society activities, publishes thoughts and opinions from the community's leasers, and allows practicing analysts the opportunity to share their current work with colleagues. Finally, MORS publishes a range of books and monographs on analytic techniques and procedures. During this session, members of the Society's Publications Committee, the MORS staff, and the editors of MOR and Phalanx will discuss opportunities for publication in each of these venues and the steps aspiring authors should take in getting their work in print. Classification: UNCLASSIFIED Working Group:Special Session		

57334 - Army Junior/Senior Analyst Panel

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Mr. Martin Dubbs		
Abstract: Coming Soon. Classification: UNCLASSIFIED Working Group:Special Session		

56974 - DHS Junior/Senior Analyst Panel

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Michael R. Hieb, PhD		
Abstract: This Session offers an opportunity for DHS Junior Analysts an opportunity to ask questions and interact with Senior Analysis in DHS. At the beginning of the session, Senior Analysts will give overviews of their experiences and topics of importance in the practice of OR for National Security. For the main portion of the meeting, the Junior and Senior Analysts will engage in a wide ranging discussion stimulated by current DHS analytic needs and issues. The session is an excellent opportunity for Junior (and other) Analysts to meet people who have made significant contributions to national security studies and to learn about the experiences of those who have "been there and done it." 40-50 people expected Classification: UNCLASSIFIED Working Group:Special Session		

56829 - Ethics Special Session

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Mr. Terrance J. McKearney, FS		
Abstract: OR practitioners must be seen as following the highest ethical standard in their daily efforts: they need to be seen as honest, forthright, and dedicated to the highest principles of honesty. This workshop, hosted by the MORS Ethics Committee, will review the MORS Code of ethics and as well as review the current thought in professional ethics for analysts and the ethical issues often faced by practicing analysts A popular session in past MORSS, the Ethics Special Session will allow junior and senior analysts from both industry and government to explore ethical issues and discuss the role of ethics in their efforts to provide forthright and honest assessment. Because attaining these ideals is a matter of constant practice and self-awareness, the Special Session 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 work as analysts will be challenged. As in past sessions, this will result in a lively dialogue on the ethical challenges analysts face. Classification: UNCLASSIFIED Working Group:Special Session		

57315 - MORS Campaign Analysis Workshop Special Session

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Dr. Andrew J. Turner		

Abstract: The 2nd MORS Campaign Analysis Workshop will be held in Feb/Mar 2022. This special session will talk about the challenges of campaign analysis, the objectives of the workshop, and the working groups to be held. Please attend to learn more, ask questions, provide feedback, and figure out how you want to participate.

Classification: UNCLASSIFIED
Working Group:Special Session

55295 - Out-Brief from the 2021 MORS Counter-Unmanned Aircraft Systems Workshop / Cost Analysis Community of Practice Annual Meeting

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Ms. Emily Anne Foglia; Mr. John Moskowitz		

Abstract: In March 2021, MORS convened the inaugural Counter-Unmanned Aircraft Systems (C-UAS) Workshop titled "Acquisition Analytics for Counter-Unmanned Aircraft Systems". The intent of the workshop was to share information and analysis used in support of C-UAS requirements development, acquisition, deployment, and sustainment across the Department of Defense and the Department of Homeland Security.

The Workshop featured three primary Working Groups (WGs), one being the Cost Estimation WG. The WG, led by the Chair and Co-Chair of the Cost Analysis Community of Practice (CoP), explored best practices for the development of cost estimates for C-UAS as well as lessons learned from related efforts. Discussions focused on tools, techniques, and products with the goal of identifying a repeatable process for generating consistent, credible estimates. Two products emerged from the workshop:

1) The outline of a comprehensive cost, technical, and performance database for C-UAS. The database will serve as an authoritative source of information, support the identification of analogous systems, and facilitate the generation of parametric cost estimating relationships.

2) A standardized Work Breakdown Structure (WBS) for C-UAS. The WBS will ensure the development of complete, credible cost estimates as well as enable consistent cost reporting across systems/programs and organizations.

This presentation will discuss the impetus behind the workshop; describe the various WG events that occurred; highlight key findings, recommendations, and deliverables; and offer insight into future WG/CoP efforts.

The Special Session will also serve as the Cost Analysis CoP's annual face-to-face meeting, which is held in conjunction with the Symposium.

Classification: UNCLASSIFIED
Working Group:Special Session

57398 - USMC Junior Analyst Session

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Mr. Douglas Klett Hoffman		
Abstract: This is an opportunity to join Mr. Hoffman, the senior analyst in the Marine Corps, in an informal setting and hear his thoughts on the application operations research analysis both in general and in the Marine Corps. It is also an opportunity to engage him in a question and answer session and learn from his vast experience. Mr. Hoffman is a Senior Leader serving as the Director of the Operations Analysis Directorate (OAD), Headquarters Marine Corps, Combat Development and Integration (CD&I), Quantico, Virginia. He leads the largest group of operations research analysts, both military and civilian, in the Marine Corps and is a member of the Senior Advisory Group of the Analytic Federation. Classification: UNCLASSIFIED Working Group:Special Session		

56722 - MORS Affordability Community of Practice Special Session

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Bruce Riggins; Dr. Kendall Wheaton		
Abstract: This year we met twice, sharing new directions for the Affordability Analysis CoP and exploring how those directions might be addressed. Resources are limited and Affordability Analysts have the processes, methods, and tools to explore how to make decisions that fit within the resources that are available. The challenge is: what resources are most important? Do decision-makers agree on the risks presented in converting one resource (e.g. equipment) into another resource (e.g. money or time). As an example: trained personnel can get things done faster and better, but are they available? Can we spend a little more time and get the same thing done with fewer trained personnel? Is the time and money spent to provide additional training a better use of resources than the extra money required to obtain trained help right away? Will the person be available for the extra time? What has to be given up to use one resource for extra time, while needs for that resource go without? Before we can address how to help decision-makers, we need to know what they need help with, what resources or contexts are in their decision mix, and how do we help provide a quantitative response that helps them make the best decision. Toward that exploration, we will hear from two guest speakers: Dr. David Tate of IDA and Kevin Buck of Mitre Corp. From Dr. Tate we will hear about two recurring challenges in defense portfolio selection problems that are multiple objectives and non-monetary (in addition to monetary) resource constraints. Established methods exist for dealing with one or the other of these, but not both at once. This talk develops a conceptual model that places these two complicating factors into a common decision analysis framework, inspired by the Lagrangean duality between resource constraints and objective function coefficients in a notional optimization formulation. Mr. Buck will share about an ROI-Based Post-Investment Value Management Capability created by The MITRE Corporation to optimize the selection, elimination, and balancing of investments based on priorities, costs, benefits, uncertainties, and risks. The capability includes ROI management process guidelines, an intuitive ROI Analysis Model (RAM) for selecting and monitoring selected investments over time (based on comparisons of actual performance relative to initial ROI expectations), and an early warning system to automatically trigger course correction recommendations for investment decision-makers and metrics owners (based on degree and duration of performance variance). While the academic underpinnings of this capability derive from commercial industry ROI techniques, they have been significantly tailored to address the unique circumstances for government agencies.		

As we continue the discussion in a Special Session, we hope you will join us to share your expertise
Classification: UNCLASSIFIED Working Group:Special Session

57325 - MORS Campaign Analysis Community of Practice

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Dr. Andrew J. Turner		
Abstract: The MORS Campaign Analysis Community of Practice was stood up in early 2020. This special session will discuss the projects and tasks that the CoP has completed, our plans for the coming year, and the general challenges we face and how we can overcome them. This special session will start with a presentation from the CoP leads. Most of the time will be left for discussion and feedback from the audience. Classification: UNCLASSIFIED Working Group:Special Session		

56568 - MORS Community of Practice (CoP) Special Session (Cyber)

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET
Authors: Mr. Donald H. Timian; Dr. Rajive Bagrodia; Mr. John W. Diem; Kent Pickett		
Abstract: The 89th Military Operations Research Society (MORS) Cyber Community of Practice (CoP) Special Session will start with a review of the Cyber CoP's Charter followed by a presentation by Dr. Rajive Bargodia titled "A Modeling & Simulation-Centric Approach to Cyber Resilience:" The need to secure information and weapon systems against cyber threats is a critical objective for the DoD. Current models used in cyber risk assessment do not include the risks inherent in (wireless) communication networks or reflect the dynamic and adaptive nature of many cyber-attacks initiated by unwary or malicious insiders. Thus, presently employed models do not provide methods to assess the emergent resilience of a system resulting from the aggregation of several components, bus or network connections, and the interactions among them while operating in a harsh and contested communication environment. Working with a diverse set of DoD partners, we have developed a dynamic, scalable, secure virtual environment for the end-end cyber resilience assessment of tactical systems. The talk will describe a live, virtual, and constrictive (LVC) cyber range with the following key attributes: o Integrate cyber and kinetic operations o Ability to incorporate unmodified, live software as emulated sub-system(s) o Ability to connect emulated sub-systems using battlefield network digital twins and/or virtualized buses (e.g., Military Standard 1553) o Replicate known and zero-day cyber-attacks at the sub-system and/or system level o Perform repeatable experiments running faster than real-time The talk will briefly cover the primary concepts of the SCALABLE cyber range and a use case for a StealthNet/CyberTASE (Test, Analysis, and Simulation Environment) Test Resource Management Center (TRMC) funded effort."		

Following questions and answers, if time permits, possible future Cyber CoP presentations / topics will be discussed.

Classification: UNCLASSIFIED
Working Group:Special Session

56983 - Report on the Counter Unmanned Aircraft Systems (C-UAS) Special Meeting

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 5:30 PM ET

Authors: Michael R. Hieb, PhD; Dr. John Dargan; Dr. Daniel Thomas Maxwell; Ms. Emily Anne Foglia; Chris Adams; Dr. John R. Hummel, FS

Abstract: Counter Unmanned Aircraft Systems (C-UAS) protect critical assets and events against UAS threats. UAS are being used in various conflicts around the world and have the potential to be used domestically in the US. An important objective of Department of Homeland Security (DHS) and the Department of Defense (DoD) is to cost- effectively field C-UAS capabilities that will protect these critical assets against UAS threats.

DHS sponsored a MORS Special Meeting on Counter Unmanned Aircraft Systems (C-UAS) Analysis for Acquisition in March, 2021. This Panel will report out on the Special Meeting and it's finding.

The Meeting had four working groups:

1) Mission effectiveness estimation and assessment,
2) Cost estimation,
3) Development of UAS risk analysis measures and techniques, and
4) Synthesis.

The workshop had representation from across DHS (includingScience and Technology Directorate, Transportation Security Administration, Customs and Border Protection, and the US Coast Guard), DoD, State and Local Authorities, and other government agencies.

Panel members will outline the findings and conduct a discussion of how to address future analysis needs.

Classification: UNCLASSIFIED
Working Group:Special Session

57288 - Global Strategic Framework (GSF) – Framework for Examining Trade-Space Spanning Time, Geography, and Strategy

Start Date: 6/25/2021	Start Time: 2:30 PM ET	End Time: 4:00 PM ET

Authors: Mr. Kyle Shipley Minor; MAJ Paul M Kearney; MAJ Dan Stack

Abstract: Defense Planning Scenarios (DPSs) support DOD senior leadership decisions addressing force sizing, shaping, and capability development by providing a starting point for analysis. These DPSs characterize important warfights for which the Joint Force must be prepared to engage and win; but are limited in their relatively narrow geographic, strategic, and temporal focus. The DPSs are necessary, but insufficient, to enable the creation and comparison of innovative, viable warfighting options addressing the full competition-crisis-conflict spectrum against adversaries with global

strategic interests and an emerging ability to defend those interests forward. This Army Special Session will characterize the strategy, planning, and programming alignment problems engendered by the limitations in the extant DPS suite; propose a global strategic framework as a potential solution; explain how to construct this framework and confirm its utility; and demonstrate how a completed framework can integrate new strategic problems into the existing senior leader decision space.

Classification: SECRET NOFORN
Working Group:Special Session

Tutorial

56821 - Antifragility and Future Conflict: A Tutorial

Start Date: 6/21/2021	Start Time: 10:30 AM ET	End Time: 11:30 AM ET
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.

Classification: UNCLASSIFIED
Working Group:Tutorial

56486 - Battlefield AI and Autonomy for Non-Technical Beginners

Start Date: 6/21/2021	Start Time: 10:30 AM ET	End Time: 4:30 PM ET
Authors: Mr. Jerry L. Schlabach		

Abstract: Modern Artificial Intelligence (AI) and Machine Learning (ML) are disruptive technologies that have recently blossomed under the market leadership of the U.S. commercial sector. The U.S. Government, its military competitors, and the global defense industry are racing to militarize these newly refreshed technologies, which ironically owe much of their contemporary existence to U.S. Defense research from previous decades. Future autonomous systems will certainly leverage and weaponize AI/ML technologies, which in turn will likely revolutionize warfare. In response to substantial positive feedback from a set of tutorials, presentations, and special sessions in 2019 and 2020, this tutorial consolidates those presentations to provide a solid conceptual overview for non-technical beginners. This extended session 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 many common misperceptions about AI/ML and battlefield autonomy, to include the likely technical, moral, and operational limits to weaponization.
- Introduce, at a very high level, the AI and ML fields, with focused 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).
- Describe the likely warfighting implications for integrating AI/ML technologies into the 'Intelligent Battlefield of Things' (iBOT) and the Smart Kill Cloud.
- 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 in the Operations Research Department at Raytheon Missiles and Defense in Tucson, who also co-chairs the newest 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 20 years' experience at integrating AI into C4ISR prototypes. Jerry will be asking the other WG-35 co-chairs to co-present, with color commentary, this special session to provide a broader perspective for understanding the impact of AI/ML on future battlefields.

Classification: UNCLASSIFIED
Working Group:Tutorial

57050 - Human Factors in Visual Data Analysis

Start Date: 6/21/2021	Start Time: 10:30 AM ET	End Time: 11:30 AM ET
Authors: Dr. Paul M. Thompson		
Abstract: This tutorial treats some of the human factors aspects of visual cognition that are key in designing effective data displays in defense and security sector planning. We review basic features and limitations of human visual processing systems, illustrate how to leverage them to design effective data displays, and show examples of displays that fail to account for these factors. We draw material from several of fields of study, including Cognitive Psychology, Visual Analytics, Scientific Visualization, Exploratory Data Analysis, and Statistics. Classification: UNCLASSIFIED Working Group:Tutorial		

56989 - Machine Learning Using Robust Data Mining Methods

Start Date: 6/21/2021	Start Time: 10:30 AM ET	End Time: 12:00 PM ET
Authors: Dr. Thomas A. Donnelly		
Abstract: Through case studies, you'll learn to build better and more robust models with advanced predictive modeling techniques. Featured methods will include many types of regression, neural		

networks, and decision trees. Part 1 will focus primarily on splitting your data into training, validation (tuning) and test subsets to prevent over fitting. Part 2 will focus on different data mining approaches. You will also see how to use graphical and statistical comparison techniques to help choose the best predictive model.

Featured case studies include building a dozen surrogate models of a computer simulation of a helicopter flying surveillance and identifying the best predicting model, as well analyzing the 1998 KDD Cup Cyber Attack Data set with over 40 possible causes of 20 types of attack and building a robust ensemble predictor model. This tutorial is for analysts, scientists, engineers and researchers interested in learning how predictive modeling can help them use the data they have today to better predict tomorrow.

Classification: UNCLASSIFIED
Working Group:Tutorial

56938 - All Graphs are Wrong – Some are Useful

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 1:20 PM ET
Authors: Dr. Thomas A. Donnelly		
Abstract: With a bow towards Design of Experiments legend George Box and his famous quote that "All models are wrong, but some are useful," this tutorial will focus on the creation of better graphs. Data visualization is our most efficient tool for understanding information, but it's far from perfect. Collected data is an imperfect representation of the underlying information. A graph is an imperfect representation of the data. Our understanding is an imperfect representation of the graph. But don't despair, this tutorial - based on the work of Xan Gregg of the SAS Institute - will discuss how understanding visual perception can help us make more effective data visualizations. Data visualization is a craft and a review of the ideas of thought leaders in the field will be presented. The 8 Grand Principles of data visualization espoused in the four books of Edward Tufte, will be demonstrated Classification: UNCLASSIFIED Working Group:Tutorial		

56865 - Design of Experiments for Stochastic Simulation Modeling

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 2:30 PM ET
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 two-hour 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 and fractional factorial do not work well because responses are typically nonlinear 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, Gaussian process models (Kriging), and neural networks.

Classification: UNCLASSIFIED
Working Group:Tutorial

56911 - Tableau for the Analyst

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 3:30 PM ET
Authors: MAJ Brian Harris		

Abstract: Tableau is one of the most popular analytics software tools across DoD and the private sector. This tutorial is intended to be a hands-on workshop where participants can learn the basics of using Tableau Desktop, Tableau Prep, and Tableau Server. The tutorial will include content around building products frequently used in the military analytic community as well as cover some additional topics such as advanced geospatial analysis, R/Python integration and advanced analytics. The tutorial will also highlight various DoD and government use cases and community resources.

Note: While having Tableau Desktop and Prep installed to allow you to follow along is not required, it is recommended. A trial license will provided during the class if needed.

Classification: UNCLASSIFIED
Working Group:Tutorial

57418 - The Art of Successful Analysis

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 1:30 PM ET
Authors: Mr Trip Barber		

Abstract: A successful analysis project is one that directly influences an important national security decision, satisfies the senior customer, and makes the analytic team that did the work proud. Achieving this success in analysis takes a focused effort. There are specific things that the leader of an analytic team needs to do in order to ensure that his or her analytic project team delivers a quality product that has this impact. The presentation summarizes the lessons that I have learned through 25 years of leading analysis projects in the Navy headquarters staff in the Pentagon and 6 years as a corporate chief analyst in private industry.. It identifies five steps in the end-to-end process of delivering useful analysis to decision-makers, from focusing the key question through podium style in delivering the end-of-project briefing to a senior audience, and it describes the order and methods by which these steps should be done.

Classification: UNCLASSIFIED
Working Group:Tutorial

56527 - Tutorial on Chancification using the free SIPmath Tools and ChanceCalc

Start Date: 6/21/2021	Start Time: 12:30 PM ET	End Time: 3:30 PM ET
Authors: Dr. Sam Savage; Mr. Shaun Doheney		

Abstract: Electrification is the process of replacing technologies that use fossil fuels with those that use electricity. Chancification is the process of replacing computations based on deterministic

numbers with those based on probability distributions. From this perspective, the electricity of Chancification are Stochastic Libraries of Monte Carlo trials in the Open SIPmath™ standard. These may be generated using R, Python, or the free SIPmath Tools from 501(c)(3) nonprofit ProbabilityManagement.org. Continuing this analogy, the nonprofit has just introduced the first generation of it power grid, the SIPmath Network, and extremely simple to use light bulb, called ChanceCalc.

This tutorial shows how The Open SIPmath™ Standard from 501(c)(3) ProbabilityManagement.org allows simulations in almost any environment to be networked by communicating uncertainties as arrays of Monte Carlo realizations called SIPs (stochastic information packets).

The free SIPmath Modeler Tools create interactive simulations in native Excel which run 10,000 trials or more per keystroke. And the models created by the tools do not require macros or add-ins to run, but leverage the Data Table function, so they may be shared with any Excel user.

This tutorial will show how to use these simple tools together to start your organization down the path of Chancification.

Participants will learn how: to create interactive risk dashboards that perform thousands of Monte Carlo trials per keystroke in native Excel with the free SIPmath Tools. Note that these dashboards may be run in native Excel by those without the tools; to create SIP (stochastic) libraries using R or the SIPmath Tools; to post SIP libraries to the internet or intranet; and to create enterprise wide decision dashboards based on these SIP Libraries

This presentation is for all Excel users who make decisions under uncertainty, so bring your laptop. No statistical background is assumed, but for those with extensive training in the area, this tutorial should repair the damage.

Classification: UNCLASSIFIED
Working Group:Tutorial

56937 - Custom DOE – Making Your Experimental Design Fit the Problem

Start Date: 6/21/2021	Start Time: 1:30 PM ET	End Time: 2:30 PM ET
Authors: Dr. Thomas A. Donnelly		

Abstract: This tutorial will present solutions to real-world Design of Experiment (DOE) problems. Nearly all of the 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.

Classification: UNCLASSIFIED
Working Group:Tutorial

57438 - Practical Implementation of Operational and Strategic Assessments

Start Date: 6/21/2021	Start Time: 1:30 PM ET	End Time: 3:30 PM ET
Authors: Colonel Marvin Lee King, III		

Abstract: Assessments in the military continue to struggle with methods of implementation. Assessment teams continue to execute inadequate processes that do not inform leaders or staffs in a meaningful way. By looking at the challenge of assessments as an analysis that requires decomposition of the problem and synthesis of results, assessment teams can better see the reasons why assessment processes vary in effectiveness.
This presentation will cover three key areas; the background on assessments through the lens of decomposition and synthesis, inadequate processes that continue to perpetuate through the military despite poor results, and best practices on how we can better use assessments to inform leadership of gaps and risk.

The training session will include the development of a gap assessment using proven best practices contained in multiservice doctrine, beginning with the development of objectives and decomposing the endstate, developing mutually exclusive Likert scale bins, and identifying gaps and the associated risk using CJCSM 3105.01.

Classification: UNCLASSIFIED
Working Group:Tutorial |

56935 - Modern Screening Design of Experiments to Get More Information from Fewer Trials

Start Date: 6/21/2021	Start Time: 2:30 PM ET	End Time: 3:20 PM ET
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.

| Classification: UNCLASSIFIED |
| Working Group:Tutorial |

56939 - Exploratory Data Analysis and Root Cause Analysis – "What Can You Do When You Don't Have a Designed Experiment?"

Start Date: 6/21/2021	Start Time: 4:00 PM ET	End Time: 4:50 PM ET
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.

Classification: UNCLASSIFIED
Working Group:Tutorial

56867 - Twenty-Three Critical Pitfalls in Simulation Modeling and How to Avoid Them

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:30 PM ET
Authors: Dr. Averill Martin Law		

Abstract: Simulation modeling is the most widely used operations research / systems engineering technique for designing new systems and optimizing the performance of existing systems. Yet, the education of many analysts is limited to vendor training or university courses that focus on how to use a simulation-software product. While such instruction is important, we would argue that it is not, in general, sufficient for performing sound simulation studies. In this one-hour tutorial, we will discuss 23 critical pitfalls that can result from not having an understanding of the entire simulation-modeling-and-analysis process. These pitfalls fall in four overall categories: modeling and validation, simulation software, modeling system randomness, and design and analysis of simulation experiments.

Classification: UNCLASSIFIED
Working Group:Tutorial

57054 - Reinforcement Learning for Optimal Decision-Making in Simulated or Real-World Systems

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 2:30 PM ET
Authors: Dr. Averill Martin Law		

Abstract: In this tutorial we give an introduction to the methodology of reinforcement learning (RL) and its application to modeling and simulation. RL along with supervised learning and unsupervised learning are the three major types of machine learning. RL is used to take an of optimal action for each possible state of a dynamically-changing simulated or real-world system. RL has application to problems in defense (e.g., autonomous systems or air defense), supply chains, maintenance of

randomly-failing equipment, robotics, and manufacturing to name a few. Reinforcement learning is arguably the "hottest" new simulation-related methodology since agent-based simulation became popular in the early 2000s. Demonstrations of several applications of RL will be given.

Classification: UNCLASSIFIED
Working Group:Tutorial

56941 - Modeling with Streamed Sensor Data -"What to do when your data is a curve."

Start Date: 6/24/2021	Start Time: 4:00 PM ET	End Time: 4:50 PM ET
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 properly leverage it. In this presentation we will show how to fit splines 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. Classification: UNCLASSIFIED Working Group:Tutorial		

WG 01 Strategic Operations National Security Analysis

56739 - Slow is Smooth and Smooth is Fast

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Michael Woudenberg; William Buppert		
Abstract: Operations research is challenged to answer complex problems in dynamic environments and under tight timeframes. Decision makers and analysts are pressured to demonstrate results and progress quickly yet often what is needed is to spend more time understanding the problem. This presentation will investigate the military adage "slow is smooth and smooth is fast", its parallels around the world and throughout history and how the operations research analyst can slow down to perform impactful analysis with reduced effort. Classification: UNCLASSIFIED Working Group:WG 01 Strategic Operations National Security Analysis		

56653 - An Overview of The Foxhunt Project

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Ronald Bruno Orzel; Douglas E Johnson		
Abstract: The Foxhunt Project International proliferation networks rely on illicit procurement of dual-use equipment, materials, and technology to supply weapons development programs. These commodities are controlled for export		

out of the United States by several U.S. export control laws and regulatory regimes, which are enforced by numerous Federal law enforcement agencies. Every year, these agencies convict, or sanction individuals and entities involved in illicitly exporting strategically sensitive goods from the United States—often to adversaries or potential adversaries.

Foxhunt is the first system to parse and integrate historical case information from multiple federal agencies and facilitate analysis of the resulting data. Foxhunt's interactive features enable analysts and investigators to explore relationships between key elements of proliferation-sensitive procurement activities—including entities involved, items sought, key events, and geographic locations. Foxhunt combines natural language processing, machine learning, and intelligent information retrieval techniques with subject matter expertise to extract and organize the information obtained from historical U.S. export control violation records.

Official documents and records of criminal or administrative actions are imported and coded to identify key information on entities involved, procurement techniques, commodities that proliferators are seeking, and methods used for procurement and diversion. This information can provide powerful new insights and actionable data to non-proliferation investigators and analysts. For example, among the hundreds of cases already ingested, Foxhunt has identified more than 10,000 entities involved in export control violations relating to goods and technology of proliferation concern.

Classification: UNCLASSIFIED
Working Group:WG 01 Strategic Operations National Security Analysis

56866 - Understanding International Treaty efforts which impact Electromagnetic Spectrum (EMS) effectiveness in permissive environments

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Jerome Foreman; Isis Culver; Torri Preston		

Abstract: Freedom of action in cyberspace and the electromagnetic spectrum (EMS) is a key enabler to 21st century Joint Force operations. Furthermore, it is the goal of the Department of Defense to dominate this environment through conducting Electromagnetic Spectrum Operations (EMSO) across all domains. Efforts such the Naval Tactical Grid, the Army's Project Convergence, and the Joint All Domain Command and Control (JADC2), are dependent upon cyber and EMS environments as the bedrock for overlaying future networks to fight our Nation's adversaries. These architectures all map out dependences on EMS for sensing, communicating, or exploiting the environment and providing a Commander's running estimate through a Common Operation Picture (COP).

This means seeking EMS dependent capabilities that meet National Strategic objectives, may not always consider our Nation's Economic Strategies. As our nation strives to work harmoniously between Federal and Non-Federal assured access of radio frequency (RF) spectrum, our adversaries do not see the divide. Some of our adversaries see electromagnetic spectrum (EMS) and RF spectrum as a single resource, unified under one holistic strategy. Our adversaries will use diplomacy to enhance its status in the economic world while securing capabilities for its military in a single strategic act. As our nation seeks economic growth in 5th Generation (5G) technologies in the race against other countries globally, inadvertently we may relinquish critical domestic RF spectrum that could equate to a temporary loss of DoD capabilities for our nations warfighters in future conflicts.

Every four years the International Telecommunications Union (ITU) hosts a World Radio Conference (WRC) to gain consensus on treaties supporting radio frequency (RF) allocations and the use of particular frequency bands. The establishment or modification of these treaties do not necessarily align spectrum use to support global harmonization. Depending on the agenda, treaties are

established to support specific regional goals within the world if an international consensus is reached. As countries shape RF to support technical advancements with strategic implications, this consequently can impact how the DoD accesses spectrum both National and International on a permissive basis.

The key concept of this paper is to bring about the call for a deliberate process to analyze trends in spectrum policy, identify cost effective ways to shape policy with a strategic goal, and expand the long-term vision of developing requirements survivable in an EMS constrained environment.

Classification: UNCLASSIFIED
Working Group:WG 01 Strategic Operations National Security Analysis

56877 - Alternate History: An Additional Source for Anticipating and Managing Future Strategic and Operational Problems,

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Brianne Petersen		

Abstract: In the US military, history provides the foundation for understanding war. History, however, presents several problems, including the inability to fully separate fact from the historians' perspective and the inability to test historical hypotheses. To overcome these problems, planners can use counterfactuals to examine alternative, unrealized futures. However, the US military's use of counterfactuals has stagnated over time and have not adopted more rigorous frameworks to develop and analyze counterfactuals. We can examine the alternate history form of counterfactuals and I propose five criteria on which to evaluate them. Alternate history looks longer and deeper into unrealized futures, thus expanding planners' cognitive models. The case study includes the three novels in Harry Turtledove's alternate history, The Hot War Trilogy. In this trilogy, the departure from the original timeline begins with a failure of the withdrawal of US forces at the Chosin Reservoir during the Korean War. This failure results in President Harry S. Truman's counterfactual decision to use the atomic bomb against the Chinese, and the subsequent atomic war with the USSR. The trilogy examines the political, military, and societal repercussions of the US atomic attack. I propose that military planners leverage alternate history as a supplement to 'normal' history for expanding their experience to better understand war, analyze various strategic contexts, and explore decision-making.

Classification: UNCLASSIFIED
Working Group:WG 01 Strategic Operations National Security Analysis

55300 - The Benefits of an International Conflict Observatory

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Dr. Spencer Graves; Dr. Douglas A. Samuelson		

Abstract: We suggest that the ultimate outcome of almost any conflict that lasts longer than a few days may be largely determined by the actions of parties who were not initially involved. Conflicts expand primarily by attracting parties off the sidelines. We therefore consider what drives actors to leave the sidelines to join one side or the other in conflict, to increase or decrease their level of support for their chosen side, to desert or defect. How can we assess how current actions affect (a) the prospects for peace in the short term and (b) post-conflict developments?

Many if not all parties to conflict select their actions based on substantial misunderstandings of what motivates their adversaries. Consequently, parties are often upset with the evolution of the conflict and developments post-conflict. This suggests a need for an international conflict observatory that compiles and organizes evidence relating to these questions and makes them available, so more people and nations make better decisions regarding conflicts. Such compilations must also develop systems to distinguish to the maximum extent feasible the difference between honest information and deceit.

This presentation reviews existing organizations and individuals whose work relates to the dynamics of conflict, information, and decision-making. We aim to identify gaps and discuss possibilities for filling those gaps. These include the Stockholm International Peace Research Institute (SIPRI), the Peace Research Institute Oslo (PRIO), the Correlates of War project, and others. These issues include the question of whether a tendency to violence is associated with tyranny while nonviolence builds democracy.

In response, we propose the creation of an non-governmental international conflict observatory that will focus such research and foster collaboration on studies. This international conflict observatory may choose to encourage people concerned about conflicts to work with repositories like Wikipedia, that is, visible places where people with very different perspectives collaborate to develop something that most people can more or less live with. This contrasts sharply with the "echo chambers," seemingly increasingly prevalent, that promote separatism and conflict. Such an observatory can promote finding ways to use tools such as text mining, context analysis, and social network analysis to help identify conflicts and describe what motivates people on each side while also developing procedures that make it hard for malicious parties to disrupt this work and distort the results of these efforts.

An added benefit of such an observatory would be the development of international trust and collaboration relationships that would not be subject to disruption by abrupt changes in one or two nations' support. Such trust networks would be very helpful in issues such as limiting the proliferation of WMD and promoting effective responses to disease outbreaks and natural disasters.

Classification: UNCLASSIFIED
Working Group:WG 01 Strategic Operations National Security Analysis

56457 - Strategies for Matching Process Models to Observational Data

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr. William E Hart; Dr. Vitus Leung		

Abstract: Process models are a natural way of representing sequences of activities that are involved in the manufacture and testing of weapons of mass destruction. For example, a process model may include the description of activities, dependencies between activities that impose scheduling constraints, resources needed to execute activities, and information about which activities are observable. Process models provide a natural context for integrating domain knowledge in a structured manner that enables a focus on how things could or should be done rather than on the details of specific instances of previous process exemplars.

In this presentation, we describe an approach for using a process model to assess whether a process is being or has been executed. Given a process model, we consider the challenge of detecting how

well the process model matches observations that indicate the execution of activities within the model. We consider process models that are represented with an acyclic network of precedence constraints. Thus, the technical goal is to schedule process activities to maximize a matching score while satisfying precedence and resource constraints.

This problem has close ties with sequence matching problems that arise in computational biology. We discuss dynamic programming algorithms that we have adapted from sequence matching for contexts where the process model consists of sequential activities. Additionally, we discuss integer programming formulations that can perform sequence matching with more general networks of process activities.

We illustrate these techniques using a process model that describes the Source Physics Experiment Phase II Dry Alluvium Geology (DAG) tests that were conducted at the Nevada National Security Site in 2018. The DAG experiments involved a sequence of activities to setup and execute high explosive underground tests. Thus, the DAG experiments illustrate the potential application of our process modeling techniques to detect processes that reflect potential activities of interest.

Classification: UNCLASSIFIED
Working Group:WG 01 Strategic Operations National Security Analysis

WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56791 - Tactical Nuclear Battlefield Wargaming: A Focused Approach to Conventional Nuclear Integration

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Robert W. Pritchard		
Abstract: Tactical Nuclear Battlefield Wargaming: A Focused Approach to Conventional Nuclear Integration In June 2020, Georgia Tech Research Institute (GTRI) was tasked by DTRA to support current DoD Conventional Nuclear Integration (CNI) initiatives related to the understanding of nuclear weapons effects on the modern battlefield. A team of current and former Joint Force maneuver leaders and nuclear weapons effects subject matter experts collaborated to develop a prototype CNI wargaming technique. The purpose of this design is to drive the participants to understand the impacts upon operational decision making given the context of nuclear weapons effects and to "fight through a nuclear operating environment." The wargame provides a view from the tactical edge of CBRN		

survivability to combatant command forces at the brigade and below while focusing on mission essential tasks.

The first phase of the spiral development process was highlighted by a collaborative experiment involving a U.S. Army Infantry Battalion staff's innate tactical decision-making processes and capabilities in the context of a battlefield nuclear exchange with a near-peer adversary. The wargame focused on conventional-nuclear integration with a view through the lens of battlestaff operators at the battalion level. The wargame elicited the tactics, techniques and procedures outlined in current Joint Force doctrine for operations in conventional battlespaces to protect, assess and mitigate the effects of nuclear weapons on maneuver forces while enabling the continuation of operations to accomplish the mission. The wargame facilitation accomplished this focus through interactive simulation in OneSAF, utilization of established technical nuclear effects data, and engagement of command and staff functions across all warfighting functions of the participating force. Lessons learned from the experiment are supporting ongoing development currently targeted towards integration of data analytics tools for assessment of capabilities and decision outcomes. Further outcomes include the enhanced simulation realism through integration of hazard modeling and assessment capabilities and in-depth study of counter- and post-nuclear detonation actions.

Through the collaborated efforts of GTRI, DTRA, DoD/ U.S. Army, Federally-Funded Research and Development Centers (FFRDCs), and industry, the team will continue to develop further iterations of the wargame technique and refine its approach to the CNI problem through active CWMD research and solicitation of participation from operational units across multiple domains. These efforts are designed to meet the objective of institutionalizing wargaming for use by the operational forces in support of the Joint Force and Combatant Command requirements regarding Conventional Nuclear Integration.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56853 - Evidence of the Unthinkable: Experimental Wargaming at the Nuclear Threshold

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Andrew Reddie; Dr. Bethany Goldblum		

Abstract: Ongoing nuclear modernization programs in Russia, China, and the United States have reopened longstanding debates among scholars concerning whether or not some forms of tailored nuclear weapons are likely to have destabilizing consequences for international security. Without data, however, this debate has remained entirely theoretical. To address this lack of data, we use an experimental wargaming platform to generate quantitative data to estimate the effect of tailored nuclear capabilities on the nuclear threshold. We then compare these results with a survey experiment using scenarios related to military basing, cyber operations, and nuclear threats from the wargame environment. Taken together, the data suggests that tailored nuclear capabilities, in both wargaming and survey contexts, may increase the likelihood of conflict escalation. Across both data-generating processes, we also find support for the proposition that lower yield nuclear weapons are used as a substitute for their higher yield counterparts.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56876 - Alternate History: An Additional Source for Anticipating and Managing Future Strategic and Operational Problems

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Brianne Petersen		

Abstract: In the US military, history provides the foundation for understanding war. History, however, presents several problems, including the inability to fully separate fact from the historians' perspective and the inability to test historical hypotheses. To overcome these problems, planners can use counterfactuals to examine alternative, unrealized futures. However, the US military's use of counterfactuals has stagnated over time and have not adopted more rigorous frameworks to develop and analyze counterfactuals. We can examine the alternate history form of counterfactuals and I propose five criteria on which to evaluate them. Alternate history looks longer and deeper into unrealized futures, thus expanding planners' cognitive models. The case study includes the three novels in Harry Turtledove's alternate history, The Hot War Trilogy. In this trilogy, the departure from the original timeline begins with a failure of the withdrawal of US forces at the Chosin Reservoir during the Korean War. This failure results in President Harry S. Truman's counterfactual decision to use the atomic bomb against the Chinese, and the subsequent atomic war with the USSR. The trilogy examines the political, military, and societal repercussions of the US atomic attack. I propose that military planners leverage alternate history as a supplement to 'normal' history for expanding their experience to better understand war, analyze various strategic contexts, and explore decision-making.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

57191 - Epidemiology by the Numbers V2.0

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: (Ret.) LtCol Anthony O'Connor		

Abstract: Epidemiology by the Numbers V2.0
Epidemiology is defined as the distribution and determination of health related states or events in human populations and the application of this study to the prevention and control of health problem. This embraces a wide area of study and this presentation will touch on many of them as it focuses in on epidemics. Epidemics and global pandemics are not new, they have destroyed cities, armies, empires and civilizations. While often only briefly mentioned, if at all, in military text, diseases have had a powerful effect on the fighting abilities of armies and navies. However the threat of a pandemic is made more acute with rapid national and international travel, and the emergence of new and unknown pathogens. This presentation will examine the sources of pathogens, the types, their modes of transmission and their effects, as well as the tools and models used to predict, prevent and control them. The discussion will include actions taken to address the pathogens and, if there was a hostile intent (biological warfare) in the spread of disease and implications in Combating Weapons of Mass Destruction (CWMD).

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56708 - Assessment of Clinical Specimen Collection and Analysis

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Mr Robert Cubeta		

Abstract: In the absence of effective environmental sampling, the military medical system will likely provide the first indication of a biological warfare attack. Accurate and timely diagnostic results provide critical situational awareness that informs the implementation of disease response measures, revised planning, and treatment of ill individuals. The Institute for Defense Analyses evaluated how various tactics techniques and procedures for the collection and analysis of clinical specimen influence the timing and accuracy of diagnostic test results. The analysis included a scientific literature review, the results of which we used to characterize the times during a given disease's progression that a given diagnostic test can generate accurate results. For multiple combinations of diseases and diagnostic technologies of interest, we were unable to find sufficient data to characterize when during the course of illness the diagnostic technology would generate accurate results. Of the disease and diagnostic technology combinations of interest for which sufficient data was available, high test sensitivity at or before symptom onset was not common. To further assess the disease and technology combinations that we found sufficient data on, we developed a stochastic individual based model to simulate disease progression, patient movement, and clinical specimen collection and analysis following a biological exposure event. We then analyzed the modeling results to determine how changes in tactics, techniques, and procedures for specimen collection and analysis affect the timing and accuracy of diagnostic results.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56589 - Development of Tolerance Interval Derived Dose Curves for Acetylcholinesterase (AChE) Inhibition via Use of the Four Parameter Logistic Model

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Douglas R. Sommerville		

Abstract: For risk assessment applications, knowledge of two types of dose-response curves are needed: DR severity (DR-S) and DR probability (DR-P) (the latter characterized by the median effective dosages (ED50s) for each endpoint and probit slope). DR-S curves with continuous responses (example--percent inhibition) pose a challenge with respect to fitting the corresponding DR-P curve. The DR-S curve alone provides little information on the DR-P curve—only the ED50s as a function of the percent response. Ordinal regression (OR) has been used to simultaneously characterize the two curves together if the DR-S curve is first transformed (via binning of responses) into quantal endpoints. However, this approach comes at the cost of lost information (and other disadvantages).

An improvement to the OR approach has been developed--Tolerance Interval derived Dose-Response Curves (TIDRC). The calculated tolerance intervals from the actual continuous DR-S curve fit are used to estimate the DR-P curve (in particular the probit slope). This new approach is illustrated via the model fit (using the Four Parameter Logistic Model) of previously published nerve agent acetylcholinesterase (AChE) inhibition datasets as a function of dose. These results are compared with those using OR. The advantages and disadvantages of the two methods are reviewed.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56748 - CSAF tasking: Estimate Impact of COVID-19 on Aircraft Availability

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Greg H. Gehret		

Abstract: At the start of the pandemic, CSAF asked the A4 community to estimate the impact that COVID-19 might have on AF readiness. HAF/A4 reached out to AFMC and we began working the tasking. We utilized several operations-research tools, including simulation, to generate high quality visuals of the cause-based, 6-month forecast of Aircraft Availability (AA) for 13 major AF fleets. COVID-19 and
 implications to perturbations in the Working Capital Fund had a small but measureable impact to AA that varied across the 13 fleets. Also of note, because the underlying inputs to the simulation were cause-based time elements, the simulation can be used to forecast AA for any time-based disruptions, including funding, manpower, and Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE). Our presentation will discuss why we used multiple tools, how we established cause-based inputs, the feedback we received during the briefing cycle (which included all AF MAJCOM A4s), and possible use of the tools/simulation for other "What If" scenarios.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56905 - Homeland Security Biological Detection and High-Quality Technology Readiness Assessments

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr. John Mendez Ortiz, Jr		

Abstract: 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 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 found some actions to improve technology readiness assessments.

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.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

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56556 - Weather Classification using Self-Organized Maps

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr Alexander Paul Castorena		

Abstract: Hazard Prediction and Assessment Capability (HPAC) is a powerful tool that can be used to determine the persistence and spread of chemical agents following the deposition of an agent over a given area. HPAC simulations may be performed using either static or variable weather conditions. In order to provide the optimal real-life applicability of the model, variable weather conditions are preferred, but they pose a singular difficulty – weather conditions over a given time period will be highly location and temporally specific. Is it possible to run simulations using historic weather data from a given location and apply the results to a wider number of locations? It seems that such an approach would fail to accurately determine the potential results from the cases for which weather data was not utilized. Alternatively, the brute force approach of running HPAC with many different weather cases may be used, but such an approach would be prohibitively time consumptive and computationally intensive. How can real location-specific weather data be used in a manner that is neither location-specific in its applicability nor too computationally cumbersome in order to accurately predict persistence for a number of locations? The solution proposed here uses a combination of a Self-Organizing Map (SOM) software in conjunction with a K-means cluster algorithm to identify clusters of weather data from a single location in a characteristic year. It is shown that these identified clusters are applicable in predicting persistence for a variety of weather locations, including those in drastically different climates.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

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56721 - I-Optimal experimental design combined with KCV (Kowalski, Cornell, Vining) statistical models applied for maximum experimental efficiency in increasing complex multivariate chemical warfare agent decontamination formulation research.

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Mr John Powell Davies, Jr		

Abstract: The Decontamination Sciences Branch at the DEVCOM Chemical Biological Center Aberdeen Proving Grounds, MD studies the physical and chemical mechanisms that are relevant to chemical warfare agents (CWAs) for the purposes of developing decontamination technologies. The research involves many potential decontamination formulation components combined with variable environmental conditions, multiple processing factors, and multiple material substrates. It is essential to keep samples sizes to a minimum since the experiments are conducted under surety conditions using actual CWAs. The simultaneous study of so many variables requires a "designed" statistically sound experimental approach. The branch makes extensive use of I-Optimal design of experiment methods including KCV (Kowalski, Cornell, Vining) statistical models when conducting

decontamination formulation studies in the multivariate scenarios. These methods have increased the potential for scientific discovery and reduced laboratory experimental costs by as much as 90%. The reduced laboratory experimental burden has allowed us to widen the scope of our research and increase the relevance of our studies.

Approved Public Release; Dist. Unlimited

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56759 - Decontamination System Performance Model: Model Development and Application to Sprayable Decontaminant Slurry Technology

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Mark Varady		

Abstract: The ability to predict decontaminant performance fills a critical gap in testing since it is often not possible to test over all operational conditions of interest. The Decontamination System Performance Model (Decon SPM) is a collection of physics-based models that predicts the vapor emission rate from an asset due to residual agent after a decontamination treatment process. To accomplish this, the Decon SPM simulates all the physical and chemical processes that occur from the time agent contacts the asset, through decontamination, and after the decontaminant is removed. The approach of using physics-based models permits confident predictions outside of previously tested conditions, whereas empirical modeling approaches are only valid close to and between tested conditions. For military coatings, the transport processes on the surface and in the bulk of the material are complex due to the irregular and heterogeneous nature of the material. This required development of the Decon SPM to incorporate higher fidelity models for surface liquid spreading and diffusion in polymer-based materials to ensure accurate prediction. Recently, a Sprayable Decontaminant Slurry (SDS) was also integrated into the Decon SPM so that predictions of its performance could be made. The process of designing experiments to obtain the necessary model parameters is described along with specific case studies varying the operating conditions and exploring scenarios not yet tested in the laboratory. Some examples include examining variations in the applied thickness of the SDS and the implications of multiple successive contamination events.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56802 - Roles of surface wetting and bulk mass transport in the contamination of polyurethane-based coatings by distilled mustard blister agent, HD

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Thomas P. Pearl		

Abstract: This work focuses on determining physicochemical interactions that influence the resistance of materials to chemical contamination, specifically for the case of a liquid phase chemical warfare agent exposed to polymer composite materials. The degree and type of retention is a function of wetting behavior at the surface as well as the propensity for penetration of the liquid phase into bulk layers of the exposed material. Experimental work has been performed to study the interaction of

distilled mustard blister agent, HD (bis(2-chloroethyl) sulfide), with polyurethane-based, low reflectivity coatings, which can be treated as high solids loaded polymer composites. Results elucidate entrainment in near-surface capillary networks and transport into bulk layers through molecular diffusion as a function of variations in polymer binder and solids loading in the composite. The understanding garnered from considering chemical retention informs next generation decontamination approaches as well as new coatings formulations that are tuned for chemical resistance, reduced decontamination burden, and mitigated hazard for warfighter personnel. Approved for public release: distribution unlimited.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56803 - Characterizing Hazard Mitigation Efficacy for Different Agent > Distributions

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr Brent A Mantooth; Dr Neil Hawbaker; Dr. Thomas P. Pearl			

Abstract: Hazard mitigation technologies are used to reduce the exposure for personnel who interact with contaminated objects. The ability to remove agent from a material is dependent on the distribution of the agent on or in the material, including absorbed, surface adhered, and capillary entrained liquids. Agent distributions can be generated and affected by different rate limiting mechanisms, and these processes influence the exposure to personnel and the efficacy of decontamination technologies for agent removal. Testing for decontamination efficacy must rely on materials-level, lab-scale tests. Therefore, specific agent distributions are created in laboratory testing to isolate and characterize the mechanisms of removal. The ability to bridge the gap from laboratory to field use depends on accounting for how these mechanisms contribute to removing the agent from each distribution. New laboratory methods are presented that explore how to generate specific agent distributions, to characterize decontamination efficacy, and to evaluate how these different distributions contribute to personnel exposure.
Approved for public release: distribution unlimited.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56701 - Integrating Low Yield Nuclear Weapons into Wargaming

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Christopher Daniel Brinker, PhD; Dan Kidd			

Abstract: The US must be prepared to fight and win with conventional weapons on a battlefield where the
opponent may use chemical, biological, radiological, or nuclear (CBRN) weapons to support conventional operations (theater use). Guidance from the Nuclear Posture Review and National Defense Strategy states that U.S. forces will ensure their ability to integrate nuclear and non-nuclear military planning and operations. To implement these concepts into the training, exercise and wargaming community, we must present this problem in a way that is palatable and in a language that is clearly understood to ensure that a nuclear insult becomes more of predicted and manageable change to the environment, and not the end of the scenario. DTRAs Wargaming and Analysis research

and development program is developing a playbook that includes developing tactical nuclear objectives and scenarios; and the models, effects, and visualizations necessary to directly assist scenario developers. The intent is to develop a holistic guide and wargaming capabilities for integrating nuclear impacts into warfare specific objectives and scenarios, identify data/models/effects to be used in future games, and identify evaluation methods. This playbook will include templates for all domains and echelons from low strategic to high tactical to provide context, scale, structure and proposed visualizations to allow seamless integration into game development.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

56702 - Operations in a Nuclear Environment – What an Operations Officer needs to know

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Adrian Reenshuler; Dan Kidd		

Abstract: Recent Department of Defense guidance directs that U.S. forces must be prepared to integrate nuclear and non-nuclear military planning and operations. But how many know what integrated conventional and nuclear operations, and the post-nuclear strike environment looks like? What effect will a 5kt nuclear strike have on a brigade, battalion or platoon? Let's face it, most just don't know. This session will provide a non-technical understanding of nuclear weapon effects and what a post-strike battlefield nuclear operating environment looks like. Participants will leave knowing enough to start asking the right questions about how a nuclear operational environment will affect the battlefield and with the resources to find the answers.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

55344 - A Multi-Criteria Decision Making Approach to Prioritizing Chemical Biological Defense Program Gaps and Activities

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Ms Shawn Davies		

Abstract: The Chemical Biological Defense Program (CBDP) Joint Strategic Portfolio Analysis Review (JSPAR) is an annual planning process during which the military Services review their strategy and prioritize activities to fill capability gaps in chemical and biological defense. The CBDP Executive Agent (dual hatted through Assistant Secretary of the Army Acquisition, Logistics and Technology (ASA(ALT)) and Headquarters Department of the Army G8) has helped the Services mature the process since its inception in 2017, and tasked the Joint Chemical, Biological, Radiological, Nuclear Defense Program Analysis and Integration Office (PAIO) with developing and facilitating a repeatable, defensible approach to conducting the review and prioritizing the activities in 2019. PAIO organized the JSPAR into three phases: gap prioritization; capability strategy review; and research, development and acquisition (RDA) activity assessment. The updated approach is the first time that Services were able to document their Service-specific operational context for Joint Requirements Oversight Council-approved gaps and prioritize those gaps using a multi-criteria decision making (MCDM) methodology according to national strategic objectives, joint force risk, and Service needs. The gaps now serve as a foundation for the capability strategy review, in which the Services review

when RDA activities are planned. PAIO generates integrated master schedules showing all planned CBDP RDA activities and conducts detailed alignment analysis for the review.   These products enable the Services to discuss activity alignment across the acquisition lifecycle (from requirement generation through sustainment and divestment) and identify capability development strategy to inform the joint staff and programming efforts. The JSPAR process culminates with a second MCDM assessment of how well the RDA activities mitigate the gaps and operational risk. The results represent the first time CBDP RDA activities are able to be traced directly to Service-specific gaps and operational plans. The first full iteration of this approach was completed in December 2020. The Services appreciated the collaborative approach used to document and assess gaps and CBDP RDA activities. The results are being used to inform the development and prioritization of decision packages during the programming phase to develop the CBDP Program Objective Memorandum.

Classification: UNCLASSIFIED
Working Group:WG 02 Chemical, Biological, Radiological, Nuclear, and Advanced Explosives (CBRNE) Defense

WG 03 Infrastructure Analyses, Protection and Recovery

56513 - Large-Scale Contingency Analysis of Transient Disruptions in Natural Gas Pipelines and Impacts on Electric Generation

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Eric R Tatara; Dr. Sinem Perk; Steve Folga; Dr. Jordan Jalving; Victor Zavala; Prakash Thimmapuram; Dr. Charles M. Macal		

Abstract: Natural gas-fired electricity generation in the United States has increased steadily over the last decade and now comprises the largest share of generation capacity among all fuels. Reliable natural gas delivery is required by operators of gas-fired electric generation plants and therefore maintaining operational resilience in interstate natural gas transmission pipelines is of critical importance. Transmission pipelines are subject to physical, regulatory, and financial constraints, obligations to customers, and are subject to environmental and man-made disruptions. Despite dynamic operational constraints and environmental conditions, gas pressures and flows at delivery points must be maintained at levels required by generators to ensure continuous operation. Unplanned transient hydraulic disruptions may occur at any time and location and have variable and delayed effects on downstream gas-fired generators. Transient disruptions can occur at a single point of failure like a compressor station, or may occur across multiple different times and locations, such as during natural disasters that affect widespread geographic areas.

We present a method to estimate worst-case (n-k) impacts of multiple simultaneous gas pipeline disruptions on power generation via a transient hydraulic pipeline model. The transient model accurately determines flows and pressures in the network and is formulated as an optimal control model that minimizes the pipeline owner's cost of operating compressor stations, while also minimizing unserved gas to customers and maintaining line pack. A massively parallel high-performance computing workflow is used to coordinate parameter space sampling and simultaneous simulation runs because the total parameter space of possible disruptions grows combinatorically with the size of the pipeline network. The existing literature for n-k contingency analysis typically formulate the problem as a steady-state reduced complexity MINLP without more complex objectives that incorporate corrective actions. The approach presented here preserves the full model complexity

for the nonlinear constraints on the hydraulic equations, along with an objective function that considers maximization of linepack and minimization of compressor power.

As an operational capability, estimating the time and impacts of pipeline disruptions on generation provides operators with a forecast of unplanned generation shutdowns. Furthermore, knowledge of potential worst-case outcomes of disruptions can help with optimizing the pipeline linepack to develop resiliency across gas and electric sectors. Cases studies are presented to illustrate the model capabilities in a hypothetical interstate-scale natural gas transmission pipeline that include compressor station power disruptions and pipeline breaks. The total loss of gas-fired generation in megawatts is used as the impact metric when evaluating combinations and timing of outages in the gas transmission pipeline.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56537 - HVDC Electricity Infrastructure: quantitative and qualitative benefits

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Liza B Reed		

Abstract: High Voltage Direct Current (HVDC) electricity transmission allows for lower loss and more controllable power flow, including a higher power density per mile compared to High Voltage Alternating Current (HVAC). HVDC has more capacity per mile due to narrower right-of-way requirements, and more power transfer over time due to the ability to load the lines near thermal limits without creating a reliability issue in the grid. National studies of future grid needs find that HVDC is a necessary part of meeting the challenge of no carbon electricity. However, the path to realize HVDC grid integration is blocked by technical, economic, and regulatory barriers. It is also often not given due consideration because of long-standing assumptions about cost and capability that ignore progress on both fronts.
There is also a new generation of power electronic devices that has the potential to shift the relative attractiveness of HVAC to HVDC in a variety of contexts using a method called Voltage Source Conversion (VSC). VSC-HVDC stations can control power flow, restart a grid after a blackout, and provide power through tap-off stations along a transmission line. These capabilities could put VSC-HVDC on par with or superior to HVAC solutions for new lines.
The research objectives of this work were as follows:
1. Develop an economic model to compare converting an HVAC line to HVDC with existing HVAC transmission options, and compare the technical and physical constraints of these solutions;
2. Assess the regulatory barriers for different kinds of transmission projects, based on outcomes of proposed projects, and determine what barriers an HVDC project could face;
3. Evaluate the benefits of multi-terminal VSC-HVDC under existing and future cost conditions compared to HVAC alternatives for new transmission line construction.
Addressing the specific barriers revealed —a systematic bias against HVDC in transmission planning, evaluation and cost estimation—are critical for the future grid. They also have impacts on military operations and infrastructure. This research was originally developed in the context of national decarbonization pathways. I will present the findings and extend the context to include implications for military infrastructure, such as: HVDC microgrids to power or island bases in response to emergencies; how the electric grid decarbonization pathway could impact military infrastructure; and finally generate some questions for how electricity security may be impacted by development of more HVDC.

| Classification: UNCLASSIFIED |
| Working Group:WG 03 Infrastructure Analyses, Protection and Recovery |

56944 - Multi-Level Optimization for Power System Security and Resilience

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Matthew Oster; Dr. Samrat Chatterjee; Feng Pan; Craig Bakker; Arnab Bhattacharya; Ethan King		
Abstract: The current Texas power outage emphasizes the importance of secure, reliable, and resilient power system operations. Modeling such systems must involve consideration of multiple interacting decision-making agents, operational system complexity, and information availability and uncertainties. Multi-level optimization models composed of nested operator, attacker, and defender decisions offer a suitable mathematical framework to address various modeling complexities. For example, they can encode industry-standard models, provide prescriptive actions to the modeler, and quantify resilience improvements. In this talk, we will begin with a brief overview of bi-level and tri-level defender-attacker-defender models employed for power system applications. This will include discussion of key modeling assumptions, optimization formulation, and decomposition-based solution strategies. Thereafter, we will demonstrate the applicability of tri-level optimization modeling for an electric grid defense planning problem including decisions associated with an operator, attacker, and defender. A two-stage decomposition approach will be described where each stage is solved with a mixed integer programming solver. Case study results using a Western System Coordinating Council (WSCC) 9-bus test system and Institute of Electrical and Electronics Engineers (IEEE) 118-bus test system will be presented. Future research directions including information uncertainties and role of machine learning for accelerating optimization solutions will also be discussed.		
Classification: UNCLASSIFIED		
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery		

56376 - Military Value Analysis and Community Support Value Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Nancy Zoller		
Abstract: The Center for Army Analysis conducts objective analyses to aid in stationing decisions for large units. Most often, this is done through the Military Value Analysis (MVA) model, a decision analysis model that analyzes the value of installations based on a common set of attributes and weights and allows installations under consideration for a stationing decision to be compared with each other. CAA has also developed a similar model to evaluate off-post, community support assets around an installation—the Community Support Value Analysis (CSVA) model. These models are two of the multiple criteria that the Army uses in stationing decisions.		
Classification: UNCLASSIFIED		
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery		

56778 - Assessment of Structures and Systems for Enterprise Tradeoffs (ASSET)

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET

Authors: William Brandon Fangio; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Kayla Cotterman; Christina Rinaudo; Dr. Richard Cody Salter; Mr. William Leonard; George Edward Gallarno; Kathleen Staebell

Abstract: The project uses decision analysis techniques to inform infrastructure asset management decision making at multiple levels within the United States Army Corps of Engineers Civil Works program (USACE-CW). USACE-CW has eight business lines, each relating to different missions and specific asset management decisions. Each business line currently has a process for making work package funding decisions. However, given the complexity of asset management funding decisions, there is a need to analyze and potentially augment the existing business line metrics in order to support the decision making process. We have developed a unified decision context that applies to all business lines and allows to better understand the similarities and differences of business lines and the role of current or new metrics. Our proposed value models build on each other. At the lowest level, value models help rank the work packages in each business line. At the next level, we develop value models to evaluate performance of each business line. The final value model evaluates the overall asset management program. The project goal is to improve the availability of information and metrics to inform asset management decisions within USACE-CW.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56814 - Analytical Assessment Methods to Directly Measure Impact and Resilience of Mission Assurance

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET

Authors: Michael Darby

Abstract: Idaho National Laboratory (INL) has developed a novel analytical assessment method to directly measure the impact and resilience of mission assurance. The resulting framework crosses over multiple organizations and enabling hardware, defines a direct metric to mission impact, develops logic-based algorithms integrated with the framework, creates an evaluation engine for identification of systematic failures, and integrates a dynamic time-based analysis capability. This methodology can be applied to any set of objectives that require any set of infrastructure support that needs to be resilient in some way, and as a case study, has been applied to the United States Air Force using a systematic approach to improve the Air Force's evaluation of mission assurance. This included objectives of 1) how to evaluate power outage impact to their important missions and 2) a method to value resilience in identifying and prioritizing solutions. The INL developed Mission Thread Analysis (MTA) approach, referred to as the Decomposition for Energy Assurance and Electrical Power Resiliency (DEEPR) process, was reported on in the 2020 MORS conference. Since last year, the INL has advanced the technical approach and supporting modeling effort to expand the analysis of dependencies beyond power by integrating the DEEPR process with an All-Hazard Analysis (AHA) GIS-based toolset that incorporates the interdependencies of utilities and services beyond the installation fence. The combined GIS-based modeling approach also incorporated automated threat and environmental analysis, enabling multiple mission threads at multiple location analyses. The developed simulation capability provides analyses of threat scenarios over time and includes impacts of supply disruptions. Additional work in progress includes using the integrated AHA analytical toolset with black out exercises at various Air Force base locations to produce observation-based validated relationships in the model. The results of threat-informed scenarios may drive evaluations to define readiness COAs and investment needs to improve mission resilience.

This presentation will provide an update on the MTA approach and advantages to integrating with the AHA tool. Show generalized results of additional threat-based scenarios using GIS data and how the AHA tool can be integrated with black out exercises to assess how and where alternatives or courses of action are needed to ultimately improve the overall mission resilience.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56761 - Utilizing Explainable Convolutional Neural Networks for Critical Infrastructure Analysis and Identification

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Shiloh Elliott; Mr. Ryan Hruska; Ms Ashley Shileds		

Abstract: Critical infrastructure systems form the backbone of modern society. Most of these systems are built, owned, and operated by private entities in isolation. Under blue sky conditions, these isolated systems perform well. However, extreme events (e.g., hurricanes) require that Federal or State disaster planning or response efforts can identify all critical infrastructure impacted, to mitigate negative environmental or human consequences. In 2017 the Arkema Chemical Plant suffered a power-failure induced explosion associated with Hurricane Harvey. Had disaster planning teams identified the plant as at-risk prior to hurricane landfall, proactive preventative measures could have implemented. Idaho National Laboratory is developing a first-of-a-kind methodology using explainable convolution neural networks (CNNs) to classify critical infrastructure facilities. First, the team curated and characterized a high-quality critical infrastructure dataset for several facility types from the United States transportation, water, healthcare, and energy sectors. These datasets were used to train a set of explainable convolution neural networks based on established neural network architectures with known high image classification accuracy; specifically, this included DenseNet161, ResNet152, and ResNeXt101. The trained CNNs were applied to new imagery datasets and successfully identified critical infrastructure facilities that were not explicitly included in the training dataset. The approach implements Local Interpretable Model-Agnostic Explanations (LIME) techniques to determine (or explain) why the CNNs are making classification determinations; thus, this approach overcomes the black-box nature of unsupervised machine learning by providing an explanation why the model has classified an object as a specific facility. Explainable machine learning models are critical to high consequence national security missions, such as disaster and response planning, and today's Commercial-Off-The-Shelf (COTS) solutions are inadequate. Initial results of this ongoing research effort have produced 80% positive critical infrastructure facility classification for the test datasets used in the transportation and energy sectors. Upon completion, the method is intended to be deployed in disaster planning and response scenarios to quickly identify at risk critical infrastructure facilities.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56988 - Institutional Relics: The Persistence of Deteriorating Roadway Bridges through Social Consecration

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: MAJ Jaison Desai, PhD; Daniel Erian Armanios, Ph.D.		

Abstract: Deteriorating infrastructure systems are a pervasive challenge and pose risks to those who rely on them as essential services. Roadway bridges and other civil infrastructure systems can persist when they are not just critical for the provision of goods and services but when local communities build social meaning into their components. This paper argues that such consecration of physical objects can inspire a desire to maintain and preserve them in their existing form, rather than effect major rehabilitative changes. Historicity and perceived impact to the community are examples of ascribing such meaning to these relics and can affect the options for management. In this study, we consider the decision to enroll bridges into the National Register of Historic Places (NRHP) on subsequent closure rates and deterioration levels. Using panel data derived from the National Bridge Inventory (NBI), preprocessed through the use of coarsened exact matching (CEM), and employing Cox proportional hazards and linear regression models, bridges enrolled on the NRHP have a 65% lower risk of closure in post-enrollment years as compared to similar non-enrolled bridges. In other words, these historically designated bridges are significantly more likely to remain an active part of roadway networks as compared to highly similar bridges that do not receive such a designation. Moreover, we note that the overall sufficiency of these bridges improves only modestly and primarily focuses on those bridge elements that are not as visible and impactful in the social consecration. This demonstrates how the built environment may be impacted through social mechanisms that reinforce the persistence of deteriorating yet locally meaningful infrastructure assets.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56623 - Development and Assessment of Resilient Telecoms System

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: George Edward Gallarno; Jeremy Daniel Muniz; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Dr. Jingxian Wu; Dr. Randy Buchanan		

Abstract: Emergency telecommunication infrastructure is essential for residents and emergency responders during natural disasters to coordinate lifesaving and life preserving efforts. Ensuring resiliency of the emergency telecommunication infrastructure is of critical importance for regions with an increased likelihood of natural disasters. This research is funded by the Institute for System Engineering Research at the U.S. Army Corps of Engineers Engineer Research and Development Center. We developed an integrated modeling framework for assessing emergency tele-communication systems. The framework was implemented in MATLAB® using performance models to assess coverage and surge capabilities for a given system architecture. The MATLAB® models assess the telecom system value using a multiple objective decision analysis value model with stakeholder and technology performance measures. After constructing a life cycle cost model for emergency telecommunication systems, we conducted an illustrative Value vs. Cost trade-off analysis using three alternative decision frames. The decision analysis framework allows for exploration of the system design tradespace so that decision makers can select the best emergency telecom architecture using a defensible and transparent, performance driven methodology.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

56690 - Water Resilience Modeling- Approaches to Assessing Consequences of Failure for Water Infrastructure Serving DoD Installations

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Noah Garfinkle; Lt Col Justin Delorit		

Abstract: Every critical mission on DoD installations depends upon the resilience of water supply, whether for serving human needs, powering industrial processes, cooling essential equipment, or providing fire suppression capacity. Planning and investing to improve resilience against a broad and uncertain catalogue of threats and hazards will require the adoption of existing and new quantitative techniques for assessing each installation's water infrastructure. Implementation of quantifiable resilience methodologies for DoD missions requires developing a detailed understanding of how our missions utilize water, as well as how water disruptions can propagate and impact interconnected infrastructures. This presentation will explore approaches to assessing the mission, economic, security, and infrastructure implications of disruptions to water infrastructure. Each implication will be compared across asset, spatial, network, and hydraulic-model risk and resilience frameworks. These analyses will build upon diverse engineering perspectives on the definitions of security and resilience, and compare varying metrics and their implications on infrastructure security investment and planning. The objective of this presentation is that participants will have the opportunity to consider the quantity and quality of water required to sustain their missions, and an increased appreciation of the diverse array of threats to their water infrastructure. Presenters will illustrate examples with current infrastructure security initiatives underway by the US Army Engineer Research and Development Center and the US Air Force Institute of Technology.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

57308 - Mission-Informed Evacuation Models for Naval Station Newport and Aquidneck Island

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Amanda Michelle Jones		

Abstract: During major hurricanes, key roads and facilities for military missions can become disrupted and unreachable. This is compounded with local evacuation orders that require nearby communities and military personnel to quickly leave the area, leading to major traffic jams that further disrupt operations on and off base. In this work, we will develop a model for optimal evacuation for Naval Station Newport and surrounding communities on Aquidneck Island. The goal is to develop plans that minimize the travel time for local communities to evacuate while maximizing mission assurance for key facilities and emergency response activities that will remain on the island.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

57439 - The US Food Supply Chain and COVID-19 Considerations A Network Structural Analysis

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Paul R. Garvey		

Abstract: The meat and poultry industry is the largest segment of U.S. agriculture. Efficient farming and processing techniques have turned the U.S. meat and poultry business into a 232 billion dollar market, leading the world in meat production. The U.S. is the world's largest beef producer and 2nd largest beef exporter. Second largest pork producer and a major player in the world pork market, ranking 2nd as an importing and exporting country.

A 2016 Meat Institute Report states that the industry is responsible for 5.4 million jobs and $257 billion in wages. An estimated 527,019 people have jobs in production and packing, importing operations, sales, packaging, and direct distribution of meat and poultry products.

The spread of COVID-19 triggered consumer buying frenzies and food stockpiling. Meatpacking operations make it challenging to meet 6-feet distancing requirements issued by OSHA and CDC, spacing is difficult in high-speed assembly line environments. According to data collected by Food and Environment Reporting Network, as of 29 October, 48,669 meatpacking workers tested positive for COVID-19 and at least 245 of those workers died.

The U.S. food supply chain is massive and complex, with over 9.8 million origin-to-destination transportation links connecting producers and consumers. "The nation's food supply chain is showing signs of strain, as increasing numbers of workers are falling ill with the coronavirus in meat processing plants, warehouses, and grocery stores".

This paper presents a major study by MITRE on the structure, resilience, and vulnerability of the US food supply chain. The dataset for the study was from research conducted by the University of Illinois Urbana-Champaign. The first phase of the study focused on analyzing the meat supply chain network (Standard Classification of Transportable Goods, to include COVID-19 and vaccine perspectives. Advanced network science algorithms were used to discover which US counties have the greatest structural influence on the overall US meat supply chain. The MITRE study investigated the potential propagative effects of exploited vulnerabilities, such as COVID-19, in one part of the meat supply on dependent counties and pathways across the SCTG 05 ecosystem.

Classification: UNCLASSIFIED
Working Group:WG 03 Infrastructure Analyses, Protection and Recovery

WG 04 Homeland Security, Homeland Defense and Civil Support

56926 - Development and Assessment of Resilient Telecoms System

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: George Edward Gallarno; Jeremy Daniel Muniz; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Dr. Jingxian Wu; Dr. Randy Buchanan

Abstract: Emergency telecommunication infrastructure is essential for residents and emergency responders during natural disasters to coordinate lifesaving and life preserving efforts. Ensuring resiliency of the emergency telecommunication infrastructure is of critical importance for regions with an increased likelihood of natural disasters. This research is funded by the Institute for System Engineering Research at the U.S. Army Corps of Engineers Engineer Research and Development Center. We developed an integrated modeling framework for assessing emergency tele-communication systems. The framework was implemented in MATLAB® using performance models to assess coverage and surge capabilities for a given system architecture. The MATLAB® models assess the telecom system value using a multiple objective decision analysis value model with stakeholder and technology performance measures. After constructing a life cycle cost model for emergency telecommunication systems, we conducted an illustrative Value vs. Cost trade-off analysis using three alternative decision frames. The decision analysis framework allows for exploration of the system design tradespace so that decision makers can select the best emergency telecom architecture using a defensible and transparent, performance driven methodology.

Classification: UNCLASSIFIED
Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support

56955 - Multi-Level Optimization for Power System Security and Resilience

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Matthew Oster; Dr. Samrat Chatterjee; Feng Pan; Craig Bakker; Arnab Bhattacharya; Ethan King		
Abstract: The current Texas power outage emphasizes the importance of secure, reliable, and resilient power system operations. Modeling such systems must involve consideration of multiple interacting decision-making agents, operational system complexity, and information availability and uncertainties. Multi-level optimization models composed of nested operator, attacker, and defender decisions offer a suitable mathematical framework to address various modeling complexities. For example, they can encode industry-standard models, provide prescriptive actions to the modeler, and quantify resilience improvements. In this talk, we will begin with a brief overview of bi-level and tri-level defender-attacker-defender models employed for power system applications. This will include discussion of key modeling assumptions, optimization formulation, and decomposition-based solution strategies. Thereafter, we will demonstrate the applicability of tri-level optimization modeling for an electric grid defense planning problem including decisions associated with an operator, attacker, and defender. A two-stage decomposition approach will be described where each stage is solved with a mixed integer programming solver. Case study results using a Western System Coordinating Council (WSCC) 9-bus test system and Institute of Electrical and Electronics Engineers (IEEE) 118-bus test system will be presented. Future research directions including information uncertainties and role of machine learning for accelerating optimization solutions will also be discussed. Classification: UNCLASSIFIED Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support

56782 - System of Systems Study of Sensors for Border Security

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr. Joseph Sartini; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Dr. Randy Buchanan; Mr. William Leonard; Mr. Joshua Jensen		
Abstract: The United States perimeter of 7,479 miles must be monitored for illicit cross-border activity such as illegal migration, contraband, and threats to national security through these regions. In support of the Engineer Research and Development Center's Institute for Systems Engineering Research, we developed an integrated sensor modeling framework and optimization algorithms to propose sensor suites and locations to improve the current CBP Border Security Systems Architecture for a specified region. We used notional sensor performance and cost data. We developed three models: the Intruder Preference Model (IPM) and the Sensor Selection and Placement Model (SSPM). The IPM considers multiple intrusion scenario characteristics to create spatially distributed intruder preferences. Based on these preferences, intruder routes are predicted using least cost algorithms to maximize intruder route preferences from the border to release points. For a given budget, the SSPM determines the optimal sensor recommendation to improve the mission performance and then determines the optimal placement of those recommended sensors. The study found that the IPM and SSPM can provide insights on the most efficient sensor suite improvements for a specified border region of interest. Classification: UNCLASSIFIED Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support

56894 - Infrastructure Data Taxonomy

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Ms. Carmen Zapata; Ms. Mary Boone; Stephen Szymanski		

Abstract: The Infrastructure Security Division (ISD) of the Critical Infrastructure Security Agency (CISA) is responsible for directing the agency's infrastructure security and resilience efforts. As such, ISD collects, analyzes, and reports massive quantities of data related to a broad variety of infrastructure elements—from vulnerability assessments of chemical facilities to intelligence about adversaries' bombing tactics. This data has the potential to be an extremely powerful asset for ISD as the division works with partners to execute its mission, and the larger CISA and Department of Homeland Security missions; however, the full realization of the data's potential requires the establishment of an updated, authoritative data taxonomy that comprehensively defines data structures and relationships. Insightful recommendations are driven and directed by data analysis, which rely on effective data analysis efforts are underpinned by data models and taxonomies. A robust data taxonomy is vital to a functioning data analysis network.

In 2020, ISD determined that its 2011 Infrastructure Data Taxonomy (IDT) could no longer fully leverage its data or new analytic constructs like CISA's Enterprise Conceptual Data Model, and initiated an update of the IDT in February 2021. This ongoing revision is aligned with the refresh of the National Infrastructure Protection Plan, ensuring the IDT's continued relevance to ISD, CISA, and critical infrastructure owners and operators. The new taxonomy will provide a common, standardized framework for all data systems and relationships within ISD as well as manage the relationships with the public critical infrastructure that ISD is mandated to protect. An updated IDT will serve as a bedrock foundation for effective analysis and consistent communications. It will allow ISD to build 'data bridges' across CISA—for example, the National Risk Management Center is using the IDT to link National Critical Functions and sub-functions to ISD's critical infrastructure asset data. This presentation will walk through the methodology used to update the IDT and highlight the benefits of an up to date taxonomy for linking and enhancing critical infrastructure analysis.

Classification: UNCLASSIFIED
Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support

56881 - Power Laws Break Things: Performance Projection Errors Induced by Ignoring Power Law Behavior in an M/G/1 Queue

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Kenneth Comer		

Abstract: Power law or Pareto distributions have been observed in numerous populations in the 120 years since Vilfredo Pareto first articulated the phenomenon. System analysts, however, often ignore the possible presence of heavy-tailed, power law distributions in existing systems. A simple examination of the difference between expected behaviors of an M/G/1 queue when the service rate is assumed to be exponential but is, in fact, power law shows that performance projections can be wildly inaccurate. Over 40% of the simulated power law-driven queues experienced mean cycle times greater than the expected three standard deviations from an M/M/1 queue. And, 33% would experience mean cycle times beyond the six-sigma point – commonly accepted as system failure. This presentation includes data diagnostic techniques that help identify the presence of power-law behavior and how to parameterize the simulation of such behavior when it is present.

Classification: UNCLASSIFIED		
Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support		

56711 - Measures for the measurers: A survey of process improvement program measures in US federal agencies

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr. Steven Lagan		
Abstract: Measuring performance and using that information to improve is a foundational concept in process improvement methodologies such as Lean, Six Sigma, and Total Quality Management. Measurement frameworks, such as the Balanced Scorecard and Logic Models, are often cited in both private and public sector performance management literature, and process improvement experts often play a key role in helping develop these frameworks for the entire organization. Ironically, published literature infrequently addresses how process improvement programs, especially in the public sector, should measure themselves. This study addresses that knowledge gap by examining the performance measurement practices of process improvement programs in the US federal government. Using survey responses from process improvement programs across numerous US federal agencies, this study reveals both the measurement frameworks and specific measures currently in use. Measures will be aggregated and presented within a logic model framework, which other public sector process improvement programs may consider when tailoring performance measures to their needs.		
Classification: UNCLASSIFIED		
Working Group:WG 04 Homeland Security, Homeland Defense and Civil Support		

WG 05 Information and Cyber Operations

55212 - Measuring Cyber and IO Workshop

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Donald H. Timian		
Abstract: The MORS Measuring Cyber and Information Operations (IO) "Virtual" Workshop was held 27-29 October 2020. The purpose of this Workshop was to begin identifying the cyber datasets and metrics needed to effectively report the impact and benefits of cyber-based operations to Congress. The 2020 Cyber Solarium Report recommendations along with language in the House and Senate 2021 National Defense Authorization Act (NDAA) served as the backdrop for the Workshop to explore: o What are we going to measure in the offensive and defensive cyber arenas? o How will the results be reported? o What new, Unclassified datasets are needed? This presentation will briefly describe the Workshop Plenary Session and the discussions during the four Working Groups' Breakout Sessions plus their Outbriefs, as well as a proposed path ahead.		
Classification: UNCLASSIFIED		
Working Group:WG 05 Information and Cyber Operations		

56606 - Training Responses to Cyber Attacks in a Perception-Based Campaign Model

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr. Charles D Burdick; Dr. Deepinder Sidhu		

Abstract: The Persistent Cyber Training Environment (PCTE) will allow us to expand the number of cyber trainees and the amount of time they have in a cyber training environment, but these will generally employ notional networks unlike the actual networks the trainees will be assigned to defend. However, the opportunity now exists to obtain better cyber effects data by collecting from exercises on low-cost digital twins of specific physical networks.

Also, most campaign level combat models allow an analyst to simply "twist a knob" to dial in a cyber effect, such as reduced kinetic lethality But in the Joint Analysis System (JAS), a government-owned, perception-based Campaign model used by JFCOM J9 to conduct simulation-supported wargaming, all information transited over simulated networks and a network disruption caused the delay or loss of specific information, which then impacted subsequent operations.

For the J9 wargames, whenever they paused JAS, human decisions-makers could replace selected simulation agents. The humans were provided the same computer-generated status reports as the agents, observed the same map-based Common Operational Picture (COP), and then made the best decisions they could, based on the information actually available, not ground truth.

The authors propose employing these new network emulations using specific virtual hardware and internet software that are now available and using them to rapidly create low-cost, full fidelity network digital twins of operational networks. These emulated networks and their defensive tools can reside on everything from small computer equipment to the cloud and can record all the actions of both attacking and defending cyber teams. They thus generate credible data for the length of time for successful detection and defense or, if an attack succeeds, the likely time needed for restoration of specific operational networks by teams proficient in their defense.

Meanwhile, the simulation-supported wargame provides all types of kinetic and nonkinetic C2 attacks, not just cyber, and reports on the damage caused. But only the White team knows the full extent of the information lost. The wargamers can survey the disruptions and employ a wide range of available measures such as alternative communications paths to restore effective C2. The effectiveness of these measures including a cyber response is the degree of mission accomplishment. The combination of credible cyber data linked to specific networks in a wargame along with a "whole of staff" response to C2 disruptions should significantly improve our understanding of the value of training cyber personnel oriented on their assigned networks, while the entire unit staff employs responses to simultaneous kinetic attacks on their C2 infrastructure and addresses nonkinetic EW and deception impacts.

Our presentation describes this combination in more detail and the authors believe its employment would greatly improve our ability to defend our C4ISR systems.

Classification: UNCLASSIFIED
Working Group:WG 05 Information and Cyber Operations

56869 - Countering the Threat of Image-Based Information Warfare

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Douglas A. Samuelson; Dr. Spencer Graves		

Abstract: Mass media communications have shifted dramatically from linear, words-and-logic messages to images and memes. As Marshall McLuhan predicted, this shift transforms the nature and possibilities of governance and promotes tribalism. Recent US political campaigns provide striking examples of this phenomenon, including the ease of incitement to insurrection, but much

broader applications are clearly possible. In particular, disinformation campaigns could disrupt C3, especially for small, loosely coordinated special operations units.

We discuss ways to identify and counter such disruptive activities. One area of experience that offers promise is Village Stability Operations, which focuses on building trusting communities that then become resilient against anti-government messages. Domestically, similar ideas are community-based policing and political community-building via extensive personal campaigning, also called "the ground game." Building trust is critical.

As in counter-terrorist operations overseas, slowly and carefully identifying the components of hostile networks and dismantling the information and financial structure are likely to work better than force-on-force "whack-a-mole" approaches. While there are highly appropriate legal restrictions on US military activities within the US, there is no reason why experienced VSO operatives could not train domestic law enforcement personnel.

Similarly, "whack-a-mole" actions against inflammatory media messages are unlikely to counter the polarization which some splinter groups promote and from which they prosper. Facilitating civil legal actions against malicious defamation, reestablishing a higher degree of Federal licensing and enforcement actions in mass media, and promoting a common trusted knowledge base seem more promising.

In military operationsore strongly establishing which sources of information to trust and how to recognize disinformation should be a high-priority operational security activity. Increasing joint training can help unit commanders discern which communications purportedly from or about other unit commanders should be treated with suspicion.

The central idea is to recognize that current threats are far more likely to be information-based rather than kinetic, and to acquire, train, prepare and respond accordingly.

Classification: UNCLASSIFIED
Working Group:WG 05 Information and Cyber Operations

56783 - Challenges and Insights from Developing an Analytical Baseline for Installation-Level Enterprise IT

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: MAJ Jaison Desai, PhD		

Abstract: This presentation highlights current challenges with developing a comprehensive and coherent baseline of enterprise information technology services at U.S. Army installations. While many monitoring systems and mandatory reporting structures exist at various echelons, these tend to be largely fragmented and desynchronized in the data they contain and the questions they attempt to answer. The diversity of services, functions, and systems across the Army installation ecosystem also creates unique challenges in the ability to form a standard approach. An ongoing pilot by U.S. Army Cyber Command (ARCYBER) and Program Executive Office Enterprise Information Systems (PEO-EIS) to explore alternative acquisition models for installation-level IT infrastructure created the requirement to effectively define the baseline for use in future comparisons of effectiveness and cost.

The author provides an overview of the work of the assessments team in identifying existing technical data sources and assessing their value in providing insights to the baseline. The use of non-technical user experience (UX) metrics is also discussed, including the effectiveness of survey instruments to gather data on both system usage and sentiment. The importance of inter-service collaboration is highlighted, along with the challenge of addressing the needs and requirements of a wide variety of stakeholders. This ongoing work provides insight into challenges faced by the Operations Research community when conducting assessments.

Classification: UNCLASSIFIED
Working Group:WG 05 Information and Cyber Operations

WG 06 Command and Control (C2)

56840 - A Simple Resource Constrained Operator Model

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Michael L Thomason; Stacy Pethel		

Abstract: Expected performance of systems interacting on the modern battlefield is frequently analyzed constructively through Monte Carlo analysis of simulated engagements. The system performance is greatly influenced by the operator of the weapon systems. In these simulations, a model of the operator is required to reflect their training and decisions on simulation results.   Within the Extended Air Defense Simulation, multiple techniques have been used for representing these human interactions over the years.

For threat evaluation leading to engagement with a specific weapon, the time required for the operator to make engagement decisions has often been characterized as a decision rate as a ruleset operated to determine the decisions. Independent of the engagement decision rate, other processes initially were a constant time delay, subsequently improved to a timing distribution for the specific decision type. Example activities for this latte representation include recognition of receipt of an assignment or possibly an initial target classification process. As the model matured, strategies for improving the representation of the operators on the battlefield were contemplated. As the need arose to better represent the impacts of the operator involved in the Combat Identification process, a simple loading constrained resource model was devised to represent operator required activities across multiple functions as a prioritized, resource constrained representation of the operator, i.e., an Operator Model.

This presentation will walk through the Operator Model characterization and provide a few examples of how it is being applied within the Combat ID and other processes utilizing implementation in EADSIM as the backdrop.

Classification: UNCLASSIFIED
Working Group:WG 06 Command and Control (C2)

56843 - What's New in EADSIM Version 20

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Stacy Pethel; Michael L Thomason		

Abstract: The capability and availability of simulation tools often determine the boundaries of analyses. The knowledge of the capability and availability of simulation tools more often places greater limits on the boundaries of analyses. The U.S. Army Space and Missile Defense Command

(USASMDC) and Teledyne Brown Engineering are excited about the version 20 release for late Spring of 2021, as many of the new capabilities significantly impact the operation of EADSIM across the Live, Virtual, and Constructive simulation gamut. Major new EADSIM features include expansion of the operator-in-the-loop capabilities, including pilot-level control of fighter flight and engagement decisions and expanded manual control of surface-to-air command chain participants; additional capabilities supporting defensive fighter operations in conjunction with support aircraft such as airborne sensors and refuel tankers; simplified methods for modeling rotating radars; an expanded 2D slew model for high energy lasers; continued expansion of representation of Integrated Air and Missile Defense capabilities; and a variety of methods to introduce new timing effects into track maintenance, combat identification processes, and achievement of fire-control level data. Not only do these features operate fully within the internal, constructive simulation, these new features provide additional depth to both truth and perception presented to other federates and operators in the loop when operating in a distributed environment.

This presentation will provide an overview of EADSIM, a summary of the newly available features in EADSIM Version 20, and a summary of the future directions of this community standard tool.

Classification: UNCLASSIFIED
Working Group:WG 06 Command and Control (C2)

56581 - Collaborative Communications through Non-Traditional Modes

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Michael Woudenberg; Joshua Deiches; Troy Shideler		

Abstract: Collaborative communications of manned and unmanned teams predominantly focuses on transmitting information via the radio frequency (RF) spectrum. This singular focus results in network overload, bandwidth limitations and susceptibility to communications denial that result in system fragility. This presentation will investigate the limitation of RF centric communications and explore non-traditional modes of communication, leveraging advanced technologies while fusing with Joint All Domain Operations (JADO) and DARPA's Mosaic construct.

Classification: UNCLASSIFIED
Working Group:WG 06 Command and Control (C2)

56605 - Joint All Domain Operations Modeling, Simulation and Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Richard K. Null		

Abstract: Joint All Domain Operations (JADO) focus on leveraging cross-domain interactions to increase combat effectiveness. Lockheed Martin has developed a discrete event modeling and simulation approach to investigate and analyze warfighting performance of JADO concepts. The simulation uses a "sense, decide, act" framework to characterize Intelligence, Surveillance and Reconnaissance (ISR); Battle Management Command and Control (BMC2) and Offensive Fires functions. The simulation utilizes the ExtendSimtm commercial software and is scenario-based offering analytic insights to JADO stakeholders, architects and decision makers. The presentation will review the simulation operation and offer sample analysis cases.

| Classification: UNCLASSIFIED |
| Working Group:WG 06 Command and Control (C2) |

56479 - Reducing Transmission Footprint while Maximizing Value of Information on Dynamic Communication Networks

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Michael Hirsch; Dr. Hector Ortiz-Pena		

Abstract: As more and more sensors are deployed across multiple assets on military missions, the amount of data collected and/or generated continues to increase at an exponential rate. When communication network topologies dynamically evolve temporally, optimally routing the collected data to the commanders/decision makers/analysts/consumers of the data is a challenging problem. As a further complication, every transmission produces a digital signal that has the possibility to be tracked and targeted by enemy forces. Reducing a unit's digital footprint and transmission time reduces the possibility of tracking and targeting by the adversarial actors. Hence, there are conflicting goals – routing data that provides value to the current and future tasks as part of the mission, and not routing data in order to reduce the possibility of detection. In this research, we investigate routing strategies taking into account both of these conflicting goals and show how significant reduction in transmission footprint can be achieved with modest reduction in the value of data routed. A mathematical model is developed and run across multiple simulated scenarios to highlight results.

Classification: UNCLASSIFIED
Working Group:WG 06 Command and Control (C2)

57045 - Resilient Decisio Making, Communication, and Distributed Maritime Operations

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Charles Swain; Dr. Amy Jo Haufler		

Abstract: The U.S. Navy, Air Force, Marine Corps, Army, Joint Staff, and Defense Advanced Research Projects Agency (DARPA) are studying distributed operations to better handle near-peer and grey zone conflict. The purpose of this study was to analyze resilient decision-making, communications and distributed operations (DO). The analytical question studied was "How do we enable distributed tactical operations that maintain integrity to the strategic objective?" Current literature and strategic studies of DO were analyzed. Key operational concepts such as the OODA loop and decision-making under uncertainty were studied. In-depth interviews of military and naval leaders as well as active duty naval commanders were conducted to gather ground truth data regarding information needs, communication patterns and preferences, analysis of the adversary, and decisions in risk environments. In addition, interviewees were queried regarding their understanding of, expectations for and concerns about DO as pertinent to the future battlespace. Six analytical insights were revealed to include information, orientation, communications, adversary intent, resiliency and decision-making. An additional key finding was that DO requires a C2 architecture that is tactically proficient and strategically astute. Identifying the smallest functional unit for operations in DO is necessary to inform the C2 architecture. Mandelbrot set experiments are recommended as next steps to determine the smallest functional unit on which more complex and scaffold naval missions can be modeled.

Classification: UNCLASSIFIED
Working Group:WG 06 Command and Control (C2)

WG 07 Intelligence, Surveillance, and Reconnaissance

56772 - Toward a Vision for Living Intelligence

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Patrick Hester		

Abstract: The term living intelligence was introduced in a 1981 science fiction novel, yet it went mostly unused until the mid-2000s, when it was given new life as a concept for the next generation of intelligence gathering and dissemination. Since then, the term has gone through limited deployment in wiki-like environments, but its meaning and use have not been formalized. This presentation sets out to trace the historical use of the term and formalize its components, namely continuous intelligence, augmented intelligence, and decision intelligence. In doing so, we set out to define the term and provide a vision for future research and development in the field of living intelligence. It is our hope that this approach will help the next generation of decision makers to be more efficient and effective during a time when data and the computing power used to harness it are exponentially growing and the pressure to make not only the right now, but also the right decision, is arguably higher than ever.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56966 - Rapid generation of information fusion architecture alternatives through algebraic graph transformations

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: John Robinson		

Abstract: Emerging concepts for defense systems such as mosaic warfare focus on the composition of novel, unpredictable systems of systems comprised of many platforms, rather than relying on a smaller number of highly performant multi-role systems. The combinatorial space of solutions to mission problems afforded by this new approach is vast, and there is a desire to engineer these systems-of-systems on the fly at a more rapid cadence than traditional SoS engineering cycles. Proper engineering of the information fusion (IF) architecture of these SoSs is critical to maintain capabilities in the face of the systems confrontation approach adopted by near peer adversaries. This presentation outlines the use of algebraic graph transformations (a mathematical tool with past application to tasks like compiler optimization and computational chemistry,) as an enabling tool for the generation of arbitrary, but physically and logically coherent, IF architectures, by means of non-deterministic rule application on a typed attributed graph. The typed attributed graphs generated by this method represent both physical and logical architecture descriptions, from which transformation into both MBSE models or executable simulations will be demonstrated. As a result, this approach provides engineers a useful tool for rapid, on-demand generation of sets of architecture alternatives from which those best suited for a particular mission can be selected.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56891 - Towards a Standardized Computable Semantic Framework for Both Blue Force and Red Force Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. William Mandrick; Dr. Forrest Hare; Ian Featherstone		

Abstract: Semantics is the branch of linguistics and logic concerned with the cognitive structure of meaning, sense, reference, implication, and logical form. We argue here that the semantics used to describe the operational readiness (i.e. equipment status and training levels) of Red Forces are interchangeable with the semantics used to describe Blue Forces. Furthermore, the semantic elements required for distinguishing red objects from blue (or gray) objects are negligible for most readiness modeling efforts. This means that discoveries in AI and NLP made in the intelligence domain (i.e. focused upon Red Forces) can be applied to domains such as Blue Force Tracking and Global Force Management. We assume the Computational Theory of Mind (CTM) whereby the classes (types) of objects, how they are defined, and the logical relationships between them comprise the cognitive structure used by intelligence analysts and computers to reason about objects moving in space and time, their functions, and the ability to execute the functions. In what follows we will describe and graphically depict how the semantics used to reason about both Red and Blue Forces is essentially the same, and what this might mean for modeling across DoD Enterprise for readiness level understanding and correlation.

Joint Publication 1 defines Operational Readiness (OR) as the capability of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it is organized or designed. OR is determined by analyzing unit configurations, manpower, training, equipment availability and maintenance levels. For example, it is helpful to analyze the composition of a ground force (military unit), the vehicles it controls, and the training exercises that it participates in. Furthermore, military vehicles serve as platforms for various weapons, sensors, and communications devices with distinct functions and capabilities, which can be assessed in terms of their performance, effectiveness, and range.

In order to establish a set of standardized computable assertions for OR that would apply to both Blue Forces and Red Forces, we propose building a computable OR ontology built around the following classes:

Ground Force (such as an Airborne Regiment or Brigade Combat Team)

Combat Vehicle (such as a Russian BMD or U.S. Stryker)

Weapon (such as a 2A70 100 mm cannon or A M1128 105 mm cannon)

Military Exercise (such as a Live Fire Exercise)

With the classes, individuals, and logic curated into a web ontology language and data exchange format called OWL-RDF, any computer can derive meaning from data coming from military units, their vehicles, or sensors, and render knowledge graphs.

Keywords: Semantics, First Order Logic, Computational Theory of Mind (CTM), Web Ontology Language (owl), Operational Readiness

Classification: UNCLASSIFIED

Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

57412 - Algorithm Evaluation Tools and Capabilities at C5ISR Center

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Jonathan Hixson; Mr Mark Jeiran; Mr. Brian Power Teaney		

Abstract: The C5ISR Center Night Vision and Electronic Sensors Directorate (NVESD) has recently developed new tools and capabilities to effectively analyze the performance of Aided Target Recognition Algorithms. The tools and capabilities developed are: the NVESD Target Acquisition Ontology (TAO), which was developed to standardize terminology and object labeling and to train

deep learning algorithms to classify objects in a meaningful way for target acquisition; the NVESD Common Data Format (CDF), which was created to resolve issues related to the use of various data formats and storage schemes of imagery and related ground truth data and is based on the well-established Hierarchical Data Format 5 (HDF5); the NVESD Algorithm Evaluation Tool used to score and visualize algorithm performance, and rapidly output results for analysis. This presentation will go step by step through the use of these tools and show their application to the YOLO (You Only Look Once) algorithm and the FLIR ADAS (Advanced Driver Assist System) data set.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56859 - High Accuracy Detection and Exploitation System (HADES) Requirements and Framing Analysis

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Noelle Douglas		

Abstract: The current Army Aerial Intelligence, Surveillance, Reconnaissance (AISR) is not optimized to support large-scale, multi domain operations (MDO). As a result, the Army has developed the High Accuracy Detection and Exploitation System (HADES), as the first increment of the Multi Domain Sensing System (MDSS) family of systems to meet the requirements for large scale, MDO AISR. To counter the expected peer- and near-peer competitor threats, HADES must provide globally deployable AISR with the precision, range, endurance and sensing capability necessary to provide relevant Indications & Warning and target development.

To better understand the HADES desired capabilities and inform the creation of the HADES Capabilities Development Document, the Army tasked The Research and Analysis Center (TRAC) to conduct a Requirements and Framing analysis as a precursor to a formal Analysis of Alternatives. TRAC led the collaborative effort with stakeholders from the HQDA G2, Project Manager Sensors Aerial Intelligence, the Aviation, Cyber, and Intelligence Centers of Excellence and operational subject matter experts from the U.S. European and Indo-Pacific Commands. The study identified the anticipated intelligence mission demands HADES would be tasked to accomplish, identified mixes of capabilities to satisfy the identified demands, and identified relevant cost drivers. The Army HQDA G8 used the results to confirm if HADES was actually required and how much resources should be allocated to develop the concept into a Program of Record.

This presentation explains the HADES problem statement, presents the methodology employed, reviews the tools used, and provides lessons learned to inform other Framing and Requirements analyses.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56547 - Adaptive Warfighting

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Bud Bishop		

Abstract: Warfighting as a network to increase military effectiveness, cost leverage, and adaptability is becoming a working reality by leveraging advances in computer processing and new command,

control and computer (C3) arrangements.   Using technology to compose new, more lethal effects at operationally relevant speeds through dynamic, intelligent allocation of available data regarding situational awareness and effector (weapon) system status is key. This awareness is intended to increase the speed and scale of weapons effects through the re-allocation of sensors and data at the forward edge -- which can be generally characterized as fast, scalable, adaptive joint multi-domain operations .

In this effort, the effects chain functions (Find, Fix, Target, Track, Engage, and Assess or (F2T2EA)) are disaggregated across a heterogeneous mix of manned and unmanned platforms and transform these disaggregated systems in a manner that makes them "addressable", i.e., they can compose and recompose effects chains at mission speeds to improve operational impacts in anti-access/area denial (A2AD) strategies.

This presentation will describe and detail the modeling and simulation (M&S) methodology, assumptions, and measures of effectiveness (MOE) in order to assess the impact and effectiveness of today's warfare processes and the differences associated with the implementation of network-enabled warfare processes. To this end it will demonstrate the potential benefits of connecting the diverse networks of different sensors to the many shooters available considering the ability to increase information flow through land, sea, air, space and cyber domains. This operational research effort characterizes and details the effects chain (F2T2EA) from initial detection to weapons engagement with subsequent battle damage assessment (BDA) of the current forces programs and processes and compare/contrast that with the network-enabled warfare programs and processes. The presumption is that through some types of automation (artificial intelligence) and/or process management changes that are incorporated into the effects chain those changes will enable a shorter timeline to achieve kills on targets.

To complete the highest priority kill-chains, networked warfare efforts must seek to hold custody longer and must reduce Sensing, C2, and Weapons TOF-after-last-update timelines. A new, forward-edge CONOPs must be developed to answer these shortfalls; our presentation provides such a construct.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

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55312 - Enhancing Intelligence, Surveillance, and Reconnaissance Teamwork Coordination via Interactive Tabletop and Software Games

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Dr. Mary Frame; Justin Morgan; Dr. Alan S. Boydstun; Dr. Bradley Robert Schlessman; Michaela Schwing		

Abstract: Intelligence analysts integrate information from multiple sources (e.g. radio signals, static and dynamic imagery, radar) in order to fully model the mission environment and pursue requirements pertinent to a commander's intent. To integrate and use this intelligence information, known as INTs, analysts must plan and cross-coordinate collection paths for a limited number of assets. In the ATO cycle, there can be more requirements than there are assets to collect them, which demands effective prioritization. Furthermore, new requirements can emerge during ongoing operations, requiring analysts to reconfigure initial plans and reprioritize requirements. Although this type of decision-making is critical to mission success, analysts may not be exposed to these concepts prior to deploying to operational environments. To address this, our SMEs and research team have developed two collaborative games, Intellection and Intrage, which focus on asset route planning and INT layering, respectively. Both games afford analysts the opportunity to hone mission-critical skills

that include mission planning, adaptive decision making, cross-coordination of assets, strategic thinking, communication, and problem solving as individuals or in teams. Use of these games, whether the tabletop of software version, has allowed researchers to study the types of communication and strategies that facilitate performance, and may transfer to operational success under varying mission conditions.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56475 - A mixed-method approach to optimising airborne maritime surveillance classification augmented by an automatically generated flight profile

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Mr. Paul Sheehan; Professor Terrence Michael Caelli; Mr. Jordan Chapman; Mr. David Kirszenblat; Ziming Tu

Abstract: Airborne maritime surveillance utilises Inverse Synthetic Aperture Radar (ISAR) as the primary means of classification within an Intelligence, Surveillance and Reconnaissance (ISR) mission. Since the quality of an ISAR image is optimised at particular aspects between radar and target, the flight profile flown must position the aircraft accordingly to ensure that the operator has the best chance of correctly classifying targets. In this paper we utilise a multi-method operations research approach to explore the utility of providing the operator with a decision aid in the form of an automatically generated flight profile that optimises the aspect to a target at the time of classification. To produce optimal flight profiles for analysis, we consider the nearest neighbour, roulette algorithm, integer linear programing, and a genetic algorithm complemented by a gradient descent method to finely tune the selection of optimal positions. We then conduct a constructive simulation using the metrics of overall path length and number of targets classified to demonstrate a statistically significant improvement on standard classification performance. Finally we conduct a human-in-the-loop (HiTL) simulation, using a typical ISR scenario, to qualitatively explore the issues concerned with operator trust and comfort in utilising such automation technologies. The results from both constructive and HiTL simulation suggest that the standard operator ISAR classification process in an ISR mission can be improved through the utilisation of an automatically generated mission profile based on target aspect. This mixed-method approach also demonstrates how using both quantitative and qualitative methods to analyse the integration of automation with human processes produces statistically significant results while also verifying the subjective operator experience.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

57223 - Per-pixel Cloud Cover Classification of Multispectral Landsat-8 Data

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: Salome Esteban Carrasco; Dr. Torrey Wagner; Brent T Langhals

Abstract: The abstract text is still being cleared by public affairs, but it was sent to the session chair Eric Harclerode via government email. The session chair replied that is was possible to accept the abstract on 3/25/2021.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

57210 - Synthetic Aperture Radar Image Recognition of Armored Vehicles

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Christopher Szul; Dr. Torrey Wagner; Brent T Langhals		

Abstract: The abstract text is still being cleared by public affairs, but it was sent to the session chair Eric Harclerode via government email. The session chair replied that is was possible to accept the abstract on 3/25/2021.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56480 - Reducing Transmission Footprint while Maximizing Value of Information on Dynamic Communication Networks

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr. Michael Hirsch; Dr. Hector Ortiz-Pena		

Abstract: As more and more sensors are deployed across multiple assets on military missions, the amount of data collected and/or generated continues to increase at an exponential rate. When communication network topologies dynamically evolve temporally, optimally routing the collected data to the commanders/decision makers/analysts/consumers of the data is a challenging problem. As a further complication, every transmission produces a digital signal that has the possibility to be tracked and targeted by enemy forces. Reducing a unit's digital footprint and transmission time reduces the possibility of tracking and targeting by the adversarial actors. Hence, there are conflicting goals – routing data that provides value to the current and future tasks as part of the mission, and not routing data in order to reduce the possibility of detection. In this research, we investigate routing strategies taking into account both of these conflicting goals and show how significant reduction in transmission footprint can be achieved with modest reduction in the value of data routed. A mathematical model is developed and run across multiple simulated scenarios to highlight results.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56504 - Coincidences: Signal or Noise?

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Thomas Reed Willemain; Dr. Nelson Seth Hartunian		

Abstract: Coincidences: Signal or Noise?

Sometimes something happens and something else happens in close temporal proximity. Example: an aircraft instrument reading shows a fluctuation, and during the same flight there is a system failure. We want to know whether the simultaneous occurrence of two events, i.e., a coincidence, is merely a chance event. If not, there may be some exploitable link between the events. Two possibly-related sequences of events can be represented as binary time series $A(t)$ and $B(t)$ for $t=1..T$. If $A(t)$ and $B(t)$ are statistically independent, then all coincidences are chance events. An appropriate test statistic is the count of coincidences over the T pairs of observations: $C = \Sigma A(t)B(t)$. If A and B are independent

Bernoulli ("coin flip") processes, C has a binomial distribution. However, real data are often more complex than Bernoulli processes. We propose more comprehensive tests based on models of events that account for autocorrelation, trend, and seasonality. However, when investigating multiple time series for possible connections, even stringent tests can uncover a huge number of apparent relationships for investigation. In these cases, attention must be paid to the false discovery rate to avoid wasting time on false targets.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56593 - Satellite Dish Detection as a Semi-Supervised Small-Object Localization Problem

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Daniel Grahn		

Abstract: Understanding the satellite communication abilities of a country provides a unique look into their civil and military capabilities. However, manually searching vast swathes of land for satellite dishes which may be just a few pixels in diameter and then determining their look angle is time-intensive and costly. Such processes are fruitful ground for learned object detection. Three major problems present itself in this task. First, there are no pre-labelled training dataset and bounding-box labels are expensive to generate. Second, satellite dishes are small objects within the images. Finally, generating a ground-truth dataset of look-angles is complicated and impractical. We overcame these challenges by making use of active and semi-supervised learning using a custom loss function and GradCAM to effectively localize dishes; a custom, minimal CNN to avoid small-object detection issues caused by excessive convolutions; and traditional CV to produce bounding boxes and look angles. This workflow demonstrates a series of techniques which could be applied to different tasks within the remote sensing and computer vision domain.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

56997 - Naval ISR Reference Architecture

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mrs. Sophie Leonard		

Abstract: Program offices and POM decisions leverage analytic efforts to inform and support decision making. The utility that decision makers can derive from a given analytic effort is directly linked to the validity of the effort's underlying data. The Naval ISR Reference Architecture (NIRA) effort provides analysts with better data by developing authoritative platform architectures and an enduring database for all Naval ISR platforms. Modeling engineers apply a data-centric MBSE approach to create platform architectures that incorporate DoDAF diagrams as well as platform and system capabilities such as sensor performance, communication links, and data processing components. Platform architectures also incorporate all of the off-board pathways to show the touch points of the ISR data. The program office in charge of each system then subjects candidate architectures to a rigorous vetting process, reviewing systems, platform capabilities, and connectivity. Only after the data has been verified by these subject matter experts are architectures considered authoritative and made available for dissemination. The NIRA effort – unique in that its only goal is to develop and validate architecture – originated out of the Naval ISR council and the idea was endorsed by an R3B and OPNAV N2N6. The central repository of valid and vetted data provided by NIRA will enable future

analytic efforts to be streamlined, more accurate, and ultimately more valuable. This presentation will describe the process, lessons learned, as well as programmatic effects involved from the NIRA effort.

Classification: UNCLASSIFIED
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance

57041 - Networked Airborne ISR&T Long Endurance (NAILE) Study

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Emily Jasien		
Abstract: The constant evolution of adversary surface warfare capabilities requires continuously evolving Navy strategies to successfully find, fix, track, and target (F2T2) adversary surface combatants at extended stand-off ranges. Additionally, maritime platforms must accomplish this in Disrupted/Disconnected, Intermittent and Limited (D/DIL) environments while operating in alignment with evolving Navy concepts of operation. Mission success therefore demands the capability to conduct Intelligence, Surveillance, Reconnaissance, and Targeting (ISR&T) over large areas of interest with assets providing persistent intelligence data to platforms in theater. The Networked Airborne ISR&T Long Endurance (NAILE) study was conducted in support of OPNAV N96 and sought to overcome these requirements by employing an airborne ISR&T network capable of providing mission-critical data for the operating area, and ultimately target-quality data to surface firing units. This study employed the mission-level modeling and analysis capability of the Executable Architecture and Management System (ExAMS) tool to assess the feasibility of the NAILE concept. Analysts simulated NAILE implementation within an anti-surface warfare (ASuW) mission context to determine its capability for providing adequate ISR&T support. Assessments were based on quantitative mission-level metrics including the probability of acquiring and maintaining a track on the target. Additional experiments were run to further refine the NAILE concept and influence recommendations and analysis-revealed requirements such as sensor and communications payloads and platform CONOPS. This presentation will describe the NAILE analysis process as well as measures of success descriptions.

Classification: SECRET NOFORN
Working Group:WG 07 Intelligence, Surveillance, and Reconnaissance | | |

WG 08 Space Acquisition, Testing and Operations

56832 - STORM Space Visualizations

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Lt Col Adam Messer; Benjamin Johnson; William McEntee; Candice Sammons		
Abstract: The Synthetic Theater Operations Research Model (STORM) is one to the DoDs preeminent campaign-level models. Used heavily by the terrestrial services, it provides many insights from operational planning to budgeting. As STORM is being updated to include enhanced space effects, the terrestrial view of the visualizations lacks the ability to capture space operations. We present ongoing efforts to build improvements to the visualization capabilities of STORM. Improvements include space effects, orbital dynamics, and improved terrestrial views.

Classification: UNCLASSIFIED
Working Group:WG 08 Space Acquisition, Testing and Operations | | |

56565 - Increasing the Fidelity & Quantitative Analyses Within the Joint Mission Thread (JMT) Baseline through Space Interaction Blueprints (SIB)

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Michael Chapa; CDR Lora Gorsky; Carl Hawkins; Mr. John R. Tindle

Abstract: In 2017, a joint USSTRATCOM/NRO endeavor (the Joint Space Warfighting Forum [JSWF] Modeling, Simulation, & Analysis [MS&A]) team instantiated 28 Joint Mission Threads (JMT) for the Air, Land, Maritime, Space, and Strategic domains. JMT Baseline 1.0 leveraged subject matter expert inputs from mission partners (SMDC, N81, AF/A9, AFSPC/A9, and SMC) to identify Space Touch Points (STPs) and generalized warfighter consequences due to loss of space services. The consequence of denied STPs (for each of Position-Navigation-Timing, Satellite Communications, Intelligence-Surveillance-Reconnaissance, Missile Warning, and Environmental Monitoring) were assessed as negligible, moderate, critical, or catastrophic in accordance with the DoD Deliberate Risk Assessment Matrix. JMT 1.0 products were top-level Tier I JMTs which allowed for qualitative insights to frame warfighter mission/space dependency discussions and analysis. They were used to enhance decisions and actions of leadership, including Space Mission Assurance Tiering, Annual Joint Assessments, Strategic Portfolio Reviews, and a Joint Warfighting Concept Wargame.
With space becoming an increasingly contested warfighting domain and the transition of the JMT Baseline to USSPACECOM, there is an urgent need to provide decision makers with higher fidelity warfighter focused quantitative analysis in a timely manner. As a result, in May 2020 the JSWF MS&A team embarked on a JMT Baseline 2.0 effort with SME-vetted mission behavior diagrams which include mission-to-mission interdependencies. To more rapidly confirm the development of diagram logic, Excel-based Markov chains were used as a risk reduction opportunity to model, collect data, and perform sensitivity analyses. The resulting products from this effort, applied as a standard format for quantitative mission thread description and analysis, are called Space Interaction Blueprints (SIB).

Classification: UNCLASSIFIED
Working Group:WG 08 Space Acquisition, Testing and Operations

56669 - Joint Mission Thread (JMT) Space Touch Point Sensitivity Analysis Using Probabilistic Markov Simulation (PMSIM)

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: Nate Tabelon; Stuart A Stanton, Lt Col, USAF, PhD

Abstract: United States Space Command Advanced Warfare Capabilities and Resources Analysis Division (USSPACECOM/J81) and the Joint Space Warfighting Forum (JSWF) Modeling, Simulation, and Analysis (MS&A) community seek to better understand and quantify how space capability degradations impact the warfighter in order to provide insights and recommendations to senior leaders based on analytic findings. Currently, the JSWF MS&A baseline consists of twenty-eight JMTs in which consequent space touchpoint loss or degradation is primarily analyzed qualitatively. In order to provide more impactful information to senior leaders and throughout the community, JSWF MS&A, as a working group within the Space Analysis Consortium (SpAC), strives to increase JMT baseline fidelity such that it is not only based in a qualitative understanding but is rooted in quantitative data.

Probabilistic Markov Simulation (PMSIM) is an Excel-based simulation framework providing a low cost, accessible, risk reduction opportunity to model, collect data, and perform sensitivity analyses. It was developed to enable continuous support to the warfighting mission throughout the COVID-19

pandemic using unclassified inputs and tools, as well as enable quantitative analysis. JSWF MS&A uses PMSIM to conduct sensitivity analyses on several missions in its JMT baseline. Using PMSIM to perform quick-turn sensitivity analysis, users can determine the effects of space capability degradations on mission metrics and outcomes in hours and days vice the weeks and months required by more advanced models. Based on several successful PMSIM experiments at the unclassified level, the model will soon be instantiated in a classified version to generate higher fidelity results.

Classification: UNCLASSIFIED
Working Group:WG 08 Space Acquisition, Testing and Operations

57137 - Strategic Planning and Analysis of Satellite Data Transmit and Receive Networks Using Mathematical Optimization

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr August G Roesener; Christopher Wishon		

Abstract: Since the launch of the first man-made satellite in 1957, satellites have become an integral part of the daily lives of many people in the world. Unfortunately, satellites are not stand-alone systems that function without interaction with terrestrial systems. As a result, satellite control ground networks exist which transmit new instructions, check subsystem health, and download critical data from the satellites. Within the US Department of Defense (DoD), one such ground network is the Air Force Satellite Control Network (AFSCN) which does not own any satellites but acts as a service provider for communications with other agencies' and departments' space assets. The AFSCN is a network of antennas spread across 7 sites throughout the world that manages 100s of satellites with over 500 communication requests daily. Scheduling the AFSCN is a known NP-Hard integer programming problem as it needs to be updated to handle current demands, must abide by orbitology physics, and has numerous binding constraints which limit scheduling flexibility. This presentation provides an overview of the problem, nuances into the difficulties in solving an instance of the formulation, and a detailed discussion of the multiple optimal and heuristic based solution methodologies currently utilized to solve the problem. The presentation will also discuss the impact of Operations Research on the operational and strategic planning of the AFSCN and similar networks.

Classification: UNCLASSIFIED
Working Group:WG 08 Space Acquisition, Testing and Operations

56912 - The challenges faced by a new service branch and combatant command in establishing a Modeling & Simulation enterprise tailored for Space Domain warfighting.

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr. Charles I. Bennett, V; Evan F Mize		

Abstract: Space has until only recently been occupied by an exclusive club of major global powers, where no adversary could menace on-orbit assets. That construct has slowly evolved as Space has evolved into a hotly contested and congested combat arena. Space-enabled warfighting capabilities are no longer assured. Current wargames and exercises conducted to develop future tactics, techniques, and procedures don't reflect this reality. Doctrine that establishes how the Space Domain is portrayed in multi-domain wargame and exercises is needed.
A former AFSPC Commander noted that current lines of effort are insufficient for a robust Space Domain modeling and simulation (M&S) enterprise that supports both the Service and combatant

commands. He also noted that additional policies and space-specific doctrine are required to facilitate exercises and readiness for current and future threats. This doctrinal gap is supposed to be resolved with the creation of both the United States Space Force (USSF) and United States Space Command, but challenges lie ahead.

Current M&S architectures that were developed during the Cold War (and are still in use today) don't properly replicate modern conflict in the Space environment. The Joint Theater-Level Simulation (JTLS) simulation/wargaming environment portrays Space capabilities as mere services that can be 'turned on or off' (simulating signal degradation) and in-domain activity simulations (direct-ascent and co-orbital anti-satellite attacks) are not supported at all.

Over-classification has been a problem that has plagued Space for years. Since its inception, technologies related to Space have warranted the most stringent protections as critical national secrets. To this day, the highest classification levels protect anything related to military Space. Over-classification has resulted in compartmentalization and stove-piping where space-related M&S innovations are not shared with the broader M&S community. Breaking down these classification walls and fostering sharing these once-cloistered M&S technologies, tools, architectures, and developments is a significant challenge.

The final challenge is building it in such a way that it is adaptive and responsive to technology change. Space is vitally dependent on constantly evolving technology. Space is more than just a service that can be turned on or off in a conflict; it is a complex and inconstant warfighting domain. In wargames and exercises today Space is often 'white-carded', to the detriment of warfighter readiness and preparedness.

Updating and changing doctrine and policies, and providing access to stove-piped capabilities are vital to preparing warfighters for the next crisis. We need M&S Space Domain doctrine and policies that allow for agile and interoperable capabilities. Continued development of Space Domain doctrine, policies, and innovative technologies will enable Joint Space Warfighters and USSF Guardians to ensure there's NEVER A DAY WITHOUT SPACE!

Classification: UNCLASSIFIED
Working Group:WG 08 Space Acquisition, Testing and Operations

WG 09 Air and Missile Defense

56793 - Reinforcement Learning Approach to Intelligent Battle Manager

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Alicia Sudol; Loren Isakson; Professor Dimitri Mavris		
Abstract: Applied reinforcement learning presents a unique challenge when developing robust solutions in environments where optimal decision making is paramount. This presentation explores the application of deep q-learning to a novel air defense scenario simulated in AFSIM (Advanced Framework for Simulation, Integration, and Modeling). The goal is to train an agent to manage geographically separated assets capable of defending against incoming threats. Aircraft, armed with air-to-ground missiles, attack the base from all directions. Time sensitive decisions are necessary to prevent the loss of the battle manager agent or its subordinates, rendering the agent incapable of defending itself. Steps are taken to investigate ways of generalizing the policy in the interest of practicality. Classification: UNCLASSIFIED Working Group:WG 09 Air and Missile Defense		

56813 - Adaptive Sampling Techniques for Efficient Response Surface Estimation of High-fidelity BMDS Simulations

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Michael Deskevich; Shane N Hall, PhD; Dr. Benjamin G. Thengvall		

Abstract: Missile Defense Agency (MDA) is creating a new high-fidelity, high-accuracy digital simulation capability to model the Ballistic Missile Defense System (BMDS). This accuracy, however, will come with high computational expense. There will be many more simulation trials desired to perform different types of analysis than there will be computing resources available to execute them. As part of a Phase II Small Business Innovation Research effort, OptTek Systems, Inc. is exploring how to use the high-fidelity digital simulation capability to generate heat maps to measure the effectiveness of different BMDS system configurations in defense of the US against various threats and threat employment options. Rather than a full enumeration approach with a static number of Monte Carlo replications at each design point, custom optimization algorithms are being 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, as well as a "hot start" algorithm that uses the results of a previous study to bootstrap a new solution. This presentation will present our methodology and initial results from this research.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

56841 - A Simple Resource Constrained Operator Model

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Michael L Thomason; Stacy Pethel		

Abstract: Expected performance of systems interacting on the modern battlefield is frequently analyzed constructively through Monte Carlo analysis of simulated engagements. The system performance is greatly influenced by the operator of the weapon systems. In these simulations, a model of the operator is required to reflect their training and decisions on simulation results.   Within the Extended Air Defense Simulation, multiple techniques have been used for representing these human interactions over the years.
For threat evaluation leading to engagement with a specific weapon, the time required for the operator to make engagement decisions has often been characterized as a decision rate as a ruleset operated to determine the decisions. Independent of the engagement decision rate, other processes initially were a constant time delay, subsequently improved to a timing distribution for the specific decision type. Example activities for this latte representation include recognition of receipt of an assignment or possibly an initial target classification process. As the model matured, strategies for improving the representation of the operators on the battlefield were contemplated. As the need arose to better represent the impacts of the operator involved in the Combat Identification process, a

simple loading constrained resource model was devised to represent operator required activities across multiple functions as a prioritized, resource constrained representation of the operator, i.e., an Operator Model.

This presentation will walk through the Operator Model characterization and provide a few examples of how it is being applied within the Combat ID and other processes utilizing implementation in EADSIM as the backdrop.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

56844 - What's New in EADSIM Version 20

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Michael L Thomason; Stacy Pethel		

Abstract: The capability and availability of simulation tools often determine the boundaries of analyses. The knowledge of the capability and availability of simulation tools more often places greater limits on the boundaries of analyses. The U.S. Army Space and Missile Defense Command (USASMDC) and Teledyne Brown Engineering are excited about the version 20 release for late Spring of 2021, as many of the new capabilities significantly impact the operation of EADSIM across the Live, Virtual, and Constructive simulation gamut. Major new EADSIM features include expansion of the operator-in-the-loop capabilities, including pilot-level control of fighter flight and engagement decisions and expanded manual control of surface-to-air command chain participants; additional capabilities supporting defensive fighter operations in conjunction with support aircraft such as airborne sensors and refuel tankers; simplified methods for modeling rotating radars; an expanded 2D slew model for high energy lasers; continued expansion of representation of Integrated Air and Missile Defense capabilities; and a variety of methods to introduce new timing effects into track maintenance, combat identification processes, and achievement of fire-control level data. Not only do these features operate fully within the internal, constructive simulation, these new features provide additional depth to both truth and perception presented to other federates and operators in the loop when operating in a distributed environment.

This presentation will provide an overview of EADSIM, a summary of the newly available features in EADSIM Version 20, and a summary of the future directions of this community standard tool.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

56642 - Application of an Optimization Model to Inform Short-Range Air Defense (SHORAD) Formation Compositions within the Context of the SHORAD Study

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr Richard Walden		

Abstract: The Army is modernizing its SHORAD capabilities to support ground forces conducting large-scale combat operations. This involves developing platforms and defeat mechanisms specific to the protection of maneuvering forces and fixed/semi-fixed sites against future air and missile threats. Among these new capabilities are developmental extended range missiles and direct energy systems to replace or complement existing interceptors (e.g., Stinger and Hellfire). The Army required a trade space study on emerging capabilities to identify resource-informed mixes in priority theaters. TRAC was tasked to determine the optimal, feasible, and affordable short range air defense mixes of

material and non-materiel approaches to mitigate operational gaps for the defense of maneuver forces. Assessed mixes focused on Maneuver-SHORAD and Indirect Fire Protection Capability formations.

Assessments involved two models: an optimization model to identify initial high-payoff mixes and an air defense simulation to determine formation saturation levels. The study team engaged intelligence analysts, area of responsibility subject matter experts, and capability managers in developing the operational environment, attributes of each SHORAD system, and other critical model inputs. These engagements provided quantitative assessments of risk, employment options, and apportionment of threat assets to United States forces. With these inputs, the study team developed a General Algebraic Modeling System model whose objective function reduced maximum risk at minimal overall cost. Analysis of the optimization results allowed the team to down select from hundreds of potential mixes to a manageable level for follow-on higher fidelity assessments. Furthermore, the optimization model provided initial insights into the trades between cost, logistical implications, and residual air and missile threats by mix.

This presentation addresses the following challenges associated with implementing the optimization model and applied modeling methodology: objective function formulation, data collection, comparison of mixes, and synthesis of analysis into overall study findings.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

57062 - Force-on-Force Modeling of High Energy Lasers

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Veronica Collins; David Halloran; Robert Smith		

Abstract: Advances in solid state laser technology and the need to close the interceptor capacity gap are driving the development of battlefield ready High Energy Laser (HEL) systems across the Department of Defense (DOD). This, in turn, necessitates an increase in HEL modeling, simulation, and analysis to provide decision makers with the data and insights necessary to inform system development, purchasing, and employment decisions. HEL systems present unique challenges to the M&S community as their operation and defeat mechanism are significantly different from the kinetic defeat systems that have been simulated for decades. Additionally, the metrics that capture HEL performance are not directly analogous to kinetic defeat systems which presents additional challenges in informing decision makers. The US Army Space and Missile Defense Center of Excellence (SMD CoE) is using Extended Air Defense Simulation (EADSIM) to perform force-on-force modeling of HELs and has developed in-house analytic software to generate HEL performance metrics used to quantify their performance and compare and contrast it against conventional kinetic defeat systems. This briefing will provide an overview of HEL systems, a comparison against kinetic defeat systems, the methodology used by SMD CoE to perform force-on-force HEL simulation, and the metrics used to capture HEL performance.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

57063 - Modeling JADC2 effects to support AMD Analysis

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Veronica Collins; Mr. Jonathan Francis; David Halloran		

Abstract: As the Army's AMD Enterprise lead, USASMDC is responsible for the development of a long-term holistic approach for Army integrated air and missile defense (AIAMD). As stated in the 2019 Missile Defense Review (MDR), "the threat environment is markedly more dangerous than in years past and demands a concerted U.S. effort to improve existing capabilities for … regional missile defense". The demand for our networks to have better connectivity, redundancies, and capabilities is essential to mission success; the Joint All-Domain Command & Control (JADC2) is capable to fill this need. The JADC2 connects distributed sensors, shooters and data from and in all domains to all forces to enable distributed mission command at the scale, tempo, and level to accomplish commander's intent - agnostic to domains, platforms, and functional lanes. Bottomline, the Army needs to better understand the operational impacts of integrating JADC2 in our AMD architecture. The US Army Space and Missile Defense Center of Excellence (SMD CoE) is using Extended Air Defense Simulation (EADSIM) to perform a military utility assessment (MUA) capturing operational impacts of the AMD mission with JADC2 within the MDO environment. This briefing will provide an overview of our modeling approach, JADC2 efforts to assist AMD operations, modeling capability of these efforts, identified metrics to capture effectiveness, and the challenges in modeling a JADC2 scenario.

Classification: UNCLASSIFIED
Working Group:WG 09 Air and Missile Defense

56550 - Miniature Self Defense Munition

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Kaitlin Harris		

Abstract: The Miniature Self-Defense Munition (MSDM) is a threat agnostic kinetic countermeasure for aerial platform self-protection and base defense. It offers an affordable kinetic countermeasure against threats as a ground or aircraft launched line of defense. Its relatively small size allows for deep magazines and pod employment on aircraft or high capacity ground launch containers. The canister design offers a reduced logistics footprint, increasing deployment readiness while posing minimal impact to platform payload capacities.

Classification: SECRET NOFORN
Working Group:WG 09 Air and Missile Defense

57064 - Homeland Defense: Force-on-Force Modeling, Simulation, and Analysis (MS&A)

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Veronica Collins; Joseph Greene; David Halloran		

Abstract: The 2018 National Defense Strategy states "It is undeniable the homeland is no longer a sanctuary". NORAD states "[we have] optimized current operations to address peer threats within the current force laydown, but homeland defense capabilities have not kept pace with adversaries' technological advancements." Decision makers across the DOD recognized this new reality and initiated steps to address it, including two studies in which the US Army Space and Missile Defense Center of Excellence (SMD CoE) has supported with MS&A. The Fort Greely Alaska Defense Study (FGAK) and the Cruise Missile Defense-Homeland (CMD-H) are two examples of analysis providing information to key leaders and planners with data to drive informed decision making. With homeland defense missions, modeling often needs to take a different approach to analysis than the traditional force-on-force Combatant Command (COCOM) analyses. This brief will discuss techniques and approaches tailored for homeland analysis, lessons learned in designing and analyzing scenarios that

feature both current and future friendly air and missile defense forces as well as current and projected enemy air and missile threats.

Classification: SECRET NOFORN
Working Group:WG 09 Air and Missile Defense

WG 10 Joint Campaign Analysis

56756 - CAA's COSAGE: Incorporating Results from the 2016 TRAC Monterey PGM Study

Start Date: 6/23/2021	Start Time: 9:30 AM ET	End Time: 10:00 AM ET
Authors: Mr. Michael Warme; Trevor Sharp		

Abstract: In 2016, The Research and Analysis Center (TRAC)-Monterey (then the Training and Doctrine Command (TRADOC) Analysis Center-Monterey) delivered a study to the Munitions Management Division in Headquarters, Department of the Army G-3 that addressed the modeling of precision-guided munitions (PGMs) and their effects in theater-level campaign models (e.g., Joint Integrated Contingency Model (JICM), Synthetic Theater Operations Research Model (STORM)). At its core, the TRAC study sought to address the discrepancy between representation of munitions effectiveness in the high-resolution FIRESIM model and the indirect-fire adjudication in the Combat Sample Generator (COSAGE) used by the Center for Army Analysis (CAA) to adjudicate ground combat attrition in the JICM model. TRAC's findings included a methodology for near-optimal aimpoints for precision guided munitions; the Campaign Analysis Division at CAA has incorporated a portion of that methodology into COSAGE and will present verification and validation results highlighting improvement of model outcomes as a result of the updated methodology.

Classification: UNCLASSIFIED
Working Group:WG 10 Joint Campaign Analysis

55316 - Developing an Analytical Framework for the Joint Warfighting Concept

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr Troy Russell; Michael Roy Neary		

Abstract: The purpose of this presentation is to illustrate the analytical framework used in the first iteration of the Joint Warfighting Concept (JWC) lifecycle, a concept directed by the Chairman of the Joint Chiefs of Staff (CJCS) to examine how the Joint Force should operate in 2030. In 2019, the Secretary of Defense directed the Joint Staff, in coordination with the Services (JCS), Combatant Commands and the Office of the Secretary of Defense, to develop and provide a JWC by December 2020 that would guide the Department's future force development and design to ensure that the right people, equipment, training and doctrine are in place to win a future conflict. Traditionally, a Joint Operating Concept (JOC) takes 2-3 years of development before completion. It follows a structured linear process prior to final signature, as discussed in CJCSI 3010.01E. Adhering to a shorter timeline to develop the new warfighting concept and introducing a new governance structure, consisting of a wider set of DoD stakeholders (i.e. all COCOM's, Services and OSD) produced new challenges for JWC development team. Creating new processes and procedures required a higher level of coordination with senior leaders and action officers from numerous agencies, and quick turn analysis output. Under these conditions the JWC team could not follow traditional concept development pathways. With greater scope of analytic partners, the new approach to concept analysis and assessment was required reinforcing the importance of structure and traceability in the

development of observations and insights. The core Analysis and Assessment (A&A) Team consisted of analysts from Joint Staff J7's Joint Warfighting Directorate. The A&A team focused its efforts on assessing the Effectiveness, Viability and Robustness (EVR) of the ideas described in the concept. The team crafted the JWC Assessment Framework to map out the relationships between the evolving concept's hypotheses, assertions, and assumptions in the form of task-effect relationships. Decomposing the concept in this manner guided data collection, organization, and analysis for events (i.e. TTXs, wargames) and ensured outputs leading to the identification of new perspectives on the operational approach, including potential strengths, weaknesses, and unanticipated consequences of its employment within a conflict scenario. Along the pathway to approval, the results inform senior leader briefings (DEPOPSDEPS/OPDEPS, JCS Tanks, Tri-Chair, DMAG, NDS-I,).

Classification: UNCLASSIFIED
Working Group:WG 10 Joint Campaign Analysis

56723 - Achieving Multi-Resolution Campaign Modelling In AFSIM

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Matthew A C Guckenberger; Nathan S Simon; Dr. Alicia Sudol; Professor Dimitri Mavris		

Abstract: This work is a continuation of the efforts presented at the 88th MORS Symposium with continued evolution of the methodology and expansions to the scenario. The interconnectedness of military systems requires the aggregation of information across different fidelity levels as system design is impacted by both the system's technologies and the composition/layout of the system of systems in which it is fielded. At the campaign-level, hierarchical aggregation can provide efficient top-level analysis while also providing further depth at the physics, engagement, and mission levels. The magnitude of data produced by such an aggregation requires the utilization of large-scale data visualization and exploration techniques to inform decision makers. The Advanced Framework for Simulation, Integration and Modeling (AFSIM) provides an open-architecture that has been shown capable of modeling at different levels on the modeling & simulation pyramid (specifically the physics, engagement, and mission levels). This work looks at AFSIM's applicability to campaign analysis and the aggregation of results from multi-fidelity modeling with a focus on different modeling and analysis techniques to overcome the runtime versus fidelity paradox. The notional campaign modelled for this work includes space, air, and land components with a dynamic campaign commander to determine the next steps within the campaign. The resulting analysis looks at the effectiveness of different force structures and system-level technologies on mission and campaign-level metrics. A successful campaign is achieved when the strike targets are destroyed, and metrics like loss rate, cost of campaign, and time to completion are monitored for each case. Agent creation is handled on-demand throughout the campaign based on mission needs and where appropriate surrogate models are assessed to reduce the model complexity. Both steps provide a better usage of runtime based on study needs.

Classification: UNCLASSIFIED
Working Group:WG 10 Joint Campaign Analysis

56735 - Bayesian Enterprise Analysis Model (BEAM): Allocation Optimization

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Stephen Sturgeon; Dr. Mark A. Gallagher, FS; Dr Brad Guthrie		

Abstract: The Bayesian Enterprise Analysis Model (BEAM) is a low-resolution campaign model. The responsiveness of the tool allows for a rapid tradespace assessment across domains, force structures, and strategies, identifying potential challenges or attractive solutions to more efficiently employ the higher resolution models to perform more detailed analyses. Allocation of assets to missions is perhaps the most critical algorithm within BEAM to achieve the computational efficiencies. We will discuss recent algorithm advancements to include work on a Defender-Attacker-Defender (DAD) allocation algorithm. We will also discuss data-format that enable rapid evaluation of a low-resolution campaign. This briefing is meant as a technical discussion of the algorithms undergirding the model.

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.

Classification: UNCLASSIFIED
Working Group:WG 10 Joint Campaign Analysis

56771 - Visualizing Multi-Resolution Campaign Analytics from AFSIM

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Alicia Sudol; Matthew A C Guckenberger; Professor Dimitri Mavris		

Abstract: The data output from a design of experiments in AFSIM provides a sizeable amount of data which can be difficult to provide useful and timely analytics to decision makers. This work looks at techniques of visualizing and providing new insights to a campaign scenario. A decision-making environment is presented to better visualize and capture the aggregated results. This dashboard provides a decision maker with quick insights into the results, trends, and visualization files calculated during a force structure comparison. The force structure comparison analyses the effectiveness of force size and force composition on the campaign length, cost, and effectiveness. Due to runtime limitations, it is uncommon for an entire design space to be explored (full-factorial), therefore a limited data set was run and surrogates have been fit to visualize the entirety of the design space. The concept allows a limited number of case data to provide trends in a much larger design space. The different dashboard tabs are capable of comparing specified force architectures or exploring the entirety of the design space. Links between the AFSIM visualization output and the dashboard allows run data and campaign progression to be seen by the decision maker. The dashboard provides a new way of visualizing data, however, the second effort of this work sought to provide new analytic insights by applying time-to-event analysis. Time-to-event analysis breaks down each campaign event to determine its effect on the campaign's outputs. In example, how did the disabling of the SAM network by the 3rd day effect a run with a small force architecture versus a large architecture? These analytics enable decision makers to understand the evolution of a campaign from a high-level, rather than solely the end effects. Overall, this effort demonstrates a new method for visualizing large data sets and providing additional analytic insights to an AFSIM campaign force comparison.

Classification: UNCLASSIFIED
Working Group:WG 10 Joint Campaign Analysis

WG 11 Land and Expeditionary Warfare

56769 - CAA's COSAGE: Incorporating Results from the 2016 TRAC Monterey PGM Study

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET

Authors: Mr. Michael Warme; Trevor Sharp
Abstract: In 2016, The Research and Analysis Center (TRAC)-Monterey (then the Training and Doctrine Command (TRADOC) Analysis Center-Monterey) delivered a study to the Munitions Management Division in Headquarters, Department of the Army G-3 that addressed the modeling of precision-guided munitions (PGMs) and their effects in theater-level campaign models (e.g., Joint Integrated Contingency Model (JICM), Synthetic Theater Operations Research Model (STORM)). At its core, the TRAC study sought to address the discrepancy between representation of munitions effectiveness in the high-resolution FIRESIM model and the indirect-fire adjudication in the Combat Sample Generator (COSAGE) used by the Center for Army Analysis (CAA) to adjudicate ground combat attrition in the JICM model. TRAC's findings included a methodology for near-optimal aimpoints for precision guided munitions; the Campaign Analysis Division at CAA has incorporated a portion of that methodology into COSAGE and will present verification and validation results highlighting improvement of model outcomes as a result of the updated methodology. Classification: UNCLASSIFIED Working Group:WG 11 Land and Expeditionary Warfare

56932 - Ground-Based Anti-Ship Missile Effectiveness in Support of Expeditionary Advanced Base Operations

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr Chad W Seagren; CAPT Jeffrey E. Kline, (Ret)		
Abstract: In his planning guidance documents, the Commandant of the Marine Corps states that his highest priority is future force design with a particular emphasis on improving integration with the U.S. Navy. Part of this integration envisions a key role for expeditionary forces to employ Ground-Based Anti-Ship Missiles (GBASM), a capability expected to be especially important to strategic and operational success in the South China Sea and elsewhere in the USINDOPACOM area of responsibility. While the Marine Corps expects to leverage existing weapon system designs, they must also plan for the longer term. A method to reasonably consider and measure the importance of characteristics of weapons systems not yet in existence is invaluable to this planning process. This study fills that gap. We develop a combat model in Modeling And Simulation Toolkit (MAST), an agent-based modeling platform, and employ efficient experimental design to analyze its output. The Marine Corps must allocate resources according to the Planning, Programming, Budgeting, and Execution process pursuant to acquiring Ground Based Anti-Ship Missile capability now and into the future. This project generates insights to inform that enterprise, particularly with respect to the tradeoffs between a number of relevant operational parameters. Classification: UNCLASSIFIED Working Group:WG 11 Land and Expeditionary Warfare		

56863 - Symmetry Methods to Deduce the Victory Condition of Lanchester Models of Warfare

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Joshua Gill; Dr Andrew Gill; Jessica Penfold		
Abstract: Nestled between Frederick Lanchester's famous, but symmetrical, direct-fire and area-fire models of combat from over a century ago sits Seymour Deitchman's asymmetrical guerrilla warfare of the 60's. These models were particularly useful in that they admitted an analytical victory condition – typically a lower bound on the initial force ratio of the combatants as an explicit function of the		

parameters of the model that was both necessary and sufficient to ensure victory for one side. The so-called Lanchester 'square law' and 'linear law' (and Deitchman's 'mixed law') thus allows analysts insight into trade-off between quantity and quality factors in differing battle types. The analytical route to the victory condition may follow either (or possibly both) solving the second-order differential equation governing one side's force trajectory explicitly, or integrating the time-independent first-order differential equation to obtain a conserved quantity involving both force trajectories.

Moshe Kress, around a decade ago, provided a framework that generalised Deitchman's guerrilla warfare model by proposing an intelligence or situational awareness function that was bounded by area-fire from below and direct-fire from above. Only the conserved quantity route to the victory condition appears tractable and is explicit depending on the integrability of the intelligence function. Kress's intelligence function provides a linear interpolation between direct-fire and area-fire while much earlier, COL Thomas Schreiber considered a curvilinear model of command and control effect on intelligence, both permitting analytical victory conditions.

Non-autonomous direct-fire and area-fire Lanchester models, whereby the weapon effectiveness parameters are allowed to vary with time, were studied analytically by James Taylor and Jerry Brown from the mid-70's. The explicit inclusion of time in the differential equations appears to result in a step-change in complexity and required the development of bespoke, or partially approximate, analytical methods to reaching the victory condition.

This presentation reports on initial investigations of the potential of symmetry methods to arrive at the victory condition of various Lanchester models of warfare. Symmetry methods were chosen as they appear to offer systematic analytical paths to either the explicit solutions or conserved quantity of ordinary differential equations, however the authors are not aware of any prior application to Lanchester models. In particular, a non-autonomous generalised Deitchman model, by allowing Kress's interpolating parameter to vary with time, investigated numerically by Marvin Schaffer in the mid-60's, will be examined.

Classification: UNCLASSIFIED
Working Group:WG 11 Land and Expeditionary Warfare

57293 - Integrating Low Yield Nuclear Weapons into Wargaming

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dan Kidd; Mr. Christopher Daniel Brinker, PhD		

Abstract: The US must be prepared to fight and win with conventional weapons on a battlefield where the
opponent may use chemical, biological, radiological, or nuclear (CBRN) weapons to support conventional operations (theater use). Guidance from the Nuclear Posture Review and National Defense Strategy states that U.S. forces will ensure their ability to integrate nuclear and non-nuclear military planning and operations. To implement these concepts into the training, exercise and wargaming community, we must present this problem in a way that is palatable and in a language that is clearly understood to ensure that a nuclear insult becomes more of predicted and manageable change to the environment, and not the end of the scenario. DTRAs Wargaming and Analysis research and development program is developing a playbook that includes developing tactical nuclear objectives and scenarios; and the models, effects, and visualizations necessary to directly assist

scenario developers. The intent is to develop a holistic guide and wargaming capabilities for integrating nuclear impacts into warfare specific objectives and scenarios, identify data/models/effects to be used in future games, and identify evaluation methods. This playbook will include templates for all domains and echelons from low strategic to high tactical to provide context, scale, structure and proposed visualizations to allow seamless integration into game development.

Classification: UNCLASSIFIED
Working Group:WG 11 Land and Expeditionary Warfare

57294 - Operations in a Nuclear Environment – What an Operations Officer needs to know

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Adrian Reenshuler; Dan Kidd		
Abstract: Recent Department of Defense guidance directs that U.S. forces must be prepared to integrate nuclear and non-nuclear military planning and operations. But how many know what integrated conventional and nuclear operations, and the post-nuclear strike environment looks like? What effect will a 5kt nuclear strike have on a brigade, battalion or platoon? Let's face it, most just don't know. This session will provide a non-technical understanding of nuclear weapon effects and what a post-strike battlefield nuclear operating environment looks like. Participants will leave knowing enough to start asking the right questions about how a nuclear operational environment will affect the battlefield and with the resources to find the answers. Classification: UNCLASSIFIED Working Group:WG 11 Land and Expeditionary Warfare		

WG 12 Maritime Operations

57035 - Coast Guard; Quantifying Search and Rescue (SAR) Demand based on Historical Responses and Geo-Spatial Analysis

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Elizabeth Runci		
Abstract: The United States Coast Guard's Search and Rescue mission is one of the most visible and universally praised efforts the Coast Guard undertakes. Given its "no fail" status, any changes in SAR execution require serious scrutiny and caution. A robust and comprehensive study was undertaken to understand SAR demand geographically in order to inform force laydown decisions. The purpose of this module is to highlight geo-spatial analytical methods used to make recommendations. Classification: UNCLASSIFIED Working Group:WG 12 Maritime Operations		

56945 - Ground-Based Anti-Ship Missile Effectiveness in Support of Expeditionary Advanced Base Operations

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr Chad W Seagren; CAPT Jeffrey E. Kline, (Ret)		
Abstract: In his planning guidance documents, the Commandant of the Marine Corps states that his highest priority is future force design with a particular emphasis on improving integration with the		

U.S. Navy. Part of this integration envisions a key role for expeditionary forces to employ Ground-Based Anti-Ship Missiles (GBASM), a capability expected to be especially important to strategic and operational success in the South China Sea and elsewhere in the USINDOPACOM area of responsibility. While the Marine Corps expects to leverage existing weapon system designs, they must also plan for the longer term. A method to reasonably consider and measure the importance of characteristics of weapons systems not yet in existence is invaluable to this planning process. This study fills that gap. We develop a combat model in Modeling And Simulation Toolkit (MAST), an agent-based modeling platform, and employ efficient experimental design to analyze its output. The Marine Corps must allocate resources according to the Planning, Programming, Budgeting, and Execution process pursuant to acquiring Ground Based Anti-Ship Missile capability now and into the future. This project generates insights to inform that enterprise, particularly with respect to the tradeoffs between a number of relevant operational parameters.

Classification: UNCLASSIFIED
Working Group:WG 12 Maritime Operations

56823 - Mixed-Integer Programming Methods for Coordinated Navy and Marine Corps Operations to Combat Adversarial Territory Expansion

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Rob M Curry		

Abstract: Territorial boundaries in some maritime settings have long been disputed. As a result, near-peer adversaries of the United States are claiming previously unoccupied islands and creating massive artificial islands to expand dominance over contested waters. Adversaries have exploited international maritime law as justification for an island-hopping territorial expansion strategy throughout these waters. In this work, we propose a data-informed approach to creating a United States Marine Corps (USMC) stand-in-force deployment and management plan in order to combat adversarial territory expansion in contested maritime settings. To do so, we formulate a mathematical model using integer and linear programming approaches that includes modeling decisions facing the USMC and the United States Navy. These math models seek to minimize or maximize quantitative objectives, such as maximizing total value of a deployment plan. We present various ways for determining this valuations, and we detail an iterative algorithm for more efficiently solving the aforementioned mathematical models. Finally, we detail the results of our work on a small example covering a portion of islands in the South China Sea. The models presented in this work seek to provide an overarching data-informed strategy for USMC/USN coordinated strategy in order to combat adversarial expansion.

Classification: UNCLASSIFIED
Working Group:WG 12 Maritime Operations

57046 - Networked Airborne ISR&T Long Endurance (NAILE) Study

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Emily Jasien		

Abstract: The constant evolution of adversary surface warfare capabilities requires continuously evolving Navy strategies to successfully find, fix, track, and target (F2T2) adversary surface combatants at extended stand-off ranges. Additionally, maritime platforms must accomplish this in Disrupted/Disconnected, Intermittent and Limited (D/DIL) environments while operating in alignment

with evolving Navy concepts of operation. Mission success therefore demands the capability to conduct Intelligence, Surveillance, Reconnaissance, and Targeting (ISR&T) over large areas of interest with assets providing persistent intelligence data to platforms in theater. The Networked Airborne ISR&T Long Endurance (NAILE) study was conducted in support of OPNAV N96 and sought to overcome these requirements by employing an airborne ISR&T network capable of providing mission-critical data for the operating area, and ultimately target-quality data to surface firing units. This study employed the mission-level modeling and analysis capability of the Executable Architecture and Management System (ExAMS) tool to assess the feasibility of the NAILE concept. Analysts simulated NAILE implementation within an anti-surface warfare (ASuW) mission context to determine its capability for providing adequate ISR&T support. Assessments were based on quantitative mission-level metrics including the probability of acquiring and maintaining a track on the target. Additional experiments were run to further refine the NAILE concept and influence recommendations and analysis-revealed requirements such as sensor and communications payloads and platform CONOPS. This presentation will describe the NAILE analysis process as well as measures of success descriptions.

Classification: SECRET NOFORN
Working Group:WG 12 Maritime Operations

WG 13 Power Projection and Strike

56516 - Using Safe Escape Methodology to Assess Fragmentation Impact Risk from Overpressurization of the ARRW Hypersonic Engine

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Michaela Coughlin; Scott Daniel Gulig		

Abstract: Safe escape analysis assesses the risk of self-fragmentation to the warfighter by modelling weapon, aircraft, and weapon fragment fly out. A safe separation time is calculated as the time in the weapons fly out where the aircraft is safe from fragmentation should the weapon detonate early. A Risk Assessment request was made for flight tests of the Air-Launched Rapid Response Weapon (ARRW) off a B-52. To assess the risk to the aircraft in the event of overpressurization of the SRM motor causing self-fragmentation, safe escape methodology was employed. Arena data was collected and used to create a fragmentation model, time space position information (TSPI) was provided for the flight of the warhead based on software simulations by the ARRW team, and aircraft trajectory models that are used in safe escape were utilized. This data was used to simulate the flight paths and relative positions of the aircraft and warhead. Analysis provided data on the distance between the aircraft and warhead at each time step and the probability of at least one fragment impacting the aircraft should an overpressurization event occur at each point in time. Safe escape provided useful tools to inform development and testing teams of the risks imposed by weapon failure. This methodology now has the proven utility to produce data on flight path, separation distance, and risk probabilities that can influence design and testing decisions beyond detonating warheads. Applying Safe Escape methodologies more robustly as more advanced weapons systems go through the aircraft/store certification process will continue to allow for safe employment of weapons in the hypersonic age and beyond.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56670 - Strategic Fires Study Table Top Exercise (TTX)

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Danielle Monique Aldrich		
Abstract: To develop a sound strategic fires acquisition strategy, the Army G-8 directed Army Futures Command (AFC) to conduct the Fiscal Year 2020 (FY20) Strategic Fires Study (SFS). AFC tasked The Research and Analysis Center (TRAC) to complete the 4-month study to inform the 2020 Program Objective Memorandum. The SFS is a comprehensive analysis that explores the trade space between cost, schedule, and performance of various Strategic Fires capable systems. Additionally, the study assessed their respective sustainment, logistical, mobility, and survivability challenges. To support the study, TRAC executed two back-to-back TTX events. The purpose of these TTX events was to obtain operational feedback on these strategic fires systems and to gain insight into how well they support the forces of the United States, allies, and partner nations against near-peer Threats. This presentation will cover the TTX approach employed by the TRAC study team, the method, models, and tools used during the event, and how the output aided in informing the overall FY20 SFS effort Classification: UNCLASSIFIED Working Group:WG 13 Power Projection and Strike		

56845 - Simulation Optimization for Hypersonic Vehicle Missions

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Jon Vigil; Shane N Hall, PhD; Drake Rivera; Daniel Schueths		
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 demonstrates the use of software to perform a metaheuristic optimization to select input parameters that improve hypersonic system performance metrics, as evaluated in a simulation. This simulation optimization approach utilizes a notional, but configurable, hypersonic mission scenario created in AFSIM to represent the systems-of-systems behavior required to evaluate elements of PK. The simulation scenario, as well as specific optimization cases are presented. Results are provided to show the parameter configurations that optimize the objective(s) for each case, as well as trends that emerge. Classification: UNCLASSIFIED Working Group:WG 13 Power Projection and Strike		

56892 - Kinematic Performance Analytics using CWS

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Christopher Jarvis; Andrew Crete		
Abstract: Kinematic performance analytics is a critical decision support element in every stage of munition development from specific technology to full system evaluation. The broad range of environments ranging from subsonic to hypersonic flight and incorporation of advanced technologies		

and novel algorithms requires the kinematic simulation tool to be modular and robust. Furthermore, to fully characterize a capability across a vast set of engagement conditions requires the tool to be fast and parallelizable.

To achieve all this, AFRL/RW has developed the CADAC++ Weapon Simulation (CWS) Engagement level simulation framework. CWS is a robust simulation framework enabling rapid development and evaluation of kinematic performance for a wide variety of munition concepts using Flat or Ellipsoidal (WGS84) Earth models and an arbitrary number of 3DoF or 6DoF weapon entities against stationary, moving or maneuvering targets.

This presentation will provide an overview of CWS and a live demonstration of capabilities using example data, scenarios and python scripts that are included to assist new users with model development and evaluation.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56472 - A Simulation Framework of Multi-objective Evolutionary Algorithms and Surrogate-based Optimization for Guided Weapon Design

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 3:00 PM ET

Authors: Mr. Andrew Lawrence Kaminsky; Mr. Isaac Wolf; Dr. Yi Wang; Seong Hyeon Hong; Dr. Kapil Pant; Dr. Rhoe A. Thompson; Kathryn Flynn; Christopher Jarvis

Abstract: The design of guided air-to-air weapon systems typically features high-dimensional, multi-system design spaces, complex relationships between design parameters and design objectives, and competing design objectives. In combination, these factors have made guided weapon design a discipline that has conventionally relied heavily upon the prior experience of subject matter experts. However, this trend is ripe to change as increased availability and reduced costs of computational resources as well as the maturation of modeling and simulation capabilities lend themselves to automated, systematic, high-throughput evaluation of guided weapon systems. Recognizing this opportunity, AFRL is developing an efficient, robust, systematic, and generalizable optimization approach to enhance guided weapon concept design decisions.

Evolutionary algorithms are well suited to the challenges of guided weapon design since they can be employed to systematically explore heterogeneous design spaces in a gradient-free manner to identify global optima. Their sole drawbacks are that they typically require significantly more evaluations than their gradient-based counterparts to identify optimal design(s), and it is hard to know which evolutionary algorithm heuristic will work best for a given problem. We have sought to address these issues, by developing surrogate models to map the relationship between the design variables and objectives from data as it is collected. These surrogate models, based on fast-to-evaluate elementary functions, are then employed to provide insight to tune the evolution heuristics and reduce the number of evaluations. This coupling of surrogate models and evolutionary algorithms creates surrogate-assisted evolutionary algorithms that significantly accelerate design optimization.

In this presentation we will outline the development of these surrogate-assisted evaluation algorithms and their coupling to high-throughput guided weapon performance evaluation tools within our multi-objective evolutionary algorithms for design of weapons (MEADOW) framework. MEADOW will be demonstrated for design studies concentrating on expansion of projected launch acceptability regions for air-to-air missiles compatible with strike fighter internal stores.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56733 - Bayesian Enterprise Analysis Model (BEAM): Overview and Evaluation Summary

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Stephen Sturgeon; David Quick; Dr. Mark A. Gallagher, FS		

Abstract: The Bayesian Enterprise Analysis Model (BEAM) is a low-resolution campaign model. The responsiveness of the tool allows for a rapid tradespace assessment across domains, force structures, and strategies, identifying potential challenges or attractive solutions to more efficiently employ higher resolution models or wargames. We will provide an overview of BEAM and summarize an evaluation of BEAM conducted by multiple organizations through a series of government reviews. During these reviews, the government posed a number of analytical questions to be evaluated using BEAM in an unclassified scenario. These questions revealed the kind of questions BEAM is suited to answer and what insights can be gained through using BEAM.

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.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56680 - Optimization Modeling with Time Component for Strategic Fires Study

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Matthew Harder		

Abstract: Army Futures Command (AFC) and the Army G-8 directed The Research and Analysis Center (TRAC) to conduct the Strategic Fires Study (SFS) to identify solutions to critical shortfalls in the ability of the Army to address operational and strategic targets with surface-to-surface fires. Without a solution, the United States could lose competitive advantage against near-peer threats and the Army may fail to support the Joint force. The SFS team identified a gap in a mid-range fires capability, leading to an urgent need for analysis of several mid-range capabilities with different attributes in an extremely compressed timeline, in order to inform timely funding decisions.
The study team utilized an optimization model to select the most cost-effective mixes that could accomplish mission goals for further analysis in a high-fidelity combat model. Area of responsibility subject matter experts and capability managers were engaged to develop the operational environment, attributes of each strategic fires system, and other critical model inputs. These engagements provided quantitative assessments of risk, basing options, and apportionment of Threat targets to Army fires.
The study team developed a General Algebraic Modeling System optimization model that used time as a factor for assessing different capability mission cycle times, capacity, and unit sizes. This played an important role in the down selection of mixes for more time-consuming and higher-fidelity combat modeling, allowing the study team to meet deadlines.
The study had immediate and profound impacts on the United Sates Army and AFC. The Army reallocated funding to support recommendations from the SFS, and the analysis underpinned the Secretary of the Army's decision to field a new fires capability. Lastly, the innovative processes used by the study team established a framework for AFC to emulate in future analytic endeavors.

This presentation discusses the challenges associated with implementing the optimization model, including objective function formulation, a time-based approach, and the analysis approach challenges.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56548 - Adaptive Warfighting

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Bud Bishop		

Abstract: Warfighting as a network to increase military effectiveness, cost leverage, and adaptability is becoming a working reality by leveraging advances in computer processing and new command, control and computer (C3) arrangements.   Using technology to compose new, more lethal effects at operationally relevant speeds through dynamic, intelligent allocation of available data regarding situational awareness and effector (weapon) system status is key. This awareness is intended to increase the speed and scale of weapons effects through the re-allocation of sensors and data at the forward edge -- which can be generally characterized as fast, scalable, adaptive joint multi-domain operations .

In this effort, the effects chain functions (Find, Fix, Target, Track, Engage, and Assess or (F2T2EA)) are disaggregated across a heterogeneous mix of manned and unmanned platforms and transform these disaggregated systems in a manner that makes them "addressable", i.e., they can compose and recompose effects chains at mission speeds to improve operational impacts in anti-access/area denial (A2AD) strategies.

This presentation will describe and detail the modeling and simulation (M&S) methodology, assumptions, and measures of effectiveness (MOE) in order to assess the impact and effectiveness of today's warfare processes and the differences associated with the implementation of network-enabled warfare processes. To this end it will demonstrate the potential benefits of connecting the diverse networks of different sensors to the many shooters available considering the ability to increase information flow through land, sea, air, space and cyber domains. This operational research effort characterizes and details the effects chain (F2T2EA) from initial detection to weapons engagement with subsequent battle damage assessment (BDA) of the current forces programs and processes and compare/contrast that with the network-enabled warfare programs and processes.

The presumption is that through some types of automation (artificial intelligence) and/or process management changes that are incorporated into the effects chain those changes will enable a shorter timeline to achieve kills on targets.

To complete the highest priority kill-chains, networked warfare efforts must seek to hold custody longer and must reduce Sensing, C2, and Weapons TOF-after-last-update timelines. A new, forward-edge CONOPs must be developed to answer these shortfalls; our presentation provides such a construct.

Classification: UNCLASSIFIED
Working Group:WG 13 Power Projection and Strike

56585 - The Standoff Weapon We Need

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Kevin Lin		

Abstract: The ever-changing environment of the modern battlefield requires continuous improvements to strategy and technology. As anti-air defense capabilities improve, the Air Force is developing weapons to engage the target set from a safer distance in order to incur less risk. What sort of capabilities does this weapon need in order to be most effective against our toughest foes? Through simulation and sensitivity analysis, we have identified key attributes important for a stand-off weapon, and compared it to the Air Force's current and planned arsenal to search for possible performance gaps.

Classification: SECRET NOFORN
Working Group:WG 13 Power Projection and Strike

56505 - Air Force Research Laboratory - Quick Sink Experiment Series

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: James Krafcik		

Abstract: (U) The United States Air Force has an often overlooked maritime defeat mission. This research investigates the capability of current inventory munition technologies to satisfy an air-delivered maritime surface vessel defeat requirement. The current research investigated the viability of the proposed munition concept to satisfy initial concerns associated with munition delivery, accuracy, stability, fuzing and lethality to sink vessels with minimal munitions. This presentation will present the results of the first of a two experiment series. Experiment 1 consisted of a number of full-scale munition drops to validate the concept and performance similarly to simulations. Experiment 2 will demonstrate the munition lethality. The presentation will complete with an overview of the Air Force Research Laboratory Munitions Directorate maritime munitions technology development roadmap.

Classification: SECRET NOFORN
Working Group:WG 13 Power Projection and Strike

56522 - E-MS&A Integrated Directorate Enterprise Analyses (IDEAs) Phase 0 Spiral 1 Excursion Study

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Kathryn Flynn; Ethan King		

Abstract: Air Force Research Lab (AFRL) Enterprise Modeling Simulation and Analysis (E-MS&A) leadership requested an excursion study off of the Multi Domain Challenge Problem (MDCP) Air Base Air Defense (ABAD) study to address USAF ability to pre-emptively strike anticipated threats during Phase 0. This study develops AFRL's understanding of the capability of a collection of proliferated Internet of Things (IoT) sensors to determine advantageous times to strike Red force. The mission-level MS&A study analyzes the impact of using new techniques to narrow the search areas for time-critical targets in order to attack these forces more effectively and thus reduce the volume of the initial wave.

Classification: SECRET NOFORN
Working Group:WG 13 Power Projection and Strike

56525 - E-MS&A SC2.1 Offensive Collaborative Strike, Campaign Study

Start Date: 6/25/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET

Authors: Kathryn Flynn; Timothy Porter
Abstract: Air Force Research Lab (AFRL) Enterprise Modeling Simulation and Analysis (E-MS&A) leadership requested a campaign-level MS&A study to analyze collaborative weapons. Utilizing the HAF/A9 Synthetic Theatre Operational Requirements Model (STORM) scenario for SC2.1, the USAF capability gaps were analyzed to determine where collaborative weapons could be utilized. Combinations of autonomy characteristics were added to various legacy weapon types in the offensive strike scenario. The analysis determined which weapon systems and which autonomy capabilities produced the most benefit at the campaign level. Results identified during this study will form tradespace for follow-on mission/engagement level analysis. Classification: SECRET NOFORN Working Group:WG 13 Power Projection and Strike

56740 - High Energy Laser (HEL) Directed Energy Utility Concept Experiment (DEUCE)

Start Date: 6/25/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr. Joseph Allen Aldrich; Mr. Douglas W. Horne; Dr Garrett Darl Lewis		
Abstract: This briefing presents the methodology and initial findings from the High Energy Laser (HEL) Directed Energy Utility Concept Experiment (DEUCE), conducted by the Air Force Research Laboratory Directed Energy Directorate's Wargaming and Simulation Branch (AFRL/RDMW). In January 2020, RDMW brought together F-16 pilots, an F-15 pilot, F-15E weapon systems officers, and an Airborne Warning and Control System (AWACS) air battle manager to evaluate the capabilities of directed energy (DE) for the future battlefield. DEUCE exposed the visiting warfighters to airborne laser weapon systems and how they might be used to counter threats to accomplish air base air defense and platform protect missions. AFRL engaged the warfighters in several battlefield scenarios. The warfighters provided excellent assessments, identifying where there is potential military utility of DE weapons. The DEUCE provided valuable operator inputs and engagement tactics to supplement technical analysis. Together, they provide critical information to the Air Force in evaluating how to implement new technologies, support investment decisions, and also gives warfighters insight into emerging technologies and how they may be used. Classification: SECRET NOFORN Working Group:WG 13 Power Projection and Strike		

WG 14 Air Warfare

56851 - Simulation Optimization for Hypersonic Vehicle Missions

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Jon Vigil; Shane N Hall, PhD; Drake Rivera; Daniel Schueths		
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 demonstrates the use of software to perform a metaheuristic		

optimization to select input parameters that improve hypersonic system performance metrics, as evaluated in a simulation. This simulation optimization approach utilizes a notional, but configurable, hypersonic mission scenario created in AFSIM to represent the systems-of-systems behavior required to evaluate elements of PK. The simulation scenario, as well as specific optimization cases are presented. Results are provided to show the parameter configurations that optimize the objective(s) for each case, as well as trends that emerge.

Classification: UNCLASSIFIED
Working Group:WG 14 Air Warfare

56906 - Multi-agent Air Combat Tactics with Self-Attention Reinforcement Learning in AFSIM

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Samuel Swanson; Mackenzie Lau; Dr. Michael Steffens; Professor Dimitri Mavris		

Abstract: Reinforcement Learning (RL) has developed rapidly in recent years, and the technique shows promise for the automatic generation of vehicle tactics. The objective of RL is to find a policy function that maps state observations to actions in a way that maximizes total reward throughout a sequential decision-making process. This function usually takes the form of an artificial neural network (ANN). Traditional feedforward ANNs map one input vector of fixed dimensions to an output vector of fixed dimensions. In multi-agent air combat scenarios, this can be limiting for several reasons. The number of entities (e.g. aircraft or missiles) that the policy function needs to take into consideration can change as the scenario unfolds. Additionally, the ideal policy function should be able to reason about relationships between entities in the environment, which traditional ANNs do not explicitly do. Finally, the policy function should be permutation invariant, such that the ordering of the entities in the input does not affect the output. This research seeks to address the limitations of traditional ANNs through the use of self-attention mechanisms, which are a form of ANN commonly used in natural language processing. Self-attention mechanisms are permutation invariant, able to learn about the relationships between entities, and can generalize over a varying number of entities. Additionally, this work employs techniques for learning from demonstration behaviors to increase the speed of learning and remove the need for the excessive reward engineering often required for effective RL. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) is used to develop a multi-agent air combat scenario in which reinforcement learning is applied. Initial results have shown that an agent can learn to capture multiple moving targets, both improving on the demonstration behavior and successfully responding to new situations in which there are significantly more targets than were seen in training. The final air combat scenario under development is a many-vs-many air combat scenario. This presentation will focus on the techniques required to achieve this learned behavior, including the implementation details specific to performing RL in AFSIM.

Classification: UNCLASSIFIED
Working Group:WG 14 Air Warfare

56878 - On Demand Data Visualization of Navy Helicopter Maintenance

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: CDR Gary Lazzaro		

Abstract: This project focuses on creating an on-demand data visualization tool for Navy MH-60R/S helicopter maintenance data using Python and Altair.   We visualize 6.6 million lines of individual helicopter maintenance actions for the past five years. This project creates a graphical user interface

tool that can create user defined graphs and charts to easily compare maintenance times across different squadrons, maintenance actions and many other possibilities. Our tool enables MH-60R/S maintenance decision makers to better understand their readiness and effectiveness. This project is sponsored by Force Readiness Analytics Group for Commander, Naval Air Forces.

Classification: UNCLASSIFIED
Working Group:WG 14 Air Warfare

56831 - FARA Key Operational Attribute Utility Assessment

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Andrew Bryce Starkey		

Abstract: Army Aviation vertical lift dominance is diminishing due to adversarial advances in all domains, primarily with the accelerated development of Anti-Access Area Denial (A2AD) and integrated Air Defense Systems (IADS). The interim solution to provide armed reconnaissance is being fulfilled by the AH-64D "Apache" which is better suited for heavy attack operations. The intent for the FARA is to mitigate the gaps in Army Aviation's attack and reconnaissance capabilities. Army aviation next generation aircraft proposes to increase reach, protection, lethality, and survivability to enable Army forces, as an element of the Joint Force, in order to prevail in competition, penetrate, dis-integrate, and defeat adversaries in armed conflict.

The Supporting Concept for Aviation Futures and Concepts depicts an operational change to the employment of aviation forces. Combat power will be integrated across the functional concepts in the future operational environment, down to the lowest level, providing optimum flexibility to the commander. The future attack reconnaissance aircraft (FARA) ecosystem is the focus of aviation science and technology (S&T) efforts. The ecosystem's implementation will address how aviation will conduct air-ground operations (AGO) in support of Army forces in multi-domain operations (MDO). The proposed presentation details the approach, utility methods, and analytical tools used to determine a quantitative understanding of the importance of Army Air Calvary Squadron's mission sets in MDO. Using a plurality based election method, the Dowdall concept provided a relative weighted rank for the operational mission sets. Furthermore the utilization of a decision support system with simple additive weighting method determined the weight value for each operational attribute followed by a ranking process to select the operational mission set with highest value. This quantified understanding of the qualitative input elicited from Army Aviation experts and Warfighting Function SMEs provides clarity to the relationships of key operational attributes and missions to inform on ecosystem requirements and trades.

Classification: UNCLASSIFIED
Working Group:WG 14 Air Warfare

56503 - Circular Error Probability and Additional Damage Effects Modeling In AFSIM

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Maxwell Camp		

Abstract: Abstract is pending public release. Abstract will be uploaded here upon approval.

Classification: SECRET NOFORN
Working Group:WG 14 Air Warfare

WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56667 - 1918 Influenza Pandemic: Overview, Actions, and Effects

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Ms. Diana M. Hanley		

Abstract: The 1918 Influenza (flu) Pandemic is known as the most severe and deadliest pandemic in the last century. Caused by an H1N1 virus, the pandemic killed an estimated 50 million people (675,000 Americans) and infected almost 500 million people worldwide (one-third of the planet's population).

As the world continues to face the recent 2019 Coronavirus (COVID-19) disease, the Analysis Development Group (ADG) at The Research and Analysis Center (TRAC) conducted in-depth research on the 1918 flu pandemic to provide information on how that pandemic can help the community to understand the effects of the SARS-CoV-2 virus.

This presentation includes an overview of the 1918 flu pandemic, the challenges it presented to society, and the control measures used to slow the disease's spread, emphasizing how theoretical modeling research helped identify these control measures' effects. The brief also provides insights into how society recovered from the illness and lessons learned to enhance decision-making for future pandemics.

Classification: UNCLASSIFIED

Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56947 - Analysis of COVID-19 transmissions, effects, and mitigations in the workplace

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Michael Taberski; sean p carey; Keith Hattes; Dr. Christopher E. Marks		

Abstract: We make use of our access to individual-level locational data to analyze COVID-19 transmission rates and propose a model for predicting
community transmissions. First, we employ state of the art pandemic modeling and publicly available data to understand and predict COVID prevalence in our work locality. Next, we employ a network model to represent the interpersonal interactions over time within a specific work campus. To build this model, we rely on "badge" data; employees on this campus are required to use security badges to log facility entrances and exits.
We use the resulting log data to track individual movements and locations over time and infer likely interactions.
Finally, we overlay known COVID-19 cases onto this network model to determine probable workplace transmissions. We use this information, combined with our local prevalence model, to infer future prevalence and transmissions in the workplace. By altering the interaction model to represent different mitigation strategies, we gain insights into their probable effects. These outputs are useful in informing decisions on the timing and nature of pandemic mitigation measures.

Classification: UNCLASSIFIED

Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

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57053 - Developing a large-scale synthetic population of persons for simulating COVID-19 transmission and response

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Sara P. Rimer; Dr. Chaitanya Kaligotla; Dr. Charles M. Macal		

Abstract: To assist Cook County and the city of Chicago in their response to the COVID-19 pandemic, Argonne National Laboratory developed CityCOVID, an agent-based model that simulates the endogenous transmission of COVID-19 and measures the impact of public health interventions. We present details on the development of the large-scale (city to multi-county) synthetic population that serves as the basis for CityCOVID. This synthetic population is comprised of a set of "agents," who are individuals assigned their own set of (i) socio-demographic characteristics, (ii) behaviors (hourly activity schedules), and (iii) places they visit (according to their schedules), which collectively are statistically representative of a given geographic region. Additionally, these agents react to disease symptoms and non-pharmaceutical interventions. CityCOVID recreates the dynamics of disease spread through this population of agents. Each simulation scenario is based on a set of assumptions (informed by data and literature, and updated regularly) concerning non-pharmaceutical interventions and the corresponding agent behavior in response. We focus this presentation on the statistical methods and population-scale datasets used to build this synthetic population.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

55340 - Proficiency Dashboard

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Amy Ankney; Mitchell Monroe Breeden; Lucas Crider		

Abstract: Navy Medicine lacks the ability to view knowledge, skills, and abilities of the medical force mapped geographically. The Navy Medicine Consolidated Information Center (CIC), working jointly with the Naval Knowledge Skills and Abilities (NKSA) team, has developed a data visualization tool that enables on-demand, web-based viewing of key readiness metrics. The Navy Medicine Proficiency Dashboard links and measures medical personnel against certain key training requirements. The training items are closely tracked and include individual clinical experiences, basic medical training courses, highly specialized training requirements, and Navy specific operational platform training. Medical specialty leaders define readiness criteria checklists, and the tool consolidates data from multiple disparate sources to create a scalable view of Navy Medicine readiness by proficiency at the individual, command, and enterprise level. This serves as a catalyst to achieve the Surgeon General's priority of a fully ready medical force. The Dashboard provides leadership with the ability to identify unit training compliance, understand force deployability, and use key readiness indicators to support staffing decisions in the operational environment. The Navy Medicine Proficiency Dashboard overview and demonstration session will showcase aggregated information categories and the types of decisions the dashboard supports.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56594 - Development of Workforce Analysis Tool to Support COVID-19 Response Efforts

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. John R. Hummel, FS; Lawrence Paul Lewis; Dr. Braeton Smith; Joshua D. Bergerson		

Abstract: The COVID-19 pandemic has resulted in major disruptions in workforces around the world, millions of jobs lost and employees forced to work in isolation away from their offices and colleagues. There are also groups of workers whose jobs are considered essential, such as health care, public safety, grocery, and utility maintenance workers, that are required to work and interact with the general public, thus potentially exposing themselves, and their families, to COVID-19 infection.
The Department of Energy Office of Science funded a major effort to develop decision support tools to analyze different COVID-19 response and mitigation concepts. Argonne developed a workforce analysis tool that included data from the Bureau of Labor Statistics on the workforces in every county of the United States, Puerto Rico, and the US Virgin Islands, as well as demographic data on these workforces from the U.S. Census Bureau American Community Survey. With this tool, analysts can determine the total number of workers and industries in their state or county. In addition, analysts can assess what portion of the workforce is considered essential, including the portion of those workers that have a higher vulnerability to infection because they are in frontline jobs. The tool also allows analysts to further evaluate the demographic attributes of these workforces that may increase their COVID-19 susceptibility and the potential negative outcomes if they contract COVID-19.
In this presentation, we will describe the methodology used to develop the analysis tool, describe the data sources used, and present examples of the products that are generated.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56591 - Development of Tolerance Interval Derived Dose Curves for Acetylcholinesterase (AChE) Inhibition via Use of the Four Parameter Logistic Model

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Douglas R. Sommerville		

Abstract: For risk assessment applications, knowledge of two types of dose-response curves are needed: DR severity (DR-S) and DR probability (DR-P) (the latter characterized by the median effective dosages (ED50s) for each endpoint and probit slope). DR-S curves with continuous responses (example--percent inhibition) pose a challenge with respect to fitting the corresponding DR-P curve. The DR-S curve alone provides little information on the DR-P curve—only the ED50s as a function of the percent response. Ordinal regression (OR) has been used to simultaneously characterize the two curves together if the DR-S curve is first transformed (via binning of responses) into quantal endpoints. However, this approach comes at the cost of lost information (and other disadvantages).
An improvement to the OR approach has been developed--Tolerance Interval derived Dose-Response Curves (TIDRC). The calculated tolerance intervals from the actual continuous DR-S curve fit are used to estimate the DR-P curve (in particular the probit slope). This new approach is illustrated via the model fit (using the Four Parameter Logistic Model) of previously published nerve agent acetylcholinesterase (AChE) inhibition datasets as a function of dose. These results are compared with those using OR. The advantages and disadvantages of the two methods are reviewed.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56913 - Best Practices for Evaluating the Readiness of Technology Could Benefit DHS Efforts to Pursue Innovative Approach to Biodetection

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET

Authors: Mr. John Mendez Ortiz, Jr

Abstract: 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 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 found some actions to improve technology readiness assessments.

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.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56555 - Developing Natural Language Processing Algorithms to Medically Code Clinical Notes in Electronic Health Records

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET

Authors: Mr. James M. Zouris; Mr. Edwin William D'Souza; Mr. Trevor Alan Elkins; LCDR Andrew MacGregor; LT Andy Olson

Abstract: Coding medical data involves analyzing unstructured text fields, including lengthy clinical narratives, physician and nurse notes, lab reports, discharge summaries, scanned documents, and medications. Unstructured text data typically requires extensive resources to annotate, describe, analyze, and convert into meaningful and actionable information. These clinical data are often found in the Subjective, Objective, Assessment, and Plan (SOAP) notes. This presentation will demonstrate and discuss various machine learning algorithms using natural language processing (NLP) to parse SOAP notes that reside in the Theater Medical Data Store (TMDS)—specifically to estimate the injury subcategories (e.g., fractures of the lower limb), the three-digit International Classification of Diseases, 9th revision (ICD-9) code (e.g., 824, fracture of ankle), or the principal ICD-9-Clinical Modification code (e.g., 824.1, fracture of medial malleolus, open). The machine learning algorithms will be trained using manually coded diagnostic data obtained from the Expeditionary Medical Encounter Database and compared to the TMDS for accuracy. Sensitivity and accuracy will be the primary performance metrics that determine model efficiency. This research project's long-term

objective is to transition the translated coded data into a clinical encounter repository, which then can be used in conjunction with Department of Defense medical data repositories.

The study protocol was approved by the Naval Health Research Center Institutional Review Board in compliance with all applicable Federal regulations governing the protection of human subjects. Research data were derived from an approved Naval Health Research Center, Institutional Review Board protocol number NHRC.2003.0025.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56554 - R Shiny: A Beginner's Introduction and Application for Mortality Estimate Collection

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Ranny Maurer; Tracy Negus		

Abstract: R Shiny is a package available in the free, open-source R-language that facilitates building quick and easy-to-use web applications for interactive data visualization, sharing of analyses, and data collection.

Updating the mortality models for the Joint Medical Planning Tool (JMPT) required data on situations that have not been recorded in recent history, thus requiring subject matter expert (SME) estimation. Using Shiny, we were able to quickly develop and deploy a web-based application for collecting time-based mortality estimates from our SMEs. The Shiny interface allowed us to provide ready access to reference materials so estimates could be collected using consistent assumptions, along with instant visualization of the estimates being entered. We were also able to chunk the data entry task to help make it more manageable for the SMEs. The ready availability of feature packages and user-community support made this a beginner-level Shiny project. This presentation will discuss the process of creating a Shiny app, some features that provide off-the-shelf enhanced capabilities, and demonstrate our simple Shiny application used to collect SME estimates of mortality.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56713 - CONUS Patient Distribution: A Quasi-Discrete Event Simulation Model Leveraging Linear Optimization Embedded in an R Shiny Application

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Jonathan Davis		

Abstract: The distribution of patients arriving in the continental United States from a major conflict to definitive care locations presents enormous logistics and medical support challenges. The number of arrival nodes is limited to locations where an airfield with adequate flight line support and capacity

can be augmented by or already includes a hospitalization capability and an aeromedical staging facility. Patients must be distributed from arrival nodes to available Department of Defense and civilian hospital beds throughout the U.S. because any localized capacity would likely be insufficient. Some patients require critical care support while in transit. This presentation summarizes the development of a prototype model. The model generally follows the form of a discrete event simulation, but some components are mathematical approximations of the discrete event process, "quasi-discrete event." The daily flight plan for inpatients at each arrival node incorporates the result of a linear optimization model to assign the flight times, patients to flights, Critical Care Air Transport Teams to flights, and destinations to maximize the number of patients moved from each arrival node on each day, while also preferring fewer flights to execute the movement. The model is written in R and embedded in a Shiny application to support user-defined input data editing, modeling parameters, and interactive graphical output.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56852 - Simulated Patient Treatments in a Prolonged Care Environment

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mrs. Jennifer L Geffre; Mr. Tim Smith; Dr Jim Robinson; Dr. Teresa Millwater		

Abstract: In combat and non-combat scenarios, adequate resources and unrestricted patient evacuation are vital to saving patient lives and returning personnel to duty (Return to Duty – RTD). In an environment where evacuations are denied or unavailable, medical staff must accommodate prolonged patient care (PC), which is a period during which medical staff treat patients while having access to limited supplies, equipment, and no/limited evacuations. As the PC duration increases, patient survival and RTD rates generally decrease.

The Prolonged Care Simulation Model (PCSM) simulates medical treatment and care of patients in the PC environment. PCSM uses modern object-oriented Simio software while maintaining relationships with the Joint Medical Planning Tool (JMPT) to simulate a Role 2, U.S. Air Force Expeditionary Medical Support (EMEDS+10). The model is intended to inform a broad user base (commanders, policymakers, researchers, developers, logisticians, planners, and healthcare providers) and employs data analytics to optimize resources or triage/treatment strategies to increase survivability and the return to duty rates. A single-run mode with animation coupled with multi-replication experimental features, enable insights to small-scale base operations in the context of a variety of comparable scenarios. Scenarios include theater operations and humanitarian response where optimal utilization of personnel, supplies, equipment, and triage strategies is the goal to improve patient care in the PC environment.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

55358 - Medical Correlates of Early Attrition in U.S. Navy Personnel

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Trevor Alan Elkins; LCDR Andrew MacGregor; Andrew Olson		

Abstract: The Naval Health Research Center (NHRC) mission is to conduct health and medical research, to develop, test, and evaluate medical preparedness, and to continue surveillance to enhance deployment readiness of Department of Defense personnel worldwide. Accordingly, NHRC

was tasked with performing an analysis of early attrition, defined as a discharge within three years of accession. A recent RAND report found that nearly one in four U.S. Navy accessions experienced early attrition, which causes significant personnel and financial cost while negatively impacting military readiness. The objective of the present study was to identify medical correlates of early attrition using data from the Military Health System Medical Data Repository (MDR) and the Disability Evaluation System. All U.S. Navy enlisted personnel between the years 2003-2018 with early (n=100,679) and regular (n=203,084) attrition were identified from administrative records and comprised the study population. When examining hospitalizations and outpatient medical encounters from MDR, those with early relative to regular attrition had a higher percentage of morbidity related to mental health conditions (i.e., adjustment disorders, mood disorders, and alcohol-related disorders). In a subset analysis among those receiving a medical discharge, those with early attrition had a higher percentage of disability related to degenerative arthritis and tibia/fibula impairment. Mental and physical factors related to early attrition require further examination, particularly whether pre-enlistment screening could lead to early identification and mitigation strategies. Future research should extend this analysis to other services and examine key population subgroups (e.g., women in newly integrated occupations).

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56531 - Using Machine Learning to Predict the Onset of Posttraumatic Stress Disorder Within 2 Years Postinjury in Battle-Injured Combat Veterans

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr. Edwin William D'Souza; LCDR Andrew MacGregor; Andrew Olson		

Abstract: Posttraumatic stress disorder (PTSD) has cost the Department of Defense billions of dollars in mental health care and has resulted in diminished quality of life for the 11–20% of Iraq and Afghanistan combat veterans who are estimated to suffer from the condition. These recent conflicts have also produced the most casualties since Vietnam, and physical injury sustained during combat is a known PTSD risk factor.

This study uses machine learning to predict the onset of PTSD within 2 years post-injury among U.S. combat veterans wounded in action (WIA) in Iraq and Afghanistan from 2001 to 2019. The injury event, as well as relevant data prior to injury, were analyzed to extract features for the machine learning models. Injury data, demographics, medical history, and deployment history for patients were obtained from the Naval Health Research Center's Expeditionary Medical Encounter Database, the Military Health System Medical Data Repository, and the Defense Manpower Data Center. Patients were followed up to 2 years post-injury to determine if they received a PTSD diagnosis. Several machine learning classification models were developed, including logistic regression, decision trees, random forests, and neural networks (or deep learning) to predict the PTSD outcome binary variable using patient-level covariates.

The development of a predictive model to identify injured soldiers who have a high risk of developing PTSD could lead to early PTSD screening and focused rehabilitation efforts, thereby improving long-term outcomes and quality of life for combat veterans.

Classification: UNCLASSIFIED
Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation

56544 - Casualty Evacuation Given Survivability Expected Values on the African Continent

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr. John Francis Zeto		
Abstract: In an effort to assist United States Africa Command (USAFRICOM) in its efforts to execute casualty evacuation operations, the Center for Army Analysis (CAA) developed an easy to use and maintain model. The requirement was a tool that allows joint and component medical planners to enter a real or hypothetical casualty location; to rapidly validate the airfields, medical treatment facilities, and evacuation platforms available at time of casualty incidence; and that expeditiously outputs the optimal routing through the supporting medical evacuation and treatment network. The tool had to be easily maintainable, allow for a layperson to enter updated data, require no specialty software nor user-coding expertise, and output a set of paths through the network ordinally prioritized to the extent they facilitate patient survivability. Such a model is presented in the context of the equality-generalized travelling salesman problem (aka the traveling politician problem) with open Hamiltonian cycles of varying group and sub-group counts, discreet start and end points, and a heuristic solution incorporating a nearest neighbor greedy algorithm. Classification: UNCLASSIFIED Working Group:WG 15 Health Service Support, Force Health Protection, and Casualty Estimation		

WG 16 Strategic Deployment and Distribution

56530 - Enabler Force Demand Analysis for Total Army Analysis

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Sandra Hatch		
Abstract: The Center for Army Analysis (CAA) has provided enabler force demand analysis support to Headquarters, Department of the Army G-3/5/7 Force Management (FM) for several decades as part of its analytical support mission to Total Army Analysis required by U.S. Army regulations. CAA employs a methodology and process that accommodates changes in guidance and analytical needs and the U.S. Army force development community widely accepts as valid. This brief will describe CAA's support to FM and identify best practices for future support. Classification: UNCLASSIFIED Working Group:WG 16 Strategic Deployment and Distribution		

WG 17 Logistics, Reliability and Maintainability

55144 - A Metrics-based Software Tool to Guide Test Activity Allocation

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jacob Aubertine; Kenan Chen; Vidhyashree Nagaraju; Dr. Lance Fiondella		
Abstract: Existing software reliability growth models are limited to parametric models that characterize the number of defects detected as a function of testing time. However, the amount and types of testing effort applied are rarely considered. This lack of detail regarding specific testing activities limits the application of software reliability growth models to inferences such as the additional amount of testing required to achieve a desired failure intensity, mean time to failure, or reliability (period of failure free operation).		

This presentation provides an overview of an open source software reliability tool implementing covariate software reliability models [1] to aid DoD organizations and their contractors to quantitatively measure and predict the reliability improvement of software. Unlike traditional software reliability growth models, the models implemented in the tool accept multiple discrete time series corresponding to the amount of each type of test activity performed in each interval as well as relevant metrics. When applied to testing data, the parameters of each activity can be interpreted as the effectiveness of that activity to expose reliability defects or security vulnerabilities. Thus, these enhanced models provide the structure to assess existing and emerging techniques in an objective framework that promotes thorough testing and process improvement, motivating the collection of relevant metrics and precise measurements of the time spent performing various testing activities.

References

[1] Vidhyashree Nagaraju, Chathuri Jayasinghe, Lance Fiondella, Optimal test activity allocation for covariate software reliability and security models, Journal of Systems and Software, Volume 168, 2020, 110643.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56440 - Incorporating a Fault Prediction Model Into Maintenance Planning

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Jonathan Paynter		

Abstract: In a military aviation unit, the efficient and intelligent use of maintenance resources drives the availability of aircraft for missions. Even with good planning, unscheduled maintenance can disrupt schedules for flights and maintenance. To minimize downtime from unscheduled maintenance, the Department of Defense (DoD) is investing in predictive maintenance research, which includes the development of component-level fault prediction models. We focus on two questions related to these prediction models: 1) "What do units do with the predictions?" and 2) "How good do the prediction models have to be?"

Units will need to adjust existing maintenance processes when they begin fielding component-level fault prediction models. The best use of these models for minimizing downtime might not be to execute a repair every time the model predicts an impending failure. In some cases, it could be advantageous to embed the repair in the existing preventive maintenance schedule, either by waiting to repair the failing component until preventive maintenance is due, or by executing preventive maintenance early.

This work develops a framework for integrating a fault prediction model into a military aviation unit's existing maintenance decision process. We then leverage this decision framework for determining the characteristics of components where a fault prediction model could be most beneficial. Additionally, we develop a method for determining the minimum required performance of a fault prediction model for it to impact the decision process. A better understanding of these aspects can inform enterprise-level research and development investments for future component-level fault prediction models.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

55363 - Optimising long-term management of a military aircraft fleet up to life-of-type

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr David O'Halloran Marlow; Dr. Robert Franklin Dell		

Abstract: Fleet planners and managers of military aircraft fleets have many competing priorities. This results in a difficult balancing act between meeting short-term immediate tasking needs and long-term management. If short-term needs always take precedence, it is likely that the fleet will be unable to meet those same needs when they arise several years into the future. This is particularly important in appropriately managing the fleet to retirement, such that aircraft are neither over-utilised (forcing them to retire before the rest of the fleet) or under-utilised (retiring them with unused flying hours). The financial consequences of sub-optimal choices can be tens of millions of dollars per fleet (Newcamp et al., 2019).

We present a mixed integer-linear program (MIP) for optimal management of a fleet over a multiple-year time horizon, up to life-of-type. The model can be run at various timescales with various time steps depending on the scenario. It can cater for a single objective or multiple objectives, or be treated as a heuristic, solved iteratively in descending order of objective term priority. The model generates decisions such as which aircraft to deploy, when to induct aircraft into depot maintenance within an induction window (for either elapsed time-based or flying hours-based intervals), and how to fly aircraft in order to both meet ongoing fleet and squadron requirements, and reach retirement targets. We demonstrate the model's capability with some examples, e.g., scheduling a major modification program to best meet availability targets.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56810 - Risk-Informed Prioritization of Operational Condition Assessments

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Dr. Jonathan Alt; George Edward Gallarno; Dr. John Richards; Willie Brown; Titus Rice		

Abstract: The U.S. Army Corps of Engineers (USACE) operates, maintains, and manages more than $232 billion worth of the Nation's water resource infrastructure. Using the Operational Condition Assessment (OCA) system, the USACE allocates limited resources to assess conditions and maintain assets in efforts to minimize risks associated with asset performance degradation. This research develops a scalable methodology to model the probability of failure of gate systems that contribute to the performance of dams in their respective watershed combined with consequences derived from hydrological models of the watershed to develop a risk score for each gate. The resulting risk score serves as an input for a mixed integer optimization program that identifies the optimal set of components to invest in to minimize risk at the watershed level. Proof-of-concept results for a case study watershed are provided.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56999 - Understanding Quantitative Dimensions of Behavior – Why it Matters in Data Analytics

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET

Authors: Dr. Kenneth W. Lewis

Abstract: In 2021 and beyond, Data Analytics & Big Data continue to be the new poster-boy buzzwords that add excitement and sparkle to the otherwise drab topics of statistics, operations research, quantitative methods, data analysis and management science. Sometimes our young or inexperienced analysts will use the wrong measurement or dimension of the behavior they are studying. They might mistakenly think they are studying the frequency of that behavior, when in fact they should actually be studying the magnitude, longevity or cost of that behavior. Understanding exactly what type of dimension of behavior the analyst is studying provides clarity and validity to the research study process. It determines the type of analysis that the research project requires. If you see the recorded data point of (7), what does it mean? Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 36 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results.

Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56961 - Maintenance Free Operating Period: Defining the Capability Gap

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: LTC Kathryn Pegues; Andrew Bellocchio; MAJ Matthew J Beigh

Abstract: The Future Vertical Lift (FVL) Program is tasked to field airframes that leverage new technology and materials to gain additional capability for combat operations in the Joint All Domain Operations environment. In addition to the physical aircraft design, the FVL program is exploring making changes to aviation operations through the integration of the Maintenance Free Operating Period (MFOP). During the MFOP the airframe must be able to continue to perform its intended functions without additional maintenance beyond replenishment. Implementation of MFOP will require investment in materiel as well as changes to existing aviation doctrine, organization, training, leadership, personnel, and facilities. This research effort looked at the impact of materiel investments and maintenance policies on airframe performance measured by MFOP success, achieved availability, maintenance ratio, and the maintenance recovery period success. The six areas of investments, termed MFOP activities, are inherent component reliability, failure life characteristics, lifing policy, prognostics, diagnostics, and maintainability. Using ProModel, the team built a simulation to examine the payoff of investments in terms of MFOP performance metrics. The results of analysis provided key stakeholders with a clear understanding of the capability gap that cannot be bridged by materiel solutions alone.

Classification: SECRET//REL TO FVEY
Working Group:WG 17 Logistics, Reliability and Maintainability

56925 - Dynamic Sortie Schedule Probabilistic Risk Model

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET

Authors: Mr. Philip Alan Fahringer

Abstract: A constant challenge for military operational planners is to forecast how many aircraft sorties they will be able to execute over the next several days to a week. The problem is that there

are numerous factors that influence how many aircraft will be available at any point during the week and ready to conduct a sortie. These factors include, how many aircraft are in the squadron, how many sorties they are scheduled to fly on any given day, how frequently a sortie results in a maintenance requirement, and how long the maintenance takes. Standard practice is to estimate these factors with averages and then compute the average number of aircraft likely to be available and then schedule sorties accordingly. The result is that due to the random nature of the underlying factors schedules often have to be redone on a daily basis to adjust to the actual number of aircraft ready. This creates a continuous burden on planners and pilots, sometimes having to cancel expected sorties when a below average number of aircraft are available, and sometimes having to try and fly additional sorties when an above average number of aircraft are available.

This presentation will demonstrate a Monte Carlo simulation approach to computing a specific probabilistic risk for a given number of aircraft being ready at any point during a week, thereby allowing military planners to determine how much risk there is in any given sortie schedule. Additionally, the approach demonstrated will enable instantaneous adjustments to key input assumptions to evaluate the impact on schedule risk. The model demonstrated will be available to all participants.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56904 - Cost Efficient and Effective Data Cleansing Strategies Utilizing Machine Learning to Optimize Analytics for Enhanced Decision Making

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Abhishek Paul; Christopher Lock		

Abstract: Data cleansing builds the foundation for making decisions with analytics. Historically, the process of cleansing data or ensuring collected data is accurate has been a manual and cost intensive effort. An example of this can be seen within the domain of predictive maintenance. The main challenge for predictive maintenance is the quality of data, with an increased risk for systems with manually entered data. Examples of manually entered data which are essential to predictive maintenance are malfunction code, type of malfunction code, etc. The data cleansing process for predictive maintenance typically consists of verifying the code for every maintenance action, based off of descriptions and other attributes. With supervised machine learning and natural language processing, this process can now be automated. The purpose of this study is to demonstrate an application of supervised machine learning with natural language processing, to significantly reduce the time and cost necessary for data cleansing. This construct aligns within the domain specific topic of predictive maintenance; a notional aircraft maintenance dataset is applied. This approach can be tailored for use on similar problems where data cleansing efforts have historically been performed manually.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56847 - Long Duration Logistics Wargaming (LDLW): Resilience Analysis Toolkit

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Zachary Shannon		

Abstract: The Air Force (AF) relies on logistics networks to support bases and other operating locations during both peacetime and contingencies. Because of its global mission, the AF's logistics networks can be extremely large and complex leading to inherent vulnerabilities that threaten the effectiveness of resource procurement, delivery, and ultimately, AF mission effectiveness. The need to predict future combat readiness resulting from sustainment and supply chain resources while facing a disruption is essential for holistically capturing the true impact of a robust supply chain on sortie generation capabilities. Current efforts, such as LDLW (Long Duration Logistics Wargame), intended to derive insights on the AF's ability to sustain an extended period of combat operations, derives sortie generation insights from simple logistic processes. Accurately capturing the impact of sustainment and supply chain concepts on AF network performance provides greater insight for decision makers when evaluating operational and strategic trade space impacts on the overall capabilities of the AF. This effort uses discrete-event simulation to model a repair-centric supply network decision trade space within a wargaming decision environment and formulates the associated network resilience tool requirements to support essential supply chain decision making. Specifically, this effort is intended to support the decision making and optimal resource allocation of supply chain capabilities to maximize network and base resilience to targeted adversarial attacks.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56807 - Two Stage Stochastic Network Programming for West Africa Logistic Network

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: Julius C Walker; Timothy W Holzmann, PhD; Frank William Ciarallo, PhD

Abstract: A resilient logistic network in the West Africa Logistic Network is key to sustaining long term humanitarian and security missions in the West Africa region. This paper employs a two-stage stochastic programming network design modeled on the WALN to build a flexible supply chain capable of responding to periodic disruptions while maintaining peak resiliency. We model disruptive events by varying cost, demand, and capacity parameters. We demonstrate that incorporating a resiliency-based response mechanism can provide a 90% reduction in cost compared to meeting the logistic challenges covered with a naive approach.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56741 - Quantitative Relationships Between Resources and Readiness

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET

Authors: Dr. Thomas Arthur Edmunds; Dr. Ya Ju Fan; Dr. Lance Bentley-Tammero; Erica Dretzka; Derrick Kozolowski; Jason Bradshaw; Jason Slusser

Abstract: The federal budget allocates a major proportion of its expenditures to ensure military readiness. Readiness can be maximized through judicious allocation of personnel, training, sustainment (supply chain), and equipment resources. The Office of the USD for Personnel and Readiness and Lawrence Livermore National Laboratory (LLNL) have developed mathematical models that correlate resource availability with readiness of the Marine F/A-18 fleet to inform budget requests. These relationships between resources and readiness will provide the oft-requested 'Receipt to Congress.' Some key outputs of the F/A-18 study to inform budget requests included:

1) Cost/benefit ratios ($/hour increase in availability) that could be realized by increases in individual cost accounts
2) Recommended optimal allocation of funding among accounts that account for interaction effects among accounts and maintenance delays
3) Recommended optimal allocation of funding to increase fundamental capabilities (some repair work may not have been completed due to lack of capabilities)
4) Identification of cost accounts that are not significantly correlated with maintenance delays (decreases in these accounts may not significantly impact fleet availability)
5) Recommendations for increases in inventories of specific parts
6) Recommendations for improved load balancing among squadrons and work centers

The team is currently undertaking a similar effort in collaboration with the 160th Special Operations Aviation Regiment (SOAR), an agile regiment which has enabled its aircraft with advanced versions of commercial voice and data recorders to collect flight data. The analysis employs the full data pipeline (data creation, ingestion, exploration, feature engineering, machine learning, and visualization). Multiple algorithms are being tested, from simplistic linear regression to partial least squares regression, feature reduction via singular value decomposition, decision trees, and neural networks. The analysis includes input from subject matter experts and is building on a previous effort by researchers at Carnegie Mellon University and the SOCOM incubator. The SOCOM Incubator is a partnership between the JAIC and SOCOM, which magnifies the impact of JAIC funding and produces transformational results, such as insights into AI development that are applicable across the DoD and AI products that are developed with, and are thus useful to the warfighter.

The models will be the foundational version of what is planned to be a multi-stage effort exploring the constrained flow of resources agnostic to demand signal. Actionable insights will help decision makers understand and mitigate process bottlenecks. In addition, models will predict component remaining useful life and probability of failure during a mission of a given duration and environmental conditions.
Lawrence Livermore National Laboratory LLNL-ABS-819329

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56730 - Hybrid Supplier Risk Assessment and Identification Methodology for the Defense Industry

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Isabella Thavi Sanders		

Abstract: This paper aims to present a supplier risk identification and assessment framework that rigorously examines the financial outlook of firms and their respective plants, focusing on disruption and disaster risk factors. Supply Chain Risk and Financial Bankruptcy literature is analyzed and different aspects are combined to create a novel supplier risk assessment methodology. This hybrid procedure combines a logit model with a multi-criteria scoring procedure to calculate plant level supplier risk indices. These risk indices enable purchasers to make data-driven decisions in their selection of supplier annual contracts. This framework is applied to a case study of a supply chain purchaser within the US Government. The model was tested and validated using historical supplier data provided by the purchaser. The developer was able to implement the framework and use it for risk management, demonstrating its importance to manufacturers and purchasers within the DoD. This hybrid data-driven risk analysis methodology is practical to implement and can be used

proactively by firms to improve the stability of their supplier base through risk assessment and reduction. Distribution Statement A. Approved for public release: distribution is unlimited.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56684 - Assessing Logistics Feasibility of Future Force Structures Using Discrete-Event Simulation

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Nicholas R Hofacker; Mr. Matthew Ledwith; Richard Moore; Prof. John O. Miller		

Abstract: Currently, the Air Force dedicates a great deal of resources to determine and analyze the operational capabilities and necessary force structures required to win potential future conflicts. However, the logistics frameworks to support these operational capabilities and necessary force structures are often overlooked. The purpose of the Logistics Campaign Assessment Simulation (LogCAS) model is to assess the logistics feasibility of completed campaign analyses and to identify potential "logistics designs." This campaign-level model is being developed in Simio, a discrete-event simulation software, based upon demand data generated from the Synthetic Theater Operations Research Model (STORM). The baseline LogCAS model takes into consideration Class III (bulk fuel) and Class V (munitions) demand signals defined for each operating location and for each day of the conflict. Other model inputs include resource resupply capabilities defined by site survey data and storage capabilities comprised of current base capacities and planned infrastructure investments. Initial model results record the satisfied and unsatisfied resource demands for each location by day and compares the number of requested sorties to those achieved given the logistics constraints. This model also identifies the logistics constraints at each operating location, determines the necessary infrastructure to support the demand signals, and quantifies the impact of experimental logistics concepts to establish a cost-to-benefit relationship. This presentation will provide an overview of the LogCAS model, demonstrate the model's initial capabilities, explain "logistics designs," and provide insight for the future of the LogCAS model.

Classification: SECRET NOFORN
Working Group:WG 17 Logistics, Reliability and Maintainability

56719 - The Distribution Network Model

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Connor S McLemore; Richard Story		

Abstract: The 38th Commandant's Planning Guidance describes new naval operating concepts that present the Marine Corps with new logistics challenges: "Rather than heavily investing in expensive and exquisite capabilities that regional aggressors have optimized their forces to target, naval forces will persist forward with many smaller, low signature, affordable platforms that can economically host a dense array of lethal and non-lethal payloads." The Marine Corps requires new logistics operating concepts to include supplying many mobile austere bases distributed over thousands of miles. The new logistics paradigm creates a network of supply and demand nodes, serviced by a wide variety of transportation types, that confounds more linear and traditional military force closure modeling approaches. The Marine Corps seeks to determine cargo and equipment prepositioning and numbers, types, and locations of traditional and non-traditional logistics enablers that are optimized to be most responsive while minimizing investment. The Distribution Network Model can determine

the most responsive and lowest cost afloat and ashore tailoring plan for inventory and transportation enablers and inform
investment decisions to allow selection of the most effective affordable platforms to support Marine Corps future operating concepts.

Classification: UNCLASSIFIED
Working Group:WG 17 Logistics, Reliability and Maintainability

56705 - Time Based Optimization

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: John Verbanick; Matthew Dickinson		
Abstract: This paper/presentation will discuss the impact and need for Time Based Optimization on the Department of Defense's (DoD) digital revolution of acquisition and sustainment process. In the last decades, the DoD has had continuous and positive pushes towards a more efficient and responsive system to acquire and manage the life cycle of major weapon systems. In a world of decreasing defense budgets and increasing weapons systems costs it becomes vital that the defense acquisition and sustainment process become integrated in all aspects of the program from design concept to system retirement, cradle to grave. The concept of Time Based Optimization becomes vital in this new paradigm for the successful application of systems logistics. The Department of Defense has mandated each service move to a Condition Based Maintenance Plus (CBM+) program which the Air Force has already successfully applied to legacy systems such as the B-1B, C-5 and KC-135. These are legacy systems that are approaching the end of their service life with limited ever decreasing supply chains for parts, the test on the effectiveness of CBM+ will take decades to determine. To truly see the impact of CBM+ you need to follow new weapons systems from cradle to grave. As the DoD continues adding CBM+ to systems, the supply chain, storage, and new technologies on parts will become more relevant. Continued use and application of CBM+ necessitates that new systems are planned from the start to account for the entire life cycle of the system including all planned block changes. Time Base Optimization by necessity will become an essential component for success. Program/Project Managers will be required to have a clear understanding on how to right size initial and follow-on purchases, do a cost analysis on parts purchases and storage considerations, as well as look at the impacts on fleet growth and subsequent decline through the natural evolution of their program. This paper/presentation will show that Opus Suites has the ability to calculate a programs Life Cycle Costs and apply Time Based Optimization giving DoD Program/Project Managers the data and flexibility to successfully run their program and be responsible stewards to the cost/budget allocated to them by the American people. Classification: UNCLASSIFIED Working Group:WG 17 Logistics, Reliability and Maintainability		

56643 - Next Generation Automatic Test System (NGATS) Effects on Operational Readiness

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Abe Payne		
Abstract: Most Army Brigade Combat Teams (BCTs) currently lack the ability to conduct automatic testing of electronic components at the unit level. When components fail, these units currently rely on some form of contractor logistics support to conduct testing and repair of the components. This leads to higher costs and equipment downtime for the unit since they are unable to test and repair at		

their level. Additionally, many components that appear faulty on built-in tests are actually functional and do not need repaired or replaced. This phenomenon is known as "no evidence of failure" (NEOF). Without organic automatic testing equipment, units are unable to screen for NEOF, which further increases the cost of maintenance and extends system downtime. The lack of automatic testing equipment at the unit level significantly impacts a unit's ability to perform effectively, especially in Multi-Domain Operations. Product Director Test, Measurement, and Diagnostic Equipment (PD TMDE) has a mission to develop, field, and sustain technologically superior Army Test, Measurement, and Diagnostic Equipment and Calibrations Standards to enable weapon systems readiness for full spectrum operations. To address these issues, PD TMDE has begun fielding the Next Generation Automatic Test Systems, which is the latest iteration of the Army's organic off-system test capability. While the effects of fielding the NGATS appear to be beneficial to units, the exact impact on unit readiness is unknown. This study examines the effects of NGATS on the operational availability of equipment in BCTs through the use of discrete event simulation. This includes an assessment of the improvement or deterioration of platform operational availability when using NGATS at the BCT level in a fix-forward role and the subsequent impact on combat power.

Classification: SECRET//REL TO FVEY
Working Group:WG 17 Logistics, Reliability and Maintainability

56464 - DoD Corrosion Maintenance Data Quality Assessment through Approximate String Matching

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Raymond Vetter		

Abstract: Corrosion is estimated to account for over 20 billion dollars' worth of maintenance parts and labor each year in the Department of Defense (DoD). The DoD's Corrosion Policy and Oversight (CPO) directorate is charged with developing and implementing a long-term strategy aimed to improve military readiness and operational efficiencies for DoD equipment and infrastructure through effective corrosion prevention and control technologies. The Maintenance and Availability Data Warehouse (MADW) was developed to improve understanding of the corrosion problem, seeking to inform corrosion policy and funding decisions. However, MADW data relies on raw maintenance data collected by the Services at the organizational and depot levels. For CPO to make data-informed decisions to effectively mitigate and manage corrosion across the Services, it must first have high quality data from users and maintainers. CPO seeks to understand the maintenance data quality for the H-60 Blackhawk, which is an aviation platform common to the Army, Navy, and Air Force. Assessing the data quality across a shared platform allows for a consistent comparison for the Services and may indicate the differences in overall quality of data. Data quality has several components, specifically accuracy, precision, completeness, and consistency. This work focuses on data consistency, using approximate string matching to assign scores to each maintenance record. Approximate string matching is a technique that considers patterns of characters within text strings. The Jaro-Winkler similarity algorithm was selected to assess the closeness of match between string data fields for maintenance entries. While each Service collects unique data in its maintenance data collection process, a few fields are parallel across Services. When considering the H-60 Blackhawk, the Army, Navy, and Air Force collect data related to the object receiving maintenance, the maintenance action performed, and the malfunction identified for that entry. Pairwise comparison and assignment of Jaro-Winkler similarity scores highlight whether maintenance records are consistent between the coded data fields and the free text narratives where higher scores indicate greater consistency across records. The use of the Jaro-Winkler similarity algorithm is also used to assess whether a maintenance

record is corrosion-related. This comparison utilizes discrepancy codes, free text fields, and defined corrosion key terms, as defined by each Service. This assessment highlights the quality of the free text fields and indicates if corrosion-coded maintenance records may be mislabeled. The analysis then informs current best practices for maintenance data across the Services and recommends potential improvements for data collection methods.

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Working Group:WG 17 Logistics, Reliability and Maintainability

55104 - Transforming Logistics networks with Location of Repair Analysis

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Robert Coleman; Vincent Mendoza

Abstract: Title:
Transforming logistics networks with Location of Repair Analysis
Abstract:
Recent world events have highlighted the transportation and logistical constraints of the Department of Defense (DOD), and the notion that there is a lack of ability to rapidly adapt to changes in force posture and projection. In this paper we identify a novel concept for quickly analyzing a notional need to increase a weapon system's population in a specific Area of Responsibility (AOR). Using a baseline mathematical model of the current deployment and sustainment organization, the structure and methodology is modified with new constraints, that once placed on the sustainment infrastructure reflect the increased population demand signal.

In this example, doubling a weapon system population, makes the current sustainment approach and throughput inexecutable, driving the need for additional Product Support Provider participation. After conducting market research, gathering past performance data from current vendors, and integrating the data into the baseline model, serval potential support solutions immerge. Through the use of a comparative analysis approach, Location of Repair Analysis (LORA), we are able to optimize depot sustainment task costs by location, while ensuring the most efficient procurement of sparing to support fleet Operational Availability (Ao) based on current contractual arrangement and managed inventory.

The analysis performed utilizes OPUS10 a steady state multi-echelon multi-indenture optimization tool to identify the combinatorial solution that best meets the situation Ao at the lowest possible Lifecycle Cost, both additional investment and reoccurring cost over the scenario length. The analytical solution(s) are then run through a Stochastic engine to identify sustainment bottle necks in the solution to 1) Ensure that non-deterministic factors (e.g. variability in deployment or transportation profiles) were not misrepresented in the multivariate optimization, 2) Identify the most influential factors to both Ao and Cost, to inform future design improvement/enhancements and 3) Focus future market research where the most sustainment opportunity exist.

Biography:
This paper / presentation will be a collaboration between; Robert Stukes, the Product Support Manager for Ship Self Defense System, James Miro an analyst from Naval Surface Warfare Center Port Hueneme Division Advanced Radars Branch A68, Vincent Mendoza the Business Development Executive from Systecon North America and Robert Coleman an Analyst from Systecon North America. With expertise in solving complex problems in and with Predictive Analytics and Systems,

Logistics & Cost Optimization we want to display how to leverage LORA to find solutions. We are focused on balancing cost and capability within the Defense industry using business strategy, data analytics, and supply chain operations management functions.

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Working Group:WG 17 Logistics, Reliability and Maintainability

56574 - Forecasting and Optimizing Spares Inventory under Changing Demands and Capabilities

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: John Hagood; Kyle Morgan		

Abstract: Over half of all costs of DOD programs are associated with operations and support of the program. For aircraft, a large percentage of that cost is directly related to the acquisition and repair of spare parts. Improperly allocated purchases run the risk of short-falls of certain items – bringing about operational delays; while others sit on shelves indefinitely— consuming funds that could have been used more effectively. Accordingly, accurately predicting stock levels and demand over the life cycle of the system is of utmost importance when trying to minimize waste while maximizing operational effectiveness. Our approach to this problem is two-fold, first predicting demand and expected short-falls in stock, then optimizing against these stock levels to suggest order frequencies and quantities. Predictions of demand and short-falls in the Total Inventory and Forecasting (TIAF) model take into account all aspects of the support structure, including squadron stand-up schedules, current inventory levels, deployment requirements, operational requirements, and OEM/Depot repair capabilities. We then utilize various optimization techniques to provide a schedule of orders and quantities which will ensure demand is met for the given life cycle. We will discuss the capabilities of our prediction model and the process of selecting an optimization method which provides the right balance of accuracy and usability.

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WG 18 Manpower and Personnel

56991 - Promotion Board Performance - Using Cohort Benchmarks to Improve Promotion Board Performance

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Nicholas E Alvarez; David Hickman		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. In this discussion we propose how decision analysis and data visualization tools could be used to improve selection/promotion board performance. Using decision analysis techniques, the team has produced a value model of the desired officer characteristics at the next grade – and used that model to calculate a composite (whole person) score for each officer. The team used data visualization methods to illustrate the composite scores for the entire cohort of promotion-eligible officers. These products may be used to provide cohort benchmarks for selection/promotion board members, enabling improved board performance.

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Working Group:WG 18 Manpower and Personnel

56545 - Department of Defense Household Goods Analysis

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Daniella Fitzhugh		

Abstract: Every year, thousands of service members move to new assignments. This triggers the stressful process of packing up all of their belongings and shipping them to a new location. For many military families, the move is more stressful because they have more belongings than the military will pay to move. The Joint Travel Regulation (JTR) provides weight limits by rank – indicating how much weight the Department of Defense will pay to move. Any amount over the limit is the responsibility of the service member – an out-of-pocket expense.

This study, sponsored by the Army G-4, looked at the JTR weight limits and moves over a 3½ year period to identify the ranks that have been most impacted by the JTR limits. The Army G-4's goal is to work with the other services to change the JTR to significantly reduce the number of service members who have to pay out of pocket to move their belongings. The presentation will discuss the study findings and recommendations, to include an innovative recommendation for changing the JTR.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56495 - A Multi-criteria Optimization Based Tool For Active Component Army Enlisted Assignments

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: MAJ Matthew Ferguson		

Abstract: A multicritera optimization formulation is developed to inform the assignment of Army enlisted personnel. A pre-emptive goal program provides a sufficient model that meets decision-maker values with respect to assignment criteria, Army readiness requirements, and expressed Soldier preferences.

An additional model use case is identified as developing enlisted markets with respect identification and scoping of requirements given to Soldiers to preference, as well as identifying market gaps that require intervention. A minimum-deviatiion goal program is used to both select requisitions and identify the need for new-build requisitions based upon demographic information of projected market participants.

An internal facing web-based interface is developed for assignment-managers, allowing for assignment-manager driven modifications to address assignment criteria exceptions as well as incorporate requirements requiring qualitative human assessment.   The result is a "live" interactive optimization capability to better inform the Army's active component enlisted assignment process.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56858 - AFMC Supervisors We Need

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Ms. Tamiko Ritschel		

Abstract: Supervisors are a key link between the senior leaders who map our strategic direction and the people that accomplish the mission. Recent surveys and focus groups have indicated Air Force Materiel Command's (AFMC's) supervisors are struggling to meet the needs of their employees in areas such as writing effective appraisals, giving constructive feedback, recognizing employees, and mentoring. The knee jerk reaction is to throw more training at supervisors but further exploration has discovered the problem goes much deeper than that. This research explores the anecdotal evidence about supervisors in the Command via survey text analysis and then tries to prove or disprove those assertions where possible with underlying human resources data validation. Understanding the true issues can help the Command identify concrete steps to improve the performance of employees in these critical positions. Insights and recommendations are applicable to organizations throughout the federal government.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56827 - Workforce Development in an Agile Environment

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Thomas J. Palmer; Mr. Barry Farrar; Dr. Aaron Bolin		

Abstract: Traditional models of workforce development rest on a foundation of thorough analysis that precedes instructional design and development (see Mager, 1988). Instructional design models that rely on front-end analysis complement software development projects that use traditional project management techniques (sometimes known as waterfall project management). In traditional project management, requirements are fully developed and the design architecture is fully conceived before any products are built. However, software developers are adapting agile project management techniques with increasing frequency (Project Management Institute, 2017). In agile project management, requirements are only partially developed at the time product development begins. Agile software development proceeds in a series of short-cycle sprints with the stated goal of delivering a small piece of the overall project very quickly. At the end of each sprint cycle, the remaining requirements are further refined, new requirements may be generated, and another portion of the overall project is selected for sprint development. Providing instructional design that is fully informed by front-end analysis in an agile environment is impossible, because requirements are still being refined in later sprint cycles even after initial products have been released. Instead, the workforce development model must evolve to meet the faster-paced demands of agile software development (Kirkpatrick & Kirkpatrick, 2016). Using the real-life example of Navy pay and personnel transformation, we chronicle the workforce development challenges of a rapid software development and transition for a geographically dispersed workforce of over 7,500 individual users. During this process, we were forced to develop a basic framework for rapid cycle instructional prototype, ripple-based delivery, and immediate adjustment based on the successive approximation nature of agile development. This framework along with lessons learned and analytic discoveries represents an emerging frontier in workforce development.

References
Kirkpatrick, J.D. & Kirkpatrick, W.K. (2016). Kirkpatrick's Four Levels of Training Evaluation. Association for Talent Development: Alexandria, VA.
Mager, R. F. (1988). Making Instruction Work. Lake Publishing: Belmont, CA.

Project Management Institute. (2017). A Guide to the Project Management Body of Knowledge (6th Ed.). Project Management Institute: Newtown Square, PA.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

55348 - Army Officer Manpower Readiness: Measuring the Price of Professional Development Guidance

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jonathan Paynter		

Abstract: In the Army, near-term manpower readiness is driven by structure, limited by available manpower, and constrained – for future benefit – by professional development guidance. Current force shaping models capture structure and available manpower over time for each rank and branch combination, but do not capture the readiness impacts of professional development guidance. While this guidance is a crucial aspect for building the Army's future mid- and senior-level officer talent pool, its impact on readiness is not clearly defined. This work develops a method for determining the "price" of professional development guidance, as a tool for helping personnel leaders and proponents evaluate trade-offs.

Professional development guidance specifies requirements and sequencing for educational opportunities and assignments and is a key aspect for shaping future leaders. Overly restrictive guidance, however, limits the flow of officers through certain assignments, and decreases the available manpower for subsequent assignments. A key example of this situation is the Army's population of captains. Even though there are more available officers than positions in almost every branch, vacancies in Key and Developmental-qualified captain positions persist. These readiness implications result from the combination of structure and professional development guidance within each branch. Proponent and personnel leaders need an analytic perspective that combines these elements.

We measure manpower readiness using a path-based network flow model, where the graph is built from the combination of jobs and professional development guidance. We formulate a bi-level mixed integer program where career specialty leaders make professional development decisions about allowable career paths in the upper level, and personnel leaders maximize manpower readiness in the lower level. This model allows us to determine the trade-offs between manpower readiness and various aspects of professional development guidance, providing insights for leaders about the impacts of schooling, required assignments, required assignment sequencing, and timing.

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56767 - Assessment Tools for The Research an Analysis Center (TRAC) Civilian Workforce

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Ms. Cindy L. Grier		

Abstract: When questions arose as to the reasons why civilian employees leave the workforce at The Research and Analysis Center – Fort Leavenworth (TRAC-FLVN), the understanding was anecdotal. Furthermore, assessment of the current workforce compared to prior years' workforce revealed a

historical data void. In order to readily assess current and historical workforce trends, a TRAC-FLVN Retention and Recruitment (R&R) system was developed. The system data from multiple sources and accumulates it in an Access database. Leveraging the R programing language, a dynamic R Markdown document is created to provide TRAC-FLVN Leadership with an in-depth analysis of TRAC-FLVN Total Workforce. This analysis includes a robust assessment of TRAC-FLVN's Workforce Mobility and Service Length Distribution. The document also pulls data from the newly developed Exit Survey to conduct Losses and Hires Analysis and provide analytical insights for employees' Departure Reasons. The initial R&R assessment was for the 2019 workforce, with expanded capabilities for the 2020 assessment.

This presentation will describe the system, sample assessment products, and plans for future assessment.

Classification: UNCLASSIFIED
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55320 - Bomber Pilot Scheduling Simulation

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr Derek John Eichin; Mark Bryant; Mr. Christopher Gillie; Mr. Isaac Jerome Roberts, IV		
Abstract: Like many organizations across the Air Force, the 7th Bomber Wing (BW) has to balance training currency or total sortie needs against the maintenance requirements and economic useful life of their aircraft. With the added pressure of losing operational aircraft to the boneyard or extended depot activities, the 7th BW needs to optimize how it schedules sorties and manages aircrews. In practice, the 7th BW requires the ability to review how certain decisions one month may affect mission readiness and aircraft availability the following months. The goal of this project is to provide the 7th BW with a data driven, web-based application capable of handing the pilot training and flight time requirements of each squadron along with the available aircraft to provide optimal flight schedules. The long-term goal of the model is to utilize historical data and user input to simulate how various decisions will affect the mission readiness of the entire wing.		
Classification: UNCLASSIFIED Working Group:WG 18 Manpower and Personnel		

56372 - Civil Affairs, Psychological Operations, Special Forces – Recruitment and Retention Database Development Analysis

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Matthew Joseph Pacheco		
Abstract: MORS 2021 ABSTRACT Civil Affairs, Psychological Operations, Special Forces – Recruitment and Retention Database Development Analysis Major Matthew Pacheco Center for Army Analysis 6001 Goethals Road Fort Belvoir, VA 22060-5230 (703) 806-5100 matthew.j.pacheco.mil@mail.mil		

The U.S. Army Special Operations Command (USASOC) Headquarters, G-5 asked the Center for Army Analysis (CAA) to independently validate their enlisted production pipeline models for their proponents and develop a dashboard to monitor production history. This presentation will report on CAA's efforts to understand key aspects of the attrition behavior of each proponent's production pipeline and development of a dashboard in Army Vantage, which is a comprehensive data management platform designed to integrate data from a multitude of Army systems.

The analysis sought to identify the proper path through the production pipeline and attrition rates along that path for each USASOC proponent. Additionally, the analysis identified the time it takes Soldiers to get through each respective production pipeline. CAA used data from the Army Training Requirements and Resource System (ATTRS) and the Recruit Quota System (REQUEST) for the analysis. CAA developed the dashboard in Army Vantage, which pulled ATTRS and REQUEST data to illustrate historic attrition rates for key courses in the proponent production pipelines. The purpose of the dashboard is to provide USASOC and the proponents with a common understanding of key drivers to changes in the production mission that is transparent to all. CAA will inform and solicit feedback from those interested in manpower and personnel analysis.

Classification: UNCLASSIFIED
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56994 - Community Performance, Experience, and Education Benchmarks - To Inform Officers and Mentors as They Make Career Management Decisions

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: David Hickman; Nicholas E Alvarez		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. Officer development is a function of career assignments. Knowing what assignment to take, and when, is a challenge. Mentors know what made them successful – but not necessarily what will make their mentees successful. One solution is to provide a body of knowledge to officers and mentors to help inform their decisions. In this discussion we propose how decision analysis and data visualization can inform officers of how their performance, experience, and education compares to community benchmarks. Using decision analysis techniques, the team has produced a value model of the desired officer characteristics at the next grade – and used that model to calculate a composite (whole person) score for each officer. Calculating, then publishing the population distributions of the elements that make up the composite score enable each officer and mentor to compare an officer's performance, experience, and education to the community benchmarks – identifying officer strengths and weaknesses. The goal is for officers and mentors to use these tools to improve the quality of assignment decisions.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56601 - Data Analysis for the USCG Body Composition Policy

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mrs. Morgan T Holden		

Abstract: In 2018, the USCG contracted RAND to complete a Women's Retention Study and Holistic Analysis. That study identified an existing policy resulting in inequitable outcomes based on gender. This imbalance in body composition standards ultimately disproportionately impacted women at a rate three times higher than men. Following the completion of that study, the USCG instituted a Body Composition Pilot Program that offers additional opportunities for active duty and reserve members to demonstrate compliance with Coast Guard readiness standards including a new abdominal circumference, fitness test, and also better connects medical professionals to the health assessment. During the pilot program period, the Coast Guard collected data to make future policy decisions that improve the personal readiness of our workforce. This MORS presentation will focus on the methods for retrieving, analyzing, and presenting the body composition data that ultimately led to body composition policy changes in the Coast Guard and the shortfalls we continue to see in our data collection methods.

Classification: UNCLASSIFIED
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56916 - Effectively Moving Sailors Following the Covid-19 Stop-Movement Order Using the Optimized Slating Tool

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: LT Kyle Belcher; Allison Hogarth		

Abstract: To mitigate the risk of COVID-19 transmission the Navy enacted a stop-movement order between March-June of 2020. The stop-movement order delayed Sailors who had permanent change of station (PCS) orders from transferring to their next duty station and executing their household goods (HHG) move until July of 2020. This created a surge of moves planned for July. The expected number of moves not only exceeded available United States Transportation Command (TRANSCOM) HHG move capacity, it also had repercussions for Fleet manning and at-sea readiness.

To address this problem, analysts from Navy Personnel Command (NPC) in Millington, TN and Enterprise Comprehensive Analytics (ESCA) in Arlington, VA collaborated to develop a quick-turnaround solution called the Optimized Slating Tool (OST). The OST is a nonlinear mixed integer program that prioritized key readiness factors such as at-sea manning and critical face-to-face turnovers while staying within TRANSCOM's HHG move capacity. As a result, the OST directly supported NPC leadership and detailers with the optimal plan to resume the PCS of Sailors and their families once the stop-movement order was lifted.

Classification: UNCLASSIFIED
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56850 - From Model to Impact: Leveraging OLS to Inform and Mitigate Gender Pay Disparity

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Jose R Carreno; Amanda George; Kelly Sobon		

Abstract: Naval Information Warfare Center (NIWC) Pacific, an Echelon III command in the Department of the Navy, conducts frequent workforce analysis to ensure its hiring and retention efforts reflect the knowledge, skills, and diversity of talent necessary to deliver C4ISR, cyber, and space warfighting capabilities. As part of the focus on diversity, NIWC Pacific's Equal Employment

Opportunity (EEO) Office recently undertook an in-depth look at the representation of female employees in the overall workforce, utilizing an advanced barrier analysis framework.

In traditional barrier analysis, a trigger is identified, and then the data is compared to a common baseline or benchmark to determine if an anomaly exists in the representation of an identifiable group (gender, ethnicity, or other characteristic) of employees. NIWC Pacific built on the traditional model of barrier analysis by using statistical regression modeling to identify predictive factors in the workforce characteristics with respect to pay.

This presentation will detail the analysis model used to determine the significance of gender in salary determinations at NIWC Pacific, and how one department used this model to derive actionable insights. While data sensitivity issues preclude sharing specific findings, this case study highlights an analytical methodology that identified specific areas in need of attention, broke down assumptions, and helped avoid a "one-size fits all" remedy. Finally, presenters will share both the strengths and limitations of the approach, and share—at a general level—the impact of these findings on the department.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56577 - Machine Learning Methods to Predict United States Air Force Personnel Retention

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Maj Joseph Hoecherl		

Abstract: Establishing effective personnel management policies in the United States Air Force (USAF) requires methods to predict the number of USAF Personnel remaining in the US Air Force for different lengths of time in the future. Determining this type of survival rate is a prediction problem that can be formulated as either a binary classification or a classical regression problem, with benefits for both approaches. We examine several machine learning techniques for each approach, including linear regression, logistic regression, tree-based methods, K-nearest neighbors, and artificial neural networks. Both military personnel and econometric data are included with the feature set, enabling improved predictions during impactful economic and labor market trends. The performance of each technique is examined across a range of hyperparameter values, and the superlative model is chosen using a validation dataset. We compare results to a benchmark approach, the current USAF's Kaplan Meier model, and find a greater than 90% reduction in aggregate prediction error.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56933 - Optimized scheduling of constrained DoD resources: a MIP optimization implementation

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Matthew Liljenstolpe; Joe Litko, P.h.D.; Joseph E Schoenbeck		

Abstract: The Center Scheduling Optimization Module (CSOM) is a customized, deterministic optimization tool utilizing Mixed Integer Programming (MIP) that provides automated and efficient scheduling of constrained DoD resources for the Air Force. CSOM quickly builds a "90% solution" to maximize the utility of high-cost, low-density resources (e.g., weapons systems, ranges, airspace, etc.) CSOM is seamlessly integrated into a well-established and robust enterprise scheduling platform. It

utilizes commercial off-the-shelf (COTS) optimization software (Gurobi) as the solver engine within a Microsoft .Net environment and is currently authorized on a DoD network.

Complicated scheduling problems require a dedicated team of experienced scheduling practitioners to think tactically about executing each mission in the face of a complex set of interconnected resource conflicts and strategically to design the best overall schedule that safely optimizes quality throughput. Traditionally, complex scheduling problems are handled serially in a manual scheduling environment, which results from a human's inability to balance potentially millions of interconnected relationships simultaneously. This serial approach creates a recursive process whereby schedulers fix a conflict downstream and then must backtrack to discover the resource constraints subsequently broken upstream. Ultimately, this "two steps forward, one step back" process wastes valuable personnel time. More importantly, this results in inefficient utilization of our limited resources. Modern computer processing power, optimization software, and Operations Research (OR) practitioners can largely mitigate these inefficiencies. A computer-assisted scheduling tool, utilizing MIP, can simultaneously view the entire solution space and select the best solution from an impossible to visualize web of interconnected constraints. CSOM aims to ease scheduling teams' burden with a robust and optimal starting point produced in minutes versus multiple person-days. Thus, it enables the scheduling team to focus on improving quality and safety from a myriad of ever-changing, contextual, and unwritten rules.

A tool supported by a MIP structure has additional benefits: high-quality analysis of alternatives (AoA) as schedulers can iterate through multiple solutions with varying inputs and priorities; and sensitivity analysis from the strategic to tactical levels of scheduling. The potential for new scheduling tools built around modern OR methods that can deliver better utilization of our resources is enormous if implemented at the enterprise level. It is possible now; CSOM proves that. Adopted holistically, advanced resource management tools will enable our services to utilize their resources to a much higher level of efficiency.

Other applications of this methodology include constrained transportation networks, scheduled-maintenance schedules, and enterprise-wide force management.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56975 - Selection/Promotion Boards - Evaluating Performance

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Nicholas E Alvarez; David Hickman		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. The focus of this discussion is the evaluation of the promotion process. Without a method to evaluate board performance, it is unclear if the best fully qualified officers are being selected for promotion. Our team has developed a method to evaluate the degree to which selected officers' education, experience, and performance match the community scores that define "best fully qualified". Using decision analysis techniques, the team created a whole-person score for each promotion-eligible officer. This score was used to determine if the actual selection was the best available at that position across the cohort of eligible officers. Comparing the sum of the scores of selected officers to the sum of the scores of the best available officers may provide a meaningful metric to understand board performance.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

57024 - Understanding Sexual Assault in the Marine Corps: Using Data to Identify Risk Factors and Outcomes

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Adam Jatho		

Abstract: The Department of Defense "strives to advance a military culture free from sexual assault" and provide "commanders with improved means to assess and address risk factors in military units" (Department of Defense Fiscal Year 2019 Annual Report on Sexual Assault in the Military). The Marine Corps Directorate of Analytics and Performance Optimization (MCDAPO) is uniquely positioned to help tackle this problem by analyzing datasets from a wide variety of stakeholders across the Department of Defense, and collaborating with subject matter experts from Behavioral Programs Branch (Marine & Family Programs Division, Manpower and Reserve Affairs, USMC) and the Judge Advocate Division (USMC). By breaking down data and program silos, and linking anonymized records (via a hash/SALT algorithm) across diverse datasets, MCDAPO seeks to understand the risk factors and outcomes for both Marine subjects and victims of sexual assault. For this project, we de-identified and analyzed records from the Department of Defense (Defense Sexual Assault Incident Database (DSAID), various medical datasets, and Child Abuse and Spousal Abuse (CASA)) as well as service-level datasets (Total Force Data Warehouse (TFDW), Suicide Tracking and Reporting Tool (START), and Discrimination and Sexual Harassment (DASH)) in order to track Marine subjects and victims of sexual assault holistically. Although Sexual Assault remains an underreported problem in the Department of Defense (Department of Defense Fiscal Year 2019 Annual Report on Sexual Assault in the Military), our approach resulted in an analytic population of 2,110 unique Marine victims and 2,703 unique Marine subjects from FY14-FY20. The first research aim included examining demographic trends and overall characterization of the reports. Descriptive results indicate that the typical Marine victim is female, between the ages of 18-25, and an E-3 and below, with nearly 70% of the assaults taking place on a military installation, including shipboard. The typical subject is male, of equal or higher rank (compared to their victims), and shares the same Military Occupational Specialty (MOS) as the victim. The second research aim applied predictive modeling to compare career, medical, and legal outcomes of Marine subjects and victims to a matched sample. Results indicate victims of sexual assault are more likely to separate from the Marine Corps early, and experience negative health outcomes, compared to their peers. By identifying the factors of Marines involved in sexual assault, the Marine Corps seeks to provide the data-informed actionable recommendations to address this destructive problem.

Classification: UNCLASSIFIED
Working Group:WG 18 Manpower and Personnel

56490 - Improving Force Element Readiness Reporting Metrics

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Joseph F Adams; Mr. Jenns A. Robertson; Dr. Amy Alrich; Neil Mithal; Nigel Mease		

Abstract: The Department faces enduring readiness and availability challenges that hamper its ability to continue meeting today's global demands while preparing for unpredictable and complex challenges on the horizon. The purpose of this research was to review current Readiness Reporting Framework (R2F) Metrics, offer refined or alternative/additional metrics, and expand the current framework by recommending additional metrics that could broaden the visibility on readiness challenges. The initial evaluation of R2F materials prompted IDA to propose a definition of "metric"

which all stakeholders could agree upon. Following sponsor guidance, IDA conducted deep dive analyses on Army readiness, more specifically on Brigade Combat Teams (BCTs) and sampled battalions. In combination with a qualitative assessment of Commanders' remarks in the Defense Readiness Reporting System (DRRS), IDA utilized these analyses to identify the key processes and drivers that feed into Personnel (P), Equipment and Supply (S), Equipment Condition (R), and Training (T) values. IDA evaluated major force elements listed on the R2F templates for the Army, Marine Corps, and Air Force, and developed proposed metrics tied to the underlying processes that could flag negative or positive trends. The final deliverable evaluates each major force element's readiness reporting trends by P/S/R/T and includes IDA's proposed metrics and rationale. One notable observation is that upon closer analysis a number of reported training deficiencies were actually personnel deficiencies—personnel was the data-driven driver of the rating. This study would inform the MORS Manpower and Personnel Working Group on the current state of R2F metrics and any trends across 10 years spanning the major force elements of the Army, Marine Corps, and Air Force.

Classification: SECRET NOFORN
Working Group:WG 18 Manpower and Personnel

WG 19 Readiness

56599 - GAO's Work Monitoring DOD Readiness Recovery and its Assessment of Domain Readiness

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Christopher Watson; Nicole Volchko		

Abstract: The Fiscal Year 2019 NDAA directed GAO to report by Feb. 28, 2019 (and annually thereafter until 2022) on the readiness of the armed forces to conduct full spectrum operations in the ground, sea, air, space, and cyber domains in order to assess readiness changes over time. Congress believes that the military services should demonstrate measurable readiness recovery with current funding and additional appropriations. The NDAA also included a provision for GAO to evaluate the validity of DOD's readiness metrics; force structure; the ability of major operational units to conduct operations; and reasons for variance in readiness.
Our presentation will include an overview of GAO's body of work examining DOD's plans to rebuild readiness and a summary of the first domain readiness assessment:
Brief introduction of who GAO is and description of our body of readiness work
Brief scope and methodology, which includes a description of what sources GAO used for its readiness analyses
Description of DOD's readiness rebuilding framework
Description of DOD's readiness in the ground, sea, air, space, and cyber domains
Brief description of ongoing work looking at specific mission assessment areas

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56582 - End-to-end Readiness Models and Forecasting

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Vincent Lillard		

Abstract: Bottom-up emulations of real sustainment systems that explicitly model spares, personnel, operations, and maintenance are a powerful way to tie funding decisions to their impact on

readiness, but they are not widely used. The simulations require extensive data to properly model the complex and variable processes involved in a sustainment system, and the raw data used to populate the simulation are often scattered across multiple organizations or stovepiped data systems.   The Navy has mandated the construction of these models for all maritime and several aviation weapon systems and asked IDA to aid these efforts and investigate the strategic levers that drive readiness. Because of the complexity of the needed data, IDA built several R packages to aggregate and interpret Navy sustainment data using statistical techniques to create component-level metrics. A second R package ("stinger") uses these metrics to automatically generate the input tables necessary to construct the end-to-end simulations. In effect, IDA has lowered the barrier for entry for building these large sustainment models. We present a summary of these efforts and showcase some of the benefits of the approach, which enables senior decision makers to make better investment decisions to improve readiness.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56559 - Military Readiness Modeling: An Actionable Data Framework

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Connor S McLemore; Mr. Shaun Doheney; Dr. Sam Savage		

Abstract: Although the purpose of the Department of Defense (DoD) is accepted broadly to be "to provide ready and sustainable military forces to protect the nation's vital interests," the meaning of that statement is largely reliant upon the definition of the word "ready." Yet it is generally unclear what it means to be ready. Ready for what? How ready? By when? To address this problem, we recommend the DoD adopt a simple, interpretable, and actionable data framework that permits calculation of the probabilities of military readiness for specified missions at uncertain future times across unit types and military branches. It is based on the concept of auditable, stochastic scenario libraries long in use in financial engineering and the insurance industry. If implemented by the military, such a framework could allow mathematically coherent readiness estimates to better communicate "how ready for what" combinations of military assets are. Additional details can be found in our paper published in MOR Journal 2021 Vol. 26, #1, "Military Readiness Modeling: Changing the Question from 'Ready or Not?' to 'How Ready for What?'"

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56533 - Air Force VAULT Platform: Enabling Distributed Analysis and Data Driven Decisions

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Isaac Jerome Roberts, IV; Mark Bryant; Mr Derek John Eichin; Mr. Christopher Gillie		

Abstract: Before the VAULT Platform, building data analytic pipelines and creating data visualizations was a monumental 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. Fortunately for the AF enterprise, the VAULT Platform, hosted in AWS GovCloud up to the secret level, gives users access to over 50 authoritative AF data sources and the ability to extract, transform, and load their own data within a secure, cloud-based environment. The VAULT Platform equips airmen, space professionals, and civilians to complete a full life-cycle analytic use case with industry leading tools and resources. Data munging and analysis tasks are made easy

with Zeppelin, Databricks, and Trifacta which provide robust and scalable solutions at your fingertips. Combining the curated data sets and visualization tools already within the VAULT, tools which include Tableau, Plotly Dash, RShiny, and Neo4J, users are empowered to solve problems, create visualizations, and make solutions accessible to Senior Leaders and across the enterprise. With the help of the VAULT Platform, you and your teams are empowered to bring your data analysis into the 21st century.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56542 - Best Practices in Decision Analytic Presentations to Influence Action

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Erika Garcia-Boliou		
Abstract: As a data professional, it is imperative that when we communicate our findings, we not only do it in a lucid manner but also in a way that will influence action. Our analysis has more value when we can help organizations make decisions and more importantly, ACT on those decisions. Classification: UNCLASSIFIED Working Group:WG 19 Readiness		

56560 - Infectious Probability: A Novel Metric for COVID-19 Risk Analysis

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Ian Paul Kloo		
Abstract: The early days of the COVID-19 pandemic were marked by big decisions and tremendous uncertainty. As a member of the USMA COVID-19 analytic team, I started working on metrics and visualization methods to help leaders throughout the DoD enterprise make decisions in this difficult environment. This presentation will discuss the analytic approaches that we tried and describe how they led to a useful and novel metric called infectious probability. Additionally, I will discuss the tooling and overall data science methodology that drives the resulting decision tool: BigMap (https://iankloo.github.io/bigmap/). Classification: UNCLASSIFIED Working Group:WG 19 Readiness		

56632 - How Short is Too Short? Helping Senior Leaders Understand the Tradeoffs Involved in the Length of Unit Life Cycles for ReARMM

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Christine Krueger		
Abstract: Headquarters, Department of the Army G-3/5/7 recently asked the Center for Army Analysis (CAA) to help develop a new framework that will allow the Army to meet global operational requirements while providing predictability during training and future modernization efforts. This presentation will report on CAA's efforts to determine the best unit life cycle model to implement in the Regionally Aligned Readiness and Modernization Model (ReARMM). After 20 years of continuous combat deployments and increasing global operational requirements, the demands on the Army have reached a point that is unsustainable. GEN McConville acknowledged		

the operational tempo has placed undue strain on our Soldiers and asked leaders to consider deployments or mission rotations shorter than 9 months. Simultaneously, the Army is embarking on a modernization effort unparalleled since the "Big Five" (Apache AH-64 and UH-60 Black Hawk helicopters, M1 Abrams tank, Bradley Fighting Vehicle, and Patriot missile defense system) were fielded. To accomplish the aforementioned modernization while providing predictability for the force, the Army is in the process of implementing ReARMM, which will serve as the new unit life cycle model. While senior leaders quickly defined some basic business rules, they were unsure of what the ideal unit life cycle should be. How long should mission rotations be? What were the tradeoffs and risks associated with the various options? How short is too short? The ReARMM team at CAA created graphical visualizations to allow decision makers to see all the tradeoffs and risks associated with various options. Ultimately, the analysis facilitated debate and decisions as to which life cycle optimized the most important parameters.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56816 - Analytical Assessment Methods to Directly Measure Impact and Resilience of Mission Assurance

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Michael Darby		

Abstract: Idaho National Laboratory (INL) has developed a novel analytical assessment method to directly measure the impact and resilience of mission assurance. The resulting framework crosses over multiple organizations and enabling hardware, defines a direct metric to mission impact, develops logic-based algorithms integrated with the framework, creates an evaluation engine for identification of systematic failures, and integrates a dynamic time-based analysis capability. This methodology can be applied to any set of objectives that require any set of infrastructure support that needs to be resilient in some way, and as a case study, has been applied to the United States Air Force using a systematic approach to improve the Air Force's evaluation of mission assurance. This included objectives of 1) how to evaluate power outage impact to their important missions and 2) a method to value resilience in identifying and prioritizing solutions. The INL developed Mission Thread Analysis (MTA) approach, referred to as the Decomposition for Energy Assurance and Electrical Power Resiliency (DEEPR) process, was reported on in the 2020 MORS conference. Since last year, the INL has advanced the technical approach and supporting modeling effort to expand the analysis of dependencies beyond power by integrating the DEEPR process with an All-Hazard Analysis (AHA) GIS-based toolset that incorporates the interdependencies of utilities and services beyond the installation fence. The combined GIS-based modeling approach also incorporated automated threat and environmental analysis, enabling multiple mission threads at multiple location analyses. The developed simulation capability provides analyses of threat scenarios over time and includes impacts of supply disruptions. Additional work in progress includes using the integrated AHA analytical toolset with black out exercises at various Air Force base locations to produce observation-based validated relationships in the model. The results of threat-informed scenarios may drive evaluations to define readiness COAs and investment needs to improve mission resilience.
This presentation will provide an update on the MTA approach and advantages to integrating with the AHA tool. Show generalized results of additional threat-based scenarios using GIS data and how the AHA tool can be integrated with black out exercises to assess how and where alternatives

| Classification: UNCLASSIFIED |
| Working Group:WG 19 Readiness |

56901 - Towards a Standardized Computable Semantic Framework for Both Blue Force and Red Force Analysis

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. William Mandrick; Dr. Forrest Hare; Ian Featherstone		

Abstract: Semantics is the branch of linguistics and logic concerned with the cognitive structure of meaning, sense, reference, implication, and logical form. We argue here that the semantics used to describe the operational readiness (i.e. equipment status and training levels) of Red Forces are interchangeable with the semantics used to describe Blue Forces. Furthermore, the semantic elements required for distinguishing red objects from blue (or gray) objects are negligible for most readiness modeling efforts. This means that discoveries in AI and NLP made in the intelligence domain (i.e. focused upon Red Forces) can be applied to domains such as Blue Force Tracking and Global Force Management. We assume the Computational Theory of Mind (CTM) whereby the classes (types) of objects, how they are defined, and the logical relationships between them comprise the cognitive structure used by intelligence analysts and computers to reason about objects moving in space and time, their functions, and the ability to execute the functions. In what follows we will describe and graphically depict how the semantics used to reason about both Red and Blue Forces is essentially the same, and what this might mean for modeling across DoD Enterprise for readiness level understanding and correlation.

Joint Publication 1 defines Operational Readiness (OR) as the capability of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it is organized or designed. OR is determined by analyzing unit configurations, manpower, training, equipment availability and maintenance levels. For example, it is helpful to analyze the composition of a ground force (military unit), the vehicles it controls, and the training exercises that it participates in. Furthermore, military vehicles serve as platforms for various weapons, sensors, and communications devices with distinct functions and capabilities, which can be assessed in terms of their performance, effectiveness, and range.

In order to establish a set of standardized computable assertions for OR that would apply to both Blue Forces and Red Forces, we propose building a computable OR ontology built around the following classes:

Ground Force (such as an Airborne Regiment or Brigade Combat Team)

Combat Vehicle (such as a Russian BMD or U.S. Stryker)

Weapon (such as a 2A70 100 mm cannon or A M1128 105 mm cannon)

Military Exercise (such as a Live Fire Exercise)

With the classes, individuals, and logic curated into a web ontology language and data exchange format called OWL-RDF, any computer can derive meaning from data coming from military units, their vehicles, or sensors, and render knowledge graphs.

Keywords: Semantics, First Order Logic, Computational Theory of Mind (CTM), Web Ontology Language (owl), Operational Readiness

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56552 - The Impact of Full-time Support on Training Readiness

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Julie Lockwood; Dr. John "Jay" Dennis; Mr. George Prugh; Mr. Nathaniel Cleaves; Dr. Cullen Alexander Roberts; Dawnn Burroughs		

Abstract: Abstract: Full-time support (FTS), or Title 32 Active Guard Reserve and Active Duty Operational Support personnel, perform days-to-day operations necessary for producing Army National Guard individual and unit readiness. We estimate a structural model to determine the impact of additional FTS counts and experience on company-level collective training. In our model, latent training output determines many different training-related outcomes. These training-related outcomes include third-party assessment of unit performance in X-Combat Training Center (XCTC) training tasks, completion of Training and Evaluation Outlines, timely utilization of the Defense Training Management System, ammunition utilization (as a proxy for successful scheduling of time at ranges), and individual, crew, and weapons qualifications. The structural model supports counterfactual predictions, which can be leveraged to more efficiently allocate personnel resources. Results are forthcoming.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56549 - Quantifying the Impact of Maintenance Manpower on Helicopter Readiness in the Army National Guard

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Michael Guggisberg; Nathanial Latshaw; Dr. Julie Lockwood; Dawnn Burroughs		

Abstract: We quantify the relationship between maintenance manpower investments and H-60 helicopter readiness in the Army National Guard (ARNG). Using causal econometric methods, IDA researchers find that increasing the number of military technician (MilTech) mechanics at ARNG Army aviation support facilities (AASFs) of all sizes reduces helicopter maintenance timelines to a statistically significant extent. Grouping faults into contiguous "fault spell" downtime events, we estimate that an additional MilTech mechanic decreases average fault spell duration by 0.7% to 1.1% (depending on baseline MilTech staffing levels). Downtime reductions were greatest for maintenance facilities with fewer initial MilTech mechanics. These downtime reductions accumulate over ARNG H-60 NMC resolution maintenance at the AASF level. We estimate that the addition of a single MilTech mechanic to each ARNG AASF would produce 23 to 30 additional mission capable (MC) hours per H-60 helicopter, or 3.2 additional ready helicopter years across the ARNG's fiscal year 2019 H-60 fleet. These results can provide targeted readiness-enhancing staffing recommendations appropriate for a resource constrained environment by informing placement of additional MilTech mechanics. Per additional ready H-60 helicopter year, we found that additional MilTech manpower is a more cost-effective way to improve readiness than borrowing or buying additional UH-60M Black Hawks.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

55364 - Optimising long-term management of a military aircraft fleet up to life-of-type

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr David O'Halloran Marlow; Dr. Robert Franklin Dell		

Abstract: Fleet planners and managers of military aircraft fleets have many competing priorities. This results in a difficult balancing act between meeting short-term immediate tasking needs and long-

term management. If short-term needs always take precedence, it is likely that the fleet will be unable to meet those same needs when they arise several years into the future. This is particularly important in appropriately managing the fleet to retirement, such that aircraft are neither over-utilised (forcing them to retire before the rest of the fleet) or under-utilised (retiring them with unused flying hours). The financial consequences of sub-optimal choices can be tens of millions of dollars per fleet (Newcamp et al., 2019).

We present a mixed integer-linear program (MIP) for optimal management of a fleet over a multiple-year time horizon, up to life-of-type. The model can be run at various timescales with various time steps depending on the scenario. It can cater for a single objective or multiple objectives, or be treated as a heuristic, solved iteratively in descending order of objective term priority. The model generates decisions such as which aircraft to deploy, when to induct aircraft into depot maintenance within an induction window (for either elapsed time-based or flying hours-based intervals), and how to fly aircraft in order to both meet ongoing fleet and squadron requirements, and reach retirement targets. We demonstrate the model's capability with some examples, e.g., scheduling a major modification program to best meet availability targets.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56541 - Spares Modeling with ARIMA Forecasting

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Erika Garcia-Boliou		
Abstract: Spares modeling is sometimes left to Consumer off-the-shelf (COTS) software when it is better done in-house. An Auto-Regressive Integrated Moving Average (ARIMA) forecast was used to better calculate spares and the forecast was imported into an Excel dashboard for analysis. Classification: UNCLASSIFIED Working Group:WG 19 Readiness		

56523 - Predictive Aircraft Maintenance: Detecting Imminent Part Failure with Advanced Ensemble Learning Methods

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Joshua Couse		
Abstract: Predictive maintenance has the potential to revolutionize Air Force operations. With a fleet of thousands of old and new aircraft, the Air Force spends nearly $50 billion dollars annually on operating costs and maintenance. Meanwhile mission capable (MC) rates decline as aging aircraft push well beyond their intended service dates. Deteriorating MC rates have become a rising concern among DoD leadership as the U.S. must innovate and modernize our force to meet today's challenges. Mission ready warfighters are key to the Air Force's ability to meet any adversary, anytime, anywhere. In collaboration with MIT Lincoln Laboratory, our team looked to advance predictive maintenance capabilities through a study on the C-5 Galaxy. By developing data-cleaning and feature generations pipelines, we transformed over three million records of maintenance events into a machine learning ready dataset. Through the application of survival analysis via Cox regression and advanced ensemble learning algorithms we were able to develop a classification model that preemptively detects over 2,500 failures of the C-5's main landing gear. Our model demonstrates the potential to deliver an		

additional 500 flights hours to the warfighter per year of operations, providing key capabilities to meet the growing challenges of tomorrow.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56570 - Improving The Digital Aviation Readiness Technology Engine with Temporal Pattern Attention Mechanisms and Hyper-Deep Ensembles

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Benjamin Michlin		

Abstract: The Digital Aviation Readiness Technology Engine (DARTE) provides unprecedented predictive readiness capabilities for the Naval FA-18 fleet. DARTE focuses on discovering actionable insights in relation to predicting two key readiness metrics: the number of mission capable (MC) aircraft and flight hours. Recent DARTE improvements are particularly noteworthy, including the adoption of cutting edge AI and deep learning techniques such as temporal pattern attention mechanism enhanced long short-term memory (LSTMA) networks, hyper-deep ensembles for enhanced performance, and improved uncertainty estimation and robustness. Hyper-deep ensembles and attention mechanisms have been shown to provide state-of-the art results in industry and academia. Furthermore, their improved uncertainty estimation provides decision makers with an increased level of confidence that allows for better, smarter decisions.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56612 - Understanding and Predicting the Future Cost of Readiness for an Aging Naval FA-18 Fleet

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jazlynn Wied; Dr Jamal Tildon Rorie		

Abstract: Recent budget constraints require the Naval Aviation Enterprise to maximize readiness while minimizing cost. We propose a data-driven approach to help decision-makers identify which aircraft are the most expensive to keep in a mission capable (MC) state and what factors affect this cost. An AI/ML model is developed as an extension to the Digital Aviation Readiness Technology Engine (DARTE) family of models to determine the factors that lead to a high average cost per day of MC for an aircraft in the Naval FA-18 fleet. This model then predicts if the average cost per day of MC will be above a fixed cost threshold in the future. Various model architectures are explored, including tree-based ensemble methods and long short-term memory (LSTM) networks. These models are trained on a combination of traditional readiness datasets (manning, training, equipping) and financial datasets. The resulting models are then examined with explainable artificial intelligence (XAI) techniques to obtain a rigorous and comprehensive feature importance which may be used to determine past and predict future aircraft status.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

55321 - Bomber Pilot Scheduling Simulation

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: Mr Derek John Eichin; Mark Bryant; Mr. Christopher Gillie; Mr. Isaac Jerome Roberts, IV
Abstract: Like many organizations across the Air Force, the 7th Bomber Wing (BW) has to balance training currency or total sortie needs against the maintenance requirements and economic useful life of their aircraft. With the added pressure of losing operational aircraft to the boneyard or extended depot activities, the 7th BW needs to optimize how it schedules sorties and manages aircrews. In practice, the 7th BW requires the ability to review how certain decisions one month may affect mission readiness and aircraft availability the following months. The goal of this project is to provide the 7th BW with a data driven, web-based application capable of handing the pilot training and flight time requirements of each squadron along with the available aircraft to provide optimal flight schedules. The long-term goal of the model is to utilize historical data and user input to simulate how various decisions will affect the mission readiness of the entire wing. Classification: UNCLASSIFIED Working Group:WG 19 Readiness

56745 - CSAF tasking: Estimate Impact of COVID-19 on Aircraft Availability

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Greg H. Gehret		
Abstract: At the start of the pandemic, CSAF asked the A4 community to estimate the impact that COVID-19 might have on AF readiness. HAF/A4 reached out to AFMC, and we used simulation to perform a cause-based forecast of Aircraft Availability (AA) for the next 6 months for 13 major AF fleets. COVID-19 and its implications to perturbations in the Working Capital Fund had a small but measureable impact to AA that varied across the 13 fleets. Also of note, because the underlying inputs to the simulation were cause-based time elements, the simulation can be used to forecast AA for any time-based disruptions, including funding, manpower, and Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE). Our presentation will discuss why we used simulation, how we established cause-based inputs, the feedback we received during the briefing cycle (which included all AF MAJCOM A4s), and possible use of the simulation for other "What If" scenarios. Classification: UNCLASSIFIED Working Group:WG 19 Readiness		

56922 - Dynamic Sortie Schedule Probabilistic Risk Model

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr. Philip Alan Fahringer		
Abstract: A constant challenge for military operational planners is to forecast how many aircraft sorties they will be able to execute over the next several days to a week. The problem is that there are numerous factors that influence how many aircraft will be available at any point during the week and ready to conduct a sortie. These factors include, how many aircraft are in the squadron, how many sorties they are scheduled to fly on any given day, how frequently a sortie results in a maintenance requirement, and how long the maintenance takes. Standard practice is to estimate these factors with averages and then compute the average number of aircraft likely to be available and then schedule sorties accordingly. The result is that due to the random nature of the underlying factors schedules often have to be redone on a daily basis to adjust to the actual number of aircraft ready. This creates a continuous burden on planners and pilots, sometimes having to cancel expected		

sorties when a below average number of aircraft are available, and sometimes having to try and fly additional sorties when an above average number of aircraft are available.

This presentation will demonstrate a Monte Carlo simulation approach to computing a specific probabilistic risk for a given number of aircraft being ready at any point during a week, thereby allowing military planners to determine how much risk there is in any given sortie schedule. Additionally, the approach demonstrated will enable instantaneous adjustments to key input assumptions to evaluate the impact on schedule risk. The model demonstrated will be available to all participants.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56600 - Aircraft Mission Capable Rates Generally Do Not Meet Goals and Cost of Sustaining Selected Weapon Systems Varies Widely

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Nicole Volchko; Christopher Watson		

Abstract: This presentation provides observations on mission capable rates and costs to operate and sustain 46 fixed- and rotary-wing aircraft in the Departments of the Army, Navy, and Air Force.
The Department of Defense (DOD) spends tens of billions of dollars annually to sustain its weapon systems in an effort to ensure that these systems are available to simultaneously support today's military operations and maintain the capability to meet future defense requirements. One measure of the health and readiness of a military aircraft fleet is the mission capable rate—the percentage of total time aircraft can fly and perform at least one mission.
GAO examined whether 46 types of aircraft met their annual mission capable goals for FYs 2011-2019, and we found:
3 met their goals in a majority of the years
24 did not meet their goals in any year
GAO also reviewed annual operating and support costs for these aircraft, such as maintenance costs. These costs totaled over $49 billion in FY 2018, ranging from $118 million for the Navy's KC-130T Hercules to $4.2 billion for the Air Force's KC-135 Stratotanker.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56488 - Improving Force Element Readiness Reporting Metrics

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Joseph F Adams; Mr. Jenns A. Robertson; Dr. Amy Alrich; Neil Mithal; Nigel Mease		

Abstract: The Department faces enduring readiness and availability challenges that hamper its ability to continue meeting today's global demands while preparing for unpredictable and complex challenges on the horizon. The purpose of this research was to review current Readiness Reporting Framework (R2F) Metrics, offer refined or alternative/additional metrics, and expand the current framework by recommending additional metrics that could broaden the visibility on readiness challenges. The initial evaluation of R2F materials prompted IDA to propose a definition of "metric" which all stakeholders could agree upon. Following sponsor guidance, IDA conducted deep dive analyses on Army readiness, more specifically on Brigade Combat Teams (BCTs) and sampled battalions. In combination with a qualitative assessment of Commanders' remarks in the Defense

Readiness Reporting System (DRRS), IDA utilized these analyses to identify the key processes and drivers that feed into Personnel (P), Equipment and Supply (S), Equipment Condition (R), and Training (T) values. IDA evaluated major force elements listed on the R2F templates for the Army, Marine Corps, and Air Force, and developed proposed metrics tied to the underlying processes that could flag negative or positive trends. The final deliverable evaluates each major force element's readiness reporting trends by P/S/R/T and includes IDA's proposed metrics and rationale. One notable observation is that upon closer analysis a number of reported training deficiencies were actually personnel deficiencies—personnel was the data-driven driver of the rating. This study would inform the MORS Readiness Working Group on the current state of R2F metrics and any trends across 10 years spanning the major force elements of the Army, Marine Corps, and Air Force.

Classification: SECRET NOFORN
Working Group:WG 19 Readiness

56707 - Modeling Full Mobilization

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET

Authors: Mr. Jeffrey Demarest; Erica Dretzka

Abstract: Mobilization is an extremely complex composition of interdependent sub-processes, each of which bears its own complexity. As stated in Joint Publication 4-05, Joint Mobilization Planning, mobilization is the process of assembling and organizing national resources to support national objectives in time of war or other emergencies. Furthermore, mobilization requires the assembly and organization of resources in twelve interdependent resource areas (legal authorities, funding, environment, manpower, materiel and equipment, transportation, facilities, industrial base, training base, joint health services, communications, and HNS). These interdependent sub-processes must be able to satisfy any of an undetermined number of objectives, meaning that the resource requirements, processes, and constraints are changeable.

The United States Military Academy's (USMA) Operations Research Center (ORCEN) and the USD(Personnel & Readiness) (P&R) are building a single, data-driven and Services-informed DoD (Services-informed) decision support model. The ORCEN will incorporate the mobilization processes from each Service into a discrete event simulation (DES) to model the flow of units, personnel, and equipment from home station to ready-to-load.
The model will be neutral to any specific demand signal, i.e., Operational Plan (OPLAN). Rather, it will be built so that demand will be flexible to any users' needs at any given time. This means that it will incorporate an agglomeration of demand signals such as OPLANs, subject matter expert (SME) inputs, and historical data. It is an OSD tool to quantitatively support decision making by exposing the demand on both the Reserve Components (RC) and Active Components (AC) in light of internal and external considerations.

Some key outputs include:
- DES's state-based modeling approach will allow for an in-depth analysis of resource requirements over time.
- The model will be the foundational version what is planned to be a multi-stage (DES) exploring the feasible flow of resources agnostic to demand signal. The base scenario will be a full mobilization, doctrinally defined in JP4-05 to include all existing Active and/or Reserve forces but not including force expansion or industrial base activation.

- Resources and locations within the simulation will have upper and lower bounds allowing decision makers to understand the effects of process bottlenecks and capacity constraints on entities' flow and time in system. - Senior leaders will be able to simulate the feasibility of fulfilling demand signals (e.g., operational plan, National Defense Strategy) Classification: SECRET NOFORN Working Group:WG 19 Readiness

56673 - Understanding the Impact of Assumptions on Combatant Command OPLANs

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: LTC James R Enos; Erica Dretzka; LTC Scott Geer; Mr. George Landis		
Abstract: (U) Each of the Combatant Commands (COCOMs) maintains several operational plans (OPLANs) in preparation for potential contingency plans within their Area of Responsibility (AOR). A critical element of these OPLANs is the Time Phased Force Deployment Data (TPFDD) which outlines the specific units and dates associated with the deployment in support of the OPLAN. However, several assumptions go into developing the TPFDD including the assumption that there will be sufficient notification prior to the operation commencing on C Day. (U) The model in this presentation examines the impact of a no-notice execution of an OPLAN on the associated TPFDD to identify constraints and risk to the mission success based on the alert, mobilization, and deployment of forces. The model incorporates unit demand for the OPLAN from the TPFDD, mobilization timelines for both active and reserve component forces, historic readiness data, and Mobilization Force Generation Installation (MFGI) throughput. The demand module incorporates several dates from the TPFDD to include the Commander's Required Date (CRD), Earliest Arrival Date (EAD), and Ready to Load Date (RLD). As the model does not focus on the transportation aspects of the deployment, the RLD is the primary date for analysis. The supply module includes all required units for the OPLAN from all components, just over 6000 individual units, at various levels from teams to battalions. The supply module uses historic readiness rates to project a future readiness for each individual unit which drives requirements for mobilization, training, and equipping prior to deployment. The model also includes a basic throughput module for each of the three types of MFGIs, individual, combat aviation brigades, and brigade combat teams. The model then combines the output of these modules to determine the number days late for each unit type. It also includes several variable adjustments to test different hypotheses and model potential outcomes. The findings and conclusion from this work are included in the classified portion of this presentation. Some key outputs include: - (U) Assessment of demand by unit for a given TPFDD; - (U) Model of individual unit readiness given historic readiness rates; - (U) Model of throughput at MFGIs for the duration of the operation; - (U) Model of throughput at APODs and SPODs for a given TPFDD; and - (U) Assessment of number of unit-days late given a no-notice deployment. Classification: SECRET NOFORN Working Group:WG 19 Readiness		

56743 - Assessing the Red in Readiness

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Kristen Ryan, PhD

Abstract: Is Blue readiness tied to countering or exploiting Red readiness? Do we have an understanding of the adversary capabilities and readiness that enables the United States to focus limited resources to gain and maintain competitive advantage at the operational level? The objective of this study is to develop a methodology for assessing adversary capabilities and readiness and translating that information into mission requirements for U.S. forces. This study reviews net assessment methodologies and intelligence collection priorities, along with existing collected data, to develop a repeatable and continuous method for assessing Red capabilities and translating those capabilities into Blue mission requirements and/or readiness assessments. The study team maps extant Blue operational- and strategic-level training programs to Red capabilities to assess if training sufficiently addresses the threat. A Blue counter-unmanned aerial system (UAS) mission against a Red UAS mission is used as a case study. Blue counter-UAS training and standards for the U.S. Army are analyzed against representative Red capabilities and tactics to identify where there might be gaps in Blue standards that would merit updates or added specificity if informed by known Red capabilities and tactics. The goal of this analysis is to enable a more nuanced, adversary-specific assessment of Blue readiness.

Classification: SECRET//REL TO FVEY
Working Group:WG 19 Readiness

56644 - Medical Correlates of Early Attrition in U.S. Navy Personnel

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Mr. Trevor Alan Elkins; LCDR Andrew MacGregor; Andrew Olson

Abstract: The Naval Health Research Center (NHRC) mission is to conduct health and medical research, to develop, test, and evaluate medical preparedness, and to continue surveillance to enhance deployment readiness of Department of Defense personnel worldwide. Accordingly, NHRC was tasked with performing an analysis of early attrition, defined as a discharge within three years of accession. A recent RAND report found that nearly one in four U.S. Navy accessions experienced early attrition, which causes significant personnel and financial cost while negatively impacting military readiness. The objective of the present study was to identify medical correlates of early attrition using data from the Military Health System Medical Data Repository (MDR) and the Disability Evaluation System. All U.S. Navy enlisted personnel between the years 2003-2018 with early (n=100,679) and regular (n=203,084) attrition were identified from administrative records and comprised the study population. When examining hospitalizations and outpatient medical encounters from MDR, those with early relative to regular attrition had a higher percentage of morbidity related to mental health conditions (i.e., adjustment disorders, mood disorders, and alcohol-related disorders). In a subset analysis among those receiving a medical discharge, those with early attrition had a higher percentage of disability related to degenerative arthritis and tibia/fibula impairment. Mental and physical factors related to early attrition require further examination, particularly whether pre-enlistment screening could lead to early identification and mitigation strategies. Future research should extend this analysis to other services and examine key population subgroups (e.g., women in newly integrated occupations).

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56602 - Data Analysis for the USCG Body Composition Policy

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mrs. Morgan T Holden		

Abstract: In 2018, the USCG contracted RAND to complete a Women's Retention Study and Holistic Analysis. That study identified an existing policy resulting in inequitable outcomes based on gender. This imbalance in body composition standards ultimately disproportionately impacted women at a rate three times higher than men. Following the completion of that study, the USCG instituted a Body Composition Pilot Program that offers additional opportunities for active duty and reserve members to demonstrate compliance with Coast Guard readiness standards including a new abdominal circumference, fitness test, and also better connects medical professionals to the health assessment. During the pilot program period, the Coast Guard collected data to make future policy decisions that improve the personal readiness of our workforce. This MORS presentation will focus on the methods for retrieving, analyzing, and presenting the body composition data that ultimately led to body composition policy changes in the Coast Guard and the shortfalls we continue to see in our data collection methods.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

56518 - A Multi-criteria Optimization Based Tool For Active Component Army Enlisted Assignments

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: MAJ Matthew Ferguson		

Abstract: A multicritera optimization formulation is developed to inform the assignment of Army enlisted personnel. A pre-emptive goal program provides a sufficient model that meets decision-maker values with respect to assignment criteria, Army readiness requirements, and expressed Soldier preferences.

An additional model use case is identified as developing enlisted markets with respect identification and scoping of requirements given to Soldiers to preference, as well as identifying market gaps that require intervention. A minimum-deviation goal program is used to both select requisitions and identify the need for new-build requisitions based upon demographic information of projected market participants.

An internal facing web-based interface is developed for assignment-managers, allowing for assignment-manager driven modifications to address assignment criteria exceptions as well as incorporate requirements requiring qualitative human assessment. The result is a "live" interactive optimization capability to better inform the Army's active component enlisted assignment process.

Classification: UNCLASSIFIED
Working Group:WG 19 Readiness

WG 20 Analytic Support to Training and Education

56973 - Overcoming Analytic Friction to Streamline Decision Making

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Kierra Shay; SIDI ZEID CHLEUH; Jamie Conti		

Abstract: In the Department of Defense's endeavor to adopt data driven practices, analytic friction emerged as a side effect of disparate development efforts. Though the theory of friction in business is not new, we will focus on the reduction of analytic friction. We define analytic friction as difficulty in identifying and navigating available and validated analytical products.

Analytical products include descriptive metrics and predictive models. Symptoms of analytic friction include duplicative datasets, incongruent products, and non-repeatable analysis.

Each analytical product is a well thought out story - a repository of domain specific use cases materialized. Developing an interface to navigate these well-defined products is analogous to connecting the use cases and processes they represent. Our interface is a roadmap for the user highlighting multiple paths to answers utilizing products with which they may not be familiar.

By developing with all users in mind, our interface reduces the friction of performing day-to-day and ad-hoc analysis while also introducing users to a wider toolset. The interface is customizable and scalable to meet fleet, program, and enterprise decision making needs in support of the DoD's transition to a data centric organization.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

57044 - Synthetic Training Environment--Live Training Systems (STE-LTS) Framing Analysis

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: David Freeman		

Abstract: The main component of the programmed live training capability is the Instrumentable-Multiple Integrated Laser Engagement System (I-MILES). I-MILES, with its current live training capabilities, replicates the firing capabilities (primarily direct fire) and the vulnerability of dismounted troops, tactical vehicles, and combat vehicles. While I-MILES, with its current training capabilities, contains some documented gaps, new operational capabilities and concepts associated with Army modernization and a shift to Multi-Domain Operations (MDO) have amplified those shortcomings, in addition to revealing gaps projected from emerging shortfalls.

At the request of the Combined Arms Center-Training, TRAC executed a framing analysis to support the development of an Abbreviated Capabilities Development Document (A-CDD) and refinement of a strategy for initial acquisition of an improvement to I-MILES. The framing analysis was executed in three phases. First, the team led an effort to identify and refine projected capability gaps for the programmed live training capabilities in MDO training for a peer/near-peer adversary in the 2028 and beyond timeframe. Following the identification of those gaps, senior warfighters assessed the severity of those gaps and further adjudicated the anticipated mitigation the proposed future live training concept, STE-LTS, would provide to meeting future live training requirements. Next, the Army Combat Capabilities Development Command Data and Analysis Center reviewed multiple categorical acquisition approaches, and supported efforts to identify key technologies, identify maturity of those key technologies, and an estimated timeline to reach TRL6 as well as some of the development timeline sensitivities (system requirements, RDT&E funding, etc.). Lastly, a cost team identified likely cost drivers within each of the acquisition approaches. This analysis provided key necessary information to senior Army leaders to inform near-term and ongoing efforts.

This presentation will primarily focus on the first line of effort of the project, the capability gap analysis, and will provide an overview of the methodology, some of the unique challenges of executing analysis during COVID, and the lessons learned from the effort.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

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56608 - Training Responses to Cyber Attacks in a Perception-Based Campaign Model

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: Mr. Charles D Burdick; Dr. Deepinder Sidhu

Abstract: The Persistent Cyber Training Environment (PCTE) will allow us to expand the number of cyber trainees and the amount of time they have in a cyber training environment, but these will generally employ notional networks unlike the actual networks the trainees will be assigned to defend. However, the opportunity now exists to obtain better cyber effects data by collecting from exercises on low-cost digital twins of specific physical networks.
Also, most campaign level combat models allow an analyst to simply "twist a knob" to dial in a cyber effect, such as reduced kinetic lethality But in the Joint Analysis System (JAS), a government-owned, perception-based Campaign model used by JFCOM J9 to conduct simulation-supported wargaming, all information transited over simulated networks and a network disruption caused the delay or loss of specific information, which then impacted subsequent operations.
For the J9 wargames, whenever they paused JAS, human decisions-makers could replace selected simulation agents. The humans were provided the same computer-generated status reports as the agents, observed the same map-based Common Operational Picture (COP), and then made the best decisions they could, based on the information actually available, not ground truth.
The authors propose employing these new network emulations using specific virtual hardware and internet software that are now available and using them to rapidly create low-cost, full fidelity network digital twins of operational networks. These emulated networks and their defensive tools can reside on everything from small computer equipment to the cloud and can record all the actions of both attacking and defending cyber teams. They thus generate credible data for the length of time for successful detection and defense or, if an attack succeeds, the likely time needed for restoration of specific operational networks by teams proficient in their defense.
Meanwhile, the simulation-supported wargame provides all types of kinetic and nonkinetic C2 attacks, not just cyber, and reports on the damage caused. But only the White team knows the full extent of the information lost. The wargamers can survey the disruptions and employ a wide range of available measures such as alternative communications paths to restore effective C2. The effectiveness of these measures including a cyber response is the degree of mission accomplishment. The combination of credible cyber data linked to specific networks in a wargame along with a "whole of staff" response to C2 disruptions should significantly improve our understanding of the value of training cyber personnel oriented on their assigned networks, while the entire unit staff employs responses to simultaneous kinetic attacks on their C2 infrastructure and addresses nonkinetic EW and deception impacts.
Our presentation describes this combination in more detail and the authors believe its employment would greatly improve our ability to defend our C4ISR systems.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

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56716 - "Adapting to Uncertainty- Surviving and Thriving in the COVID Virtual Learning Environment"

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Torri Preston; Peter Braxton; Ryan Horn; John Titus		

Abstract: Major world events are often an inflection point for rapid innovation – a clear example is the sudden shift away from in-person education in many parts of the globe due to the COVID-19 pandemic. What has been made clear through this pandemic is the significance of propagating knowledge across borders, businesses, bureaus and all parts of society. As a result, education has changed dramatically, with the distinctive rise of distance learning, whereby teaching is undertaken remotely and on digital platforms. Since online learning technology is playing a vital role in its execution, it is incumbent upon all of us to explore its full potential, assess its effectiveness, and encourage its innovation.

Whether it is virtual tutoring, video conferencing tools, or online learning software, there has been a significant surge in usage since COVID-19 and the survivability of the ADDIE model is up for debate. This presentation will explicate on the lessons learned, benefits, and deficits of online learning. Furthermore, it elaborates on the need for a concerted effort to provide structure that goes beyond duplicating a physical class/lecture through video capabilities, but instead, using an array of collaboration tools that enhance engagement, exploration, explanation, elaboration and evaluation (5 Es).

While the armed forces are inextricably a part of American society, has it performed better or worse relative to the civilian population? This presentation further explores the effectiveness of the U.S. military's abilities to maintain high-level training exercises, deployments, and readiness and how its ability to adapt compares to other civilian institutions as the incorporation of e-learning trends towards becoming the 'new normal.'

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

56596 - A Flexible Method for Scoring Pilot Training Performance using Time Series Data

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: James Stockton, PhD		

Abstract: Objective quantitative measures of performance at a task are the basis of repeatable evaluation and are the foundation of any follow-on predictive analyses. Altamira data scientists on contract with the Air Force's Chief Data Office (SAF/CO) have developed a flexible method for constructing these necessary performance metrics for tasks that can be captured by multiple time series data channels. Given many instances of expert performance at a task, it is possible to construct an idealized task example that determines the experts' average behavior and, importantly, encodes the allowable variability exhibited by those experts. The resulting multi-dimensional construction enables scoring performances of the task on a quantitative, objective, and repeatable scale. This methodology was initially developed for scoring student flight maneuvers in Pilot Training Next (PTN) virtual reality simulators, but could be applied in any domain where the relevant data is collected over time during the task.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

56995 - Community Performance, Experience, and Education Benchmarks - To Inform Officers and Mentors as They Make Career Management Decisions

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: David Hickman; Nicholas E Alvarez		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. Officer development is a function of career assignments. Knowing what assignment to take, and when, is a challenge. Mentors know what made them successful – but not necessarily what will make their mentees successful. One solution is to provide a body of knowledge to officers and mentors to help inform their decisions. In this discussion we propose how decision analysis and data visualization can inform officers of how their performance, experience, and education compares to community benchmarks. Using decision analysis techniques, the team has produced a value model of the desired officer characteristics at the next grade – and used that model to calculate a composite (whole person) score for each officer. Calculating, then publishing the population distributions of the elements that make up the composite score enable each officer and mentor to compare an officer's performance, experience, and education to the community benchmarks – identifying officer strengths and weaknesses. The goal is for officers and mentors to use these tools to improve the quality of assignment decisions.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

56806 - Defining Air Force Digital Literacy

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Patrick Rolwes; Laura Barron		

Abstract: The Air Force Foundational Competencies represent competencies that all Airmen, across career fields and ranks/grades, need to perform successfully in their careers. Based upon the growing importance of digital technologies, digital literacy was evaluated as a potential addition to Air Force Foundational Competency. Digital literacy needed to be defined, and an assessment to evaluate proficiency in the competency developed and validated. In addition, the importance of digital literacy for Airmen in their jobs needed to be established Two surveys were developed and administered. Items for the digital literacy surveys were taken from the research literature on digital literacy and the DoD Cyber Awareness Training. In the first survey, 2,748 Airmen rated the importance of each of the digital literacy items in their current positions, as well as the overall importance of digital literacy, relative to other foundational competencies. In the second survey, 1,894 supervisors were asked to consider 2 airmen they had known, one with high potential and another with low potential, and rate to what extent they each exhibited each of the digital literacy behaviors. The survey results allowed for analysis of which behaviors were the best differentiators of high and low performance. Survey results indicated that digital literacy is considered an important competency and all subcomptencies of digital literacy had behaviors that were rated as highly important in current Airmen's jobs. In addition, digital literacy behaviors associated with digital exploration and critical evaluation of information were considered significant differentiators of career success. The proposed digital literacy competency definition was adjusted based on survey results, and a 3-item scale of digital literacy was developed based on the combination of subcompetency importance and differentiating capability.

Classification: UNCLASSIFIED		
Working Group:WG 20 Analytic Support to Training and Education		

55338 - Generation of Visual Scenarios for Use in Operator Training

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Thomas Reed Willemain		

Abstract: Generation of Visual Scenarios for Use in Operator Training
Thomas R. Willemain

Operator training is enhanced by exposure to scenarios depicting real-world data streams. Properly tuned time series bootstraps can create univariate and multivariate scenarios that meet standards for quantity, cost, fidelity and variety. Proper tuning is based on the principle that the difference between real and bootstrap samples should have the same distribution as that between two real samples. Scenarios meant for operator eyeballs can be validated by a visual Turing test.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

56693 - Machine Learning: DataRobot and Class Projects

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Joseph Troy Morgan; Marguerite Benson; Sam Goldstein		

Abstract: It's never been a more exciting time to be an analytical professional. With the rise of big data, the explosion of data analytics and data science jobs, and the vast amount of business problems that can now be solved with machine learning and artificial intelligence (AI), the time is ripe for data professionals to take the world by storm. The catch? It takes a lot of time to develop traditional data science expertise and the field continues to advance at a rapid pace – which is where automated machine learning technology comes in.

The DataRobot automated machine learning platform eliminates the barriers to machine learning for business analysts by automating many of the complex steps in machine learning model building that have traditionally required a trained data scientist. To start, DataRobot's runs a competition of machine learning algorithms on your data, building dozens of models in minutes and ranking them against each other by their predictive accuracy. Not only that, DataRobot's automation capabilities and visualization tools drastically reduce time-to-insight, allowing analysts to quickly and easily explain the results of the models built to their organizations. With DataRobot, analytical professionals evolve into Citizen Data Scientists – no coding necessary.

Unlike visualization tools with machine learning features that only work if your problem squares precisely with the technology, DataRobot is flexible, automatically testing hundreds of advanced algorithms until it finds the right options based on the business problem you seek to solve. Along the way, DataRobot's built-in guardrails help you identify questions or errors to help you feel more confident about your process.

DataRobot has a variety of built-in systems to help you explain and defend your use of machine learning, whether to leadership, data scientist collaborators, or even to regulators. For example, DataRobot automatically generates customized, model-specific documentation that captures the

choices you've made and the findings uncovered. Model blueprints are downloadable and reflect the specific steps that a model takes on the dataset, providing full transparency. Importantly, the robust suite of documentation allows individuals to use the platform to continually improve their knowledge as they experiment and deliver results. With advanced options built-into the platform, as well as Python and R clients, DataRobot is ideally suited to serve the full-spectrum of analytic professionals.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

56972 - MCFLIE: A Digital Game for Teaching Marine Corps Logistics

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Robert Seater; Ms Jesslyn Alekseyev		

Abstract: We will describe MCFLIE (Marine Corps Forward Logistics Instructional Environment), a digital game created to teach mid-career Marine Corps officers with non-logistic specialties about the principles of logistics. The game provides students with rapid feedback on logistics plans they create, helping build mental models of the tradeoffs incurred by sustainment decisions. We will describe how we developed the game to balance multiple stakeholder constraints, what the student experience is like playing the game, and preliminary data we collected on the game's impact on student learning outcomes. MCFLIE was conceived of by 3 Marine Captains, won the 2019 USMC Commandant's Innovation Challenge, was funded and supported by the Navy and Marine Corps for maturation in 2020, and is now being deployed at the Marine Corps University. This work represents a collaboration between ONR Global TechSolutions, MIT Lincoln Laboratory, USMC Expeditionary Energy Office, and the Marine Corps University Expeditionary Warfighting School.

Classification: UNCLASSIFIED
Working Group:WG 20 Analytic Support to Training and Education

WG 21 Operational Energy

56611 - Adaptive Security Engineering for Detecting Coordinated Cyber Attacks in Energy Cyber-Physical Systems

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Jessica Whitaker; Prof. Danda B Rawat		

Abstract: The smart energy grid, often referred to as an energy cyber-physical system, is expected to provide better services and manageability for energy supply and demand. This system leverages the bidirectional flow of energy and information through a massive number of connected smart grid devices. However, such an enormous amount of connectivity among smart grid devices used by consumers, utilities, and alternative energy producers for bidirectional energy and information flow presents vulnerabilities for a multitude of cyber attacks. Coordinated cyber attacks are major issues in the smart grid where attackers can launch cyber attacks in a coordinated manner to mislead the entire smart grid and consumers. Recent studies have shown that traditional/existing cyber attack detection techniques are not equipped to handle such coordinated attacks. In this work, we develop and evaluate a data-driven cyber attack detection technique for coordinated cyber attacks in the smart energy grid. We also leverage Kalman and other filters for prediction, which are used to detect the coordinated cyber attacks. We will conduct experiments using a real dataset for coordinated cyber attack detection, and numerical results will be used to corroborate our formal analysis.

56683 - Component Level Energy Analysis Tool (CLEAT) Overview

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Paul Pedersen		

Abstract: Fuel supply on the battlefield is a critical enabler and proper forecasting is important. The DEVCOM Data & Analysis Center uses the Fuel Consumption Prediction Model (FCPM) to estimate steady-state vehicle fuel consumption rates based on physics-based algorithms and empirical test data. However, as vehicle system components become electrified relying more on energy storage and hybrid power sources, traditional steady-state modeling does not give a complete picture of the capabilities, limitations, and operational energy consumption. The Component-Level Energy Analysis Tool (CLEAT) was created to evaluate the time-based energy exchanges commonly seen in hybrid electric systems.

CLEAT is comprised of individual component models based on manufacturer specifications and/or component testing. Once combined into a vehicle system within the Simulink operating environment, the system models are validated using existing Army test data. The validated system models can then be applied across terrain profiles including route-specific operationally relevant vignettes to estimate fuel consumption and mobility performance. In addition to logistic supply forecasting, these estimates are used for comparing vehicle prototypes during acquisition to support the Department of Defense (DOD) requirement for factoring fuel logistics into acquisition lifecycle costs for new military capabilities. Because of the component/system architecture, CLEAT components can be re-used in other configurations to support Army modernization efforts across various platforms (e.g., ground, air, Soldier).

Classification: UNCLASSIFIED
Working Group:WG 21 Operational Energy

57066 - Enriching Operational Energy Metrics

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Dr Jordan Eccles		

Abstract: Operational energy is a key resource in generating combat capability and producing effects on the battlefield. However, the link between energy consumption and efficiency and readiness or combat capability can be tenuous. Engineering, technical, or process improvements may make aircraft more efficient, but it can be difficult to understand how these improvements translate to key decision metrics. Strategic investment priorities align with broad measures of readiness or capability, and operational energy metrics must speak to these priorities. Enriched metrics connect increases in readiness or capability to efficiency improvements and enable data-driven decisions at tactical through strategic levels. Examples include the impact of fuel planning on readiness, fuel efficiency on aerial refueling, and training infrastructure on pilot production.   Each example demonstrates how enriched metrics elevate the ability of decision-makers to understand how operational energy impacts the battlefield and support smart, cost-effective investments in Air Force readiness.

Classification: UNCLASSIFIED
Working Group:WG 21 Operational Energy

56750 - U.S. Army Squad Based Energy and Power Research

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr Robert Scott Jane; Gail Vaucher; Mr. Morris Berman; LTC Corey James; Mike Cook		

Abstract: The average U.S. Army solider will be carrying more than 50 lbs. of supplementary weight which includes water, food, and more importantly energy storage resources needed to operate their distributed electronic devices (night vision goggles, radio, anti-drone-based weapons, etc.) which are critical in securing their tactical overmatch. Each added electronic-based device provided to the warfighter increases their energy storage and weight requirements, which can lead to increased fatigue. Additionally, the management of these energy resources imparts additional cognitive burden that detracts from the primary mission. A squad's energy and power resources are tightly coupled with time, space, environment, and operational constraints. Improper understanding and management of energy and power could impact their ability to remain competitive in the presence of an adversary. As such, we need to understand how, where, and when our soldiers are consuming, generating, and storing energy subject to their predefined mission objectives and constraints. Using MATLAB/Simulink, we created a simulation tool to understand the energy and power requirements for the future warfighter subject to a U.S. Army-relevant event schedule depicting a 96-hour mission. In this presentation, we will show that by incorporating a tactical resupply event within a 96-hour mission, energy storage capacity could be reduced by half, which leads to a reduction in weight for each solider. The tool can also be used to understand the possible limitations of deploying alternative high energy density platforms during a 96-hour mission profile in terms of weight and energy storage capacity. The same tool can also be used to size the tactical resupply infrastructure's energy generation capabilities.

Classification: UNCLASSIFIED
Working Group:WG 21 Operational Energy

56485 - Optimizing Isolated Tactical Power through Atmospheric Analytics

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Gail Vaucher; Prof Gordon Parker; Mr. Morris Berman; Dr. Michael Lee; Thomas Price; Dr Robert Scott Jane; Micheal 'Sean' D'Arcy		

Abstract: Tactical power distribution for an isolated grid depends on analyzing and exploiting atmospheric intelligence. The strategic approach for this research consisted of 3 major elements: atmospheric intelligence, power optimization and power distribution. In this presentation, we explain each element and how their associated analytic approaches impacted power production.

Due to the independent nature of the grid scenarios, atmospheric intelligence was gleaned through on site sampling, only. Three methods pursued included (1) using machine learning algorithms to discern real-time sky conditions, which were then entered into a solar radiation model; (2) discerning future sky conditions based on a current sky assessment; and (3) modeling future sky conditions through current and locally-historical measurements. To optimize power, an Energy Management System (EMS) was designed to minimize fuel consumption by the diesel generator(s). The EMS used a Model Predictive Control (MPC) strategy in conjunction with the forecasted photovoltaic energy production which was extracted from the atmospheric intelligence information. Recognizing that

forecast quality decreases with time, a weighting strategy was implemented in the EMS to put greater emphasis on near-term forecasts. The weighting strategy's effect on both fuel consumption and energy storage requirements is presented for several different sky condition scenarios. The effects of the power optimization were characterized with respect to the required energy storage and availability to power critical loads. These power distribution results will be used to understand the trade-offs as related to the mass/volume of a storage facility, reliability of power for critical loads, and required fuel availability.

Classification: UNCLASSIFIED
Working Group:WG 21 Operational Energy

58458 - National Training Center (NTC) Fuel Consumption Analysis Overview

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Gregory Dogum		

Abstract: The study objective was to analyze Army ground vehicle usage data (e.g., engine operations, traveled distance, fuel consumption) from NTC rotations and develop a methodology using these data to estimate fuel consumption for future exercises. This methodology is based on mileage recorded during low and high OPTEMPO training phases while utilizing traditional Operation Mode Summary/Mission Profile (OMS/MP) calculation techniques (e.g., percent distance on terrain, speed on terrain).
By examining recorded vehicle platform usage (i.e., each vehicle serial number matched to specific miles driven and engine hours), assumptions can be applied relative to vehicle movement and idle times, as well as individual terrain splits to predict total training event fuel consumption quantities. Additionally, changes in seasonal fuel consumption can be discerned which likely reflect changing electrical demands for environmental control units. With this methodology, it is possible to generate estimates of ground vehicle fuel consumption for future training events and the associated magnitude of potential error. The basis for this study are DEVCOM DAC's Fuel Consumption Prediction Model and field data collection through DAC's former Sample Data Collection (SDC) program.

Classification: UNCLASSIFIED
Working Group:WG 21 Operational Energy

WG 22 Military Assessments

56709 - The accountability paradox confirmed: Positive and negative effects of accountability on improvement in US federal agencies

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Steven Lagan		

Abstract: Public organizations are expected to use performance information to improve their programs and to give account to the public. However, a large and growing body of research suggests that using performance information for accountability decreases the likelihood that public managers will use performance information to improve their programs -- a so-called 'accountability paradox.' The US Government Accountability Office conducts periodic surveys of US federal managers, examining their performance measurement and management practices, yet almost no research has examined the effects of accountability on managerial use of performance information. This study seeks to fill that gap by examining recent GAO survey data and drawing conclusions regarding the

types of account-giving activities that promote or discourage federal managers' use of performance information in decision-making.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

57034 - COMSPACEFOR Assessment Dashboard

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Lt Col Adam Messer		
Abstract: The emergence of space as a warfighting domain has driven many developments in the structure of the DoD. One such development is increased focus on the status of space forces. In a highly dynamic and remote environment, properly assessing the status and presenting that information to the commander is vital to staying ahead of the enemy. We present developmental efforts to build a data pipeline from squadron to headquarters and web-deployed dashboard capabilities to present real-time status to the commanders. Classification: UNCLASSIFIED Working Group:WG 22 Military Assessments		

56675 - Joint Mission Thread (JMT) Space Touch Point Sensitivity Analysis Using Probabilistic Markov Simulation (PMSIM)

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Nate Tabelon; Stuart A Stanton, Lt Col, USAF, PhD		
Abstract: United States Space Command Advanced Warfare Capabilities and Resources Analysis Division (USSPACECOM/J81) and the Joint Space Warfighting Forum (JSWF) Modeling, Simulation, and Analysis (MS&A) community seek to better understand and quantify how space capability degradations impact the warfighter in order to provide insights and recommendations to senior leaders based on analytic findings. Currently, the JSWF MS&A baseline consists of twenty-eight JMTs in which consequent space touchpoint loss or degradation is primarily analyzed qualitatively. In order to provide more impactful information to senior leaders and throughout the community, JSWF MS&A, as a working group within the Space Analysis Consortium (SpAC), strives to increase JMT baseline fidelity such that it is not only based in a qualitative understanding but is rooted in quantitative data. Probabilistic Markov Simulation (PMSIM) is an Excel-based simulation framework providing a low cost, accessible, risk reduction opportunity to model, collect data, and perform sensitivity analyses. It was developed to enable continuous support to the warfighting mission throughout the COVID-19 pandemic using unclassified inputs and tools, as well as enable quantitative analysis. JSWF MS&A uses PMSIM to conduct sensitivity analyses on several missions in its JMT baseline. Using PMSIM to perform quick-turn sensitivity analysis, users can determine the effects of space capability degradations on mission metrics and outcomes in hours and days vice the weeks and months required by more advanced models. Based on several successful PMSIM experiments at the unclassified level, the model will soon be instantiated in a classified version to generate higher fidelity results. Classification: UNCLASSIFIED Working Group:WG 22 Military Assessments		

56379 - DAF Operations Assessment Working Group: Overview

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Linda Lee; Lt Col Allen Cohen		

Abstract: In July 2020, the Air Force Analytic Community (AFAC) re-invigorated a standing Operations Assessment Working Group (OAWG), which provides a scalable framework for AFAC leaders and subject-matter experts to collaborate and share tactics, techniques, and procedures. The OAWG links operations research and assessment practitioners from across the globe to achieve four primary goals: 1) strengthen local OA efforts for decision-makers, 2) improve OA collaboration and cross-organizational support, 3) enable OA analysts to remain connected throughout their careers, and 4) enhance OA analysts' mentorship, resources, and toolkit.

The OAWG tackles assessment-related issues using a distributed approach and Agile methodology. OAWG members propose issues, problems, and suggestions related to specific units, areas of responsibility, or the entire Department. With sponsorship from an AFAC senior leader, OAWG members frame issues into short-term projects to deliver tangible results. Projects are sequenced within lines of effort, which encourages cooperation across all ranks, experience levels, and interests.

This briefing provides an update to the OAWG's current lines of effort: AOC Cloud Analytics, Assessment Education & Training, Collaboration Platform, and Data Handling. OAWG representatives will present successes and lessons learned over the past year, and outline future efforts. Enhancements to the Air and Space Forces' OA capabilities directly benefit decision-makers within every Major Commands, Air Operations Centers, and Joint Task Forces.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

56381 - DAF Operations Assessment Working Group: Education & Training Update

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Linda Lee; Lt Col Allen Cohen		

Abstract: The lack of structured education and training (E&T) for operations assessment (OA) creates capability deficiencies where Department of the Air Force (DAF) personnel must learn on-the-job through trial and error. OA practitioners require proper E&T, as any operator within their respective field, to successfully fulfill their roles supporting joint warfighting commanders. While some venues exist, there is no standard OA pipeline for DAF members.

The DAF's OA Working Group recently completed two 3-month Sprints within its Assessment E&T Line of Effort. Sprint 1 examined the current state of DAF OA E&T, proposed a future state for DAF assessors, identified enterprise-wide gaps, and recommended options to enhance institutional OA proficiency. Sprint 2 refined the recommendations from Sprint 1, developed an Implementation Plan with prioritized options, and coordinated near- and far-term actions with DAF E&T organizations.

This briefing presents findings from Sprints 1 and 2. It lays out immediate next-steps for the DAF to continue improving OA E&T. The goal of this presentation is not merely to convey information, but to advocate an ongoing path towards improving OA E&T, for the benefit of decision-makers and assessors at every Major Command, Air Operations Center, and Joint Task Force.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

57318 - Assessment Best Practices Using a Lens of Decomposition and Synthesis

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Colonel Marvin Lee King, III		
Abstract: Assessments in the military continue to struggle with methods of implementation. Assessment teams continue to execute inadequate processes that do not inform leaders or staffs in a meaningful way. By looking at the challenge of assessments as an analysis that requires decomposition of the problem and synthesis of results, assessment teams can better see the reasons why assessment processes vary in effectiveness. Classification: UNCLASSIFIED Working Group:WG 22 Military Assessments		

56714 - Selecting performance measures for a defense process improvement program via consensus-based action research

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr. Steven Lagan		
Abstract: Public organizations are expected to measure their performance and use this information for external accountability and internal managerial purposes. Prior research indicates that using the same performance information for both external and internal purposes may trigger a variety of unintended negative consequences, including decreased use for internal purposes. This study presents the results of an action research project in which a defense process improvement program used consensus methodologies to select program performance measures that were useful for external purposes and, separately, for internal purposes; for dual-purpose measures, the group deliberated to determine the most appropriate use(s) for each measure. Measures were built around a logic model framework, using three action cycles. This innovative measurement selection process may be employed by other public sector organizations, in any industry or agency, to help decrease risks and increase benefits associated with implementing a comprehensive performance measurement system. Classification: UNCLASSIFIED Working Group:WG 22 Military Assessments		

56987 - Challenges and Insights from Developing an Analytical Baseline for Installation-Level Enterprise IT

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: MAJ Jaison Desai, PhD		
Abstract: This presentation highlights current challenges with developing a comprehensive and coherent baseline of enterprise information technology services at U.S. Army installations. While many monitoring systems and mandatory reporting structures exist at various echelons, these tend to be largely fragmented and desynchronized in the data they contain and the questions they attempt to answer. The diversity of services, functions, and systems across the Army installation ecosystem also creates unique challenges in the ability to form a standard approach. An ongoing pilot by U.S. Army Cyber Command (ARCYBER) and Program Executive Office Enterprise Information Systems (PEO-EIS) to explore alternative acquisition models for installation-level IT infrastructure created the requirement to effectively define the baseline for use in future comparisons of effectiveness and cost.		

The author provides an overview of the work of the assessments team in identifying existing technical data sources and assessing their value in providing insights to the baseline. The use of non-technical user experience (UX) metrics is also discussed, including the effectiveness of survey instruments to gather data on both system usage and sentiment. The importance of inter-service collaboration is highlighted, along with the challenge of addressing the needs and requirements of a wide variety of stakeholders. This ongoing work provides insight into challenges faced by the Operations Research community when conducting assessments.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

56638 - Assessment Methodology for Multi-Domain Simulated Combat through Value-Focused Thinking

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Ben Finch; Dr. Mark A. Gallagher, FS; Stephen Sturgeon		

Abstract: Quantitative assessment of objective completion is a straightforward task when handling concrete objectives, such as "destroy enemy assets" in a combat scenario. However, if the objective is more abstract, say "efficiency," then quantitative assessment must integrate art with science. Approaches for assessment of abstract objectives often involve subjective distillation into more and more concrete components, until an assessor can translate the tangible into the abstract, whether it be qualitatively or quantitatively. This presentation discusses how the complexity of simulated combat requires a tailored quantitative assessment methodology. Centered on a value-focused thinking approach, the presentation suggests a single methodology as optimal for multi-domain (e.g. land, maritime, space) simulated combat. Results from the literature provide key insights, via the considered list of alternatives, into the application of the methodology.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

57145 - Stochastic Model for Analyzing Combat Strategies (SMACS)

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Suzanne Marie DeLong; Adwoa Gyekye; Adam Patterson		

Abstract: Combat modeling can be a labor intensive, time consuming and expensive venture. SMACS was developed to analyze combat capability packages in a "back of the envelope" way through probabilistic calculations based on the functions of Blue systems stimulating, sensing, and striking Red targets. While initially developed as a spreadsheet Monte Carlo Simulation, SMACS grew into a Python simulation model that allows for the analysis of simple combat scenarios, exploring Blue system characteristics while varying Red target level of importance and engagement priority strategies. SMACS applies Monte Carlo simulation to decision trees to generate a success score based on the success of destroying the red targets conditional upon stimulating, sensing, and striking the red targets. Design of experiments is employed to conduct course of action analysis of multiple scenarios to gain insight into the Blue system parameters as well as how to weight and prioritize red system targets. SMACS is demonstrated with the use of future Blue combat systems where system parameters are not readily available, but rather are experimented with to help define combat system requirements to inform science and technology system goals and parameters.

Classification: UNCLASSIFIED
Working Group:WG 22 Military Assessments

55297 - Great Power Competition Strategic Alignment and Network Analysis

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Raymond Vetter; Mr. Jeffrey Demarest		

Abstract: This study proposes a method for COCOM's to visualize a network of activities taken by Great Power Competition (GPC) actors. The GPC paradigm focuses on the desire of rival states to project power and exert global influence on developing regions. For example, China and Russia are currently considered the United States' primary GPC competitors. Utilizing unclassified, open-source data from multiple sources focused on Chinese economic investments and diplomatic engagements in Africa from 2000 to 2016, the study team uses network visualization techniques to illustrate GPC activities in the AFRICOM Area of Responsibility (AOR). The study team proposes a unique alignment scoring method to assess and measure how GPC actor activities across the African continent positively or negatively align with AFRICOM's published lines of effort (LOEs). The first implication from this work is that network analysis can help to visualize how activities relate to instruments of national power, LOEs, and strategic objectives. Relationships can then be compared using network metrics to determine trends by actors across the AFRICOM AOR and allow decision makers to allocate limited resources using the most appropriate instruments of national power. The second implication is the development of a clear scoring method for strategic alignment that assesses the ends, ways, and means of activities. This alignment methodology can be applied to friendly, neutral, and enemy actors and implies the likelihood of success for a given activity. Future research includes applying this methodology to operational decision making by integrating classified and unclassified data sources.

Classification: SECRET//REL TO FVEY
Working Group:WG 22 Military Assessments

56744 - Assessing the Red in Readiness

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Kristen Ryan, PhD; Jonathon Cosgrove; Patrick Jockisch; Mr. Michael Moskowitz		

Abstract: Is Blue readiness tied to countering or exploiting Red readiness? Do we have an understanding of the adversary capabilities and readiness that enables the United States to focus limited resources to gain and maintain competitive advantage at the operational level? The objective of this study is to develop a methodology for assessing adversary capabilities and readiness and translating that information into mission requirements for U.S. forces. This study reviews net assessment methodologies and intelligence collection priorities, along with existing collected data, to develop a repeatable and continuous method for assessing Red capabilities and translating those capabilities into Blue mission requirements and/or readiness assessments. The study team maps extant Blue operational- and strategic-level training programs to Red capabilities to assess if training sufficiently addresses the threat. A Blue counter-unmanned aerial system (UAS) mission against a Red UAS mission is used as a case study. Blue counter-UAS training and standards for the U.S. Army are analyzed against representative Red capabilities and tactics to identify where there might be gaps in Blue standards that would merit updates or added specificity if informed by known Red capabilities and tactics. The goal of this analysis is to enable a more nuanced, adversary-specific assessment of Blue readiness.

| Classification: SECRET//REL TO FVEY |
| Working Group:WG 22 Military Assessments |

55296 - USCYBERCOM Operation Assessment

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: John Walsh; Dr. Francine Nelson; E. Thomas Powers; David Summers		

Abstract: (U) USCYBERCOM Operation Assessments Branch produces an operation assessment for the USCYBERCOM Annual Campaign Operation Order (ACO), as well as operation assessments for priority operations and Tier 1 Joint Exercises. This presentation will provide a summary of the USCYBERCOM operation assessment methodology and products used to present findings on achievement of ACO objectives and recommendations for improvement. This methodology includes a hierarchical approach using traditional assessment elements of Objectives, Effects, and Indicators. Additionally, the assessment also provides information on the mission posture of units conducting cyber and information operations. The process to produce assessments involves a substantial data collection effort through interactions with multi-level subject matter experts and stakeholders from across the Headquarters Directorates and Subordinate Headquarters. Finally, this presentation will conclude with discussion on how USCYBERCOM Operations Directorate (J3) is working to standardize metrics and automate data collection to provide assessment information at all levels of USCYBERCOM.

Classification: SECRET//REL TO FVEY
Working Group:WG 22 Military Assessments

56648 - Terrain Shaping Operations: Decision Analysis

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: LTC Christopher Collins		

Abstract: The Terrain Shaping Operations (TSO) Sprint is an Army Futures Command (AFC) directed sprint, or a 90-day quick turn study to determine and evaluate the conceptual options, not constrained by near-term technologies, for shaping the land domain beyond 2035 in multi-domain operations. The Terrain Shaping Strategy and the Dominating Mobility through Terrain Shaping and Engagement Initial Capabilities Document serve as the impetus of the TSO Sprint. Advocating a desired endstate of the TSO Sprint, the documents define an enduring capability to rapidly shape the terrain by emplacing reinforcing obstacles in the land domain throughout the depth of the battlefield and throughout all phases of the campaign.
The Research and Analysis Center (TRAC), as the analytical lead for the sprint, developed, implemented, and executed the analytical approach for the effort. The analytical process incorporated a multi-phase approach that included mission analysis, measurement space development, analytical framing, assessment, and integration of results. The deliverable bridged the terrain shaping linkages to ongoing and future modernization efforts across the Army and Joint Enterprise.
This presentation will detail the analytic and assessment approach TRAC applied to capture and catalog subject matter expert (SME) evaluation of industry and Joint science and technology (S&T) TSO Options (TSOO). Specifically, the iterative process of collecting disparate concepts, research, and S&T across 23 Army, Joint, Department of Defense, and industry partners will illuminate the concatenation of terrain shaping options, applying concepts to create TSOO combinations. Parlaying the "what" that the TSOO combinations provide, the characteristics are used to assess how effectively each TSOO supports or enables the desired operational endstates. Development of the attributes

characteristics, easily differentiable between the TSOO combinations, was derived in a structured manner, stressing SMEs input to frame and prioritize the evaluation criteria.

Assessment of the tactical implications of each TSOO was conducted through an SME panel workshop, at varying depths and Joint Planning Phases. The input was amalgamated and processed through the application of two multi-criteria decision making processes: the Analytical Hierarchy Process and weighted averages. Normalization of the attributes alleviated some of the inconsistencies in the ordinal ranking from the assessment, thus the TSOO combinations were ultimately tiered to mitigate lower associated confidence levels.

The layered, future TSOO combinations provide a range of decision space detailing the S&T that make up each option. The linkages aim to support the development and integration of these and subsequent S&T roadmaps with the potential to spur future directed sprints. Thus, the tactics, techniques, and procedures captured in this sprint will inform future AFC and TRAC efforts.

Classification: SECRET NOFORN
Working Group:WG 22 Military Assessments

57124 - Air Force Net Assessment: Resilient Communications in support of Joint All-Domain Command and Control (JADC2)

Start Date: 6/25/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr. Daniel O'Keefe; Dr. John Young; Dr. Dominic Babbini		

Abstract: Air Force Net Assessments are holistic assessments of competitive areas that centralize, consolidate, and distill the best available insights from previous wargames, intelligence, studies, and analyses into a single product. They provide staffs and leadership with a common understanding of the challenges facing the Air Force that enables decisions based on the best available data. This presentation will focus on process and results from the final report of the Air Force Net Assessment: Resilient Communications in support of Joint All-Domain Command and Control (JADC2). This topic was selected in 2019 by senior leaders of HQ USAF/A2/6, A5, A8X, A9, and SAF/AQ. The assessment was conducted by a working group across the Air Staff, MAJCOMs, and the Intelligence Community, led by Headquarters AF/A9I.

Classification: SECRET NOFORN
Working Group:WG 22 Military Assessments

WG 23 Measures of Merit

56712 - Measures for the measurers: A survey of process improvement program measures in US federal agencies

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Steven Lagan		

Abstract: Measuring performance and using that information to improve is a foundational concept in process improvement methodologies such as Lean, Six Sigma, and Total Quality Management. Measurement frameworks, such as the Balanced Scorecard and Logic Models, are often cited in both private and public sector performance management literature, and process improvement experts often play a key role in helping develop these frameworks for the entire organization. Ironically, published literature infrequently addresses how process improvement programs, especially in the public sector, should measure themselves. This study addresses that knowledge gap by examining

the performance measurement practices of process improvement programs in the US federal government. Using survey responses from process improvement programs across numerous US federal agencies, this study reveals both the measurement frameworks and specific measures currently in use. Measures will be aggregated and presented within a logic model framework, which other public sector process improvement programs may consider when tailoring performance measures to their needs.

Classification: UNCLASSIFIED
Working Group:WG 23 Measures of Merit

56578 - Human Capital Analytic Pyramid: A Structure for Assessing the Performance of our Manpower, Personnel, Training, and Force Development Enterprise

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Maj Joseph Hoecherl		

Abstract: Human capital challenges are robust, wicked problems. The overarching human capital challenge the USAF must meet is to field the human capital needed to execute our missions now and in the future. Solving this core problem requires solutions to a number of intermediary problems, spread over myriad institutions and chains of command across the Manpower, Personnel, Training, and Force Development Enterprise. As a complicating feature, many of the metrics commonly referenced across the USAF to inform solutions to these problems are misleading, misunderstood, or lack a meaningful basis. This presentation introduces the Human Capital Analytic Pyramid (HCAP), a structural framework for understanding current challenges. The HCAP seeks to enhance cogent, deliberate thinking about human capital management problems. Planned technical contributions for the author's Ph.D. dissertation -- in the form of operations research and artificial intelligence methods for solving some of these difficult human capital management problems -- will be discussed within the context of the HCAP.

Classification: UNCLASSIFIED
Working Group:WG 23 Measures of Merit

56996 - Lessons Learned from Conducting a Multi-Installation User Experience Survey on Information Technology

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: MAJ Jaison Desai, PhD		

Abstract: Obtaining high-quality data about the end user experience (EUX) is an essential part of understanding both existing challenges and future opportunities for the provisioning of enterprise information technology (IT). The manner in which surveys are designed and presented to users is consequential in both response rates and quality of responses. This presentation discusses a series of surveys conducted in 2020 across nine different Army installations to obtain an EUX perspective on interactions with IT and sentiment regarding Government-provided products and services. Specifically, it illuminates the process of developing the survey, hurdles in its execution, and the impact of distribution choices on responses. Overall, response rates were higher at installations offering strong senior leader support for the survey and using direct-to-user distribution through installation-wide e-mail systems. Response rates were lower at installations that distributed invitations through piecemeal distribution lists or only formal orders processes (i.e. Daily FRAGOs).

This provides insights for analysts seeking to enhance the way they conduct and distribute survey instruments across multiple installations or dispersed sub-sets of respondents.

Classification: UNCLASSIFIED
Working Group:WG 23 Measures of Merit

56619 - Evaluating Checkpoint Value in Afghanistan

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr Joseph L Stallings, Jr		
Abstract: (U) The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to defeat Improvised Threats, to include Improvised Explosive Devises (IEDs), as weapons of strategic influence. Additionally, the Trends Branch conducts analysis support Command Assessments and Operational Decision-making. (U) There are over 6000 checkpoints reported by the Afghan Security Force Commands. Checkpoints may be used to secure key terrain, limit enemy freedom of movement, protect civilian populations, or monitor traffic along key commercial or tactical routes, among other things. Despite perceived value for each, it is not feasible to man and maintain all reported checkpoints. As a result, the Resolute Support (RS) Command has been searching for a methodology to assess the value of checkpoints reported by the Afghanistan Security Forces in order to prioritize resourcing activities. (U) The problem was approached as a Multi-Criteria Decision Analysis (MCDA). The dynamic decision environment and challenging utility assessment make this discussion noteworthy. The discussion will examine the selection of metrics that captured the utility of each checkpoint to the Afghan Security mission. Additionally, the discussion will address the development of a utility curve for each metric that could be used to determine a utility value for each checkpoint relative to each metric. Having established metrics and utility curves, it was possible to determine a "Contribution to Security" value for each checkpoint and rank order the checkpoints accordingly. (U) Additional analysis was provided to assist in developing a discussion with Provincial leadership with respect to resourcing justifications. The logic behind the MCDA supported a starting point for discussions that would reveal new perceptions of utility and a basis for revisiting the MCDA process. Classification: UNCLASSIFIED Working Group:WG 23 Measures of Merit		

WG 24 Test and Evaluation (T&E) and Experimentation

55278 - A framework for improving the efficiency of operational testing through Bayesian adaptive design

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Victoria Rose Carrillo Sieck; Fletcher G W Christensen		
Abstract: When developing a system, it is important to consider system performance from a user perspective. This can be done through operational testing---assessing the ability of representative users to satisfactorily accomplish tasks or missions with the system in operationally-representative environments. This process can be expensive and time-consuming, but is critical for evaluating a		

system. We show how an existing design of experiments (DOE) process for operational testing can be leveraged to construct a Bayesian adaptive design. This method, nested within the larger design created by the DOE process, allows interim analyses using predictive probabilities to stop testing early for success or futility. Furthermore, operational environments with varying probabilities of encountering are directly used in product evaluation. Representative simulations demonstrate how these interim analyses can be used in an operational test setting, and reductions in necessary test events are shown. This method will allow future testing to be conducted in less time and at less expense, on average, without compromising the ability of the existing process to verify the system meets the user's needs.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

55336 - Testing for Equality of Several Distributions in High Dimensions

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Thomas Reed Willemain		
Abstract: Testing for Equality of Several Distributions in High Dimensions Thomas R. Willemain and Adam G. Petrie A fundamental Testing and Evaluation analysis task is looking for differences among alternative systems or processes. This task is difficult when there are a relatively small number of observations in a relatively high number of dimensions. The existing Energy statistic works well for effects that only change means in multivariate Normal (MVN) data. Several new tree-based statistics work well for effects that have multiple impacts in both MVN and non-MVN data. Classification: UNCLASSIFIED Working Group:WG 24 Test and Evaluation (T&E) and Experimentation		

56502 - AWS-3 LTE Impacts on AMT: Supplemental Analysis Considerations

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Timothy B. Mull		
Abstract: The focus of this paper is to summarize the data and analysis methodologies from the National Advanced Spectrum and Communications Test Network (NASCTN) AWS-3 LTE Impacts on AMT project and present supplemental analysis methodologies and findings to provide additional insights from the existing data other than what was presented in the NASCTN report. The NASCTN report (NIST Technical Note 2140) is available at https://doi.org/10.6028/ NIST.TN.2140. The views and conclusions in this paper are independent of and not endorsed by NASCTN. Although experimental design principals were used in the formulation of the test design, the NASCTN data analysis avoided parametric modeling, which is traditionally used for analyzing designed experiments, and instead focused on graphical plots of the test responses with nonparametric regression fits. Nonparametric regression avoids parametric modeling assumptions and can be useful to investigate trends in test results. However, parametric modeling enables characterization of the degree that individual factors influence the response and interact with other factors along with checking the adequacy of the model. In addition to gaining insights into system behavior that may not be apparent from nonparametric models, parametric modeling can inform sensitivity analysis as well as future experiments.		

The objective of the NASCTN effort was to design, demonstrate, and validate a test methodology to measure the impacts of commercial LTE UE emissions (AWS-3 frequency band 1755MHz - 1780 MHz) on the adjacent federal use L-band (1780MHz - 1850 MHz) where aeronautical mobile telemetry (AMT) is used. Impacts were assessed by collecting and analyzing response variables of the AMT system, in this case tracks bit error rate (BER) and the ratio of energy per bit to noise floor (Eb/N0). The testing was performed in a laboratory setting using government off the shelf AMT hardware and over the air recordings of LTE signals. Two test beds were constructed for this test campaign, the first was located at the NIST facilities in Boulder, Colorado and the second located at the MITRE campus in Bedford, Massachusetts.

The NASCTN mission is to provide, through its members, a network for robust test methods and validated measurement data necessary to develop, evaluate, and deploy spectrum sharing technologies that can improve access to the spectrum by both federal agencies and non-federal spectrum users. Members include DoD, NASA, NIST, NOAA, NSF, and NTIA. NIST hosts the NASCTN capability at the Department of Commerce Boulder Laboratories in Boulder, Colorado.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

57060 - Cyber Red Zone

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Jonathan Harris; Cat Adams; Steve Klynsma		

Abstract: The National Cyber Range Complex (NCRC) hosts a DoD wide competitive capture the flag (CTF) event called Cyber Red Zone (CRZ). The development of the CRZ event and the white cell support during the event are funded by Test Resource Management Center (TRMC) so participation in CRZ has no incurred costs for DoD teams. CRZ was initially chartered to support the T&E community as a way to help red teams stay current on vulnerabilities that threaten our DoD infrastructure. However, we have broadened the aperture for participation to include any DoD cyber focused team. Even though CRZ is an offensive focused event, about half the teams that participate are defensive teams. The change in roles allows for defensive minded participants to gain insight and perspective in to an adversary's mindset. There are several key differences between CRZ and a traditional CTF. First and foremost, we are focused on training. All the flags are aligned to KSAs defined in the Cyber DT's Vulnerability Analysis Standards. CRZs are 48 hours in duration and have nine primary flags (three at each level: apprentice, journeyman and expert). This allows for all skill levels to participate, have fun and most importantly learn. Second, each CRZ is focused on a DoD context relevant mission with engaging back story. Services take turns in helping align the event to simulate a meaningful DoD mission. This helps us design flags that are context rich and void artificialities that would never be seen in operation. Lastly, what truly makes CRZ different and impactful is that doesn't just focus on enterprise IT, all CRZ include hardware in the loop that mimics weapon systems, platforms, or other specialty systems used by the DoD.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

56557 - Statistically defensible interval estimates for small sample System Usability Scale (SUS) scores

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET

Authors: LTC Nicholas Clark; Matthew Dabkowski; Prof. Patrick J. Driscoll; Dereck Kennedy; Ian Paul Kloo; Heidy Shi

Abstract: For the past 35 years the System Usability Scale (SUS) has provided practitioners with a simple, reliable way to quickly assess a system's perceived usability. Relying on a 10-question survey, the SUS mathematically transforms a respondent's answers onto a 0-to-100-point scale, where larger scores imply greater usability, and the survey's mean score estimates the usability of the system. Despite its widespread investigation and use among researchers, calculating and communicating the uncertainty associated with a mean SUS score remains problematic, especially when the sample size is small (n ≤ 10). Accordingly, in this presentation we propose an empirically-derived methodology that provides statistically defensible interval estimates of the mean SUS score in small sample circumstances. Leveraging bootstrapping and Bayesian approaches, this methodology is operationalized with straightforward decision rules and automated inside of a freely available, online application.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

56789 - IPT3N: Automated Network Planning for Test and Training Networks

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET

Authors: Mr. Defeng Xu

Abstract: The goal of the Integrated Planning of Tactical, Test Support, and Tactical Engagement Network (IPT3N) project is to provide a flexible network planning toolkit to address the preceding challenges. IPT3N provides an automated capability for planning a network laydown that optimizes the use of available communication resources, allowing the test officer to work with incomplete information regarding the proposed maneuvers, and to help them compare alternative configurations of range network laydowns by scoring each configuration in terms of its capacity to meet specified coverage, bandwidth, and power consumption requirements.

Sufficient coverage, bandwidth and power consumption are central requirements for Test Support Network (TSN) to ensure:
*Personnel and platforms participating in the event can be monitored continuously
*All traffic needed to monitor the participants, both live and constructive, is delivered to the Exercise Control (ExCon) in a timely manner for accurate computation of Real Time Casualty Assessment (RTCA)
*All components of the TSN have sufficient battery/energy resources to operate without interruption during the test/training event.

When planning a TSN layout, the test planner must test and evaluate the appropriate TSN technology and configure tower layout to satisfy coverage and bandwidth requirements subject to the constraint of available resources. The primary challenges include:
*Incomplete information on the test and training events such as area of operations and distribution of traffic
*Limited feasible tower locations due to terrain and infrastructure limitations
*The potential impact of terrain, mobility, weather, and vegetation on coverage during the exercise.
*Potential interference between the TSN, system under test, and surrounding civilian communication sources

Our presentation will describe the problem formulation of TSN planning and AI-based algorithms to automatically identify optimal tower layout and associated configurations for a given test event. The presentation will also discuss the value of iterative workflow to support the TSN planning operations, which uses computational assist to simplify frequent planning tasks. Finally, our presentation will demonstrate the planning of an illustrative use case to plan a realistic network laydown for proposed maneuvers on a test range.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

56729 - Using MBSE Practices in Test and Evaluation

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Jennifer Sharpe; Richard Wise; Whit Matteson; Retonya Dunning		

Abstract: Model-Based Systems Engineering (MBSE) currently applies to several system engineering stages: concept development, requirements engineering, system architecture and system design stages. However, Test and Evaluation (T&E) can utilize MBSE practices as well. Although the automatic execution of test cases exists for some test cases, such as software test cases, the creation of the test cases is still largely a manual process. As such, T&E can be one of the most time consuming steps within system engineering. System engineers must manually write test cases to verify requirements, with test scripts executing the test cases. This presentation will alternatively showcase a model-based approach leveraging the Systems Modeling Language (SysML) and the UML Testing Profile (UTP) currently in development by researchers at the Georgia Tech Research Institute to expedite T&E practices by automatically generating test cases based upon a state machine model of the expected system behavior. The auto-generation of test cases from a comprehensive, unified system model facilitates more complete testing of systems. This minimizes risk of systems failure, creates an efficient framework for regression testing and functional testing of new features as the systems evolve, and allows for earlier detection and resolution of discrepancies between system design and requirements. Incorporating MBSE by utilizing a system model of the expected behavior of the system creates a sustainable and maintainable process to produce test cases that can be run in an existing test infrastructure.

GTRI has developed a procedure to utilize MBSE to create a test suite to verify requirements. This process uses a SysML model of the expected system behavior to generate a test suite which can be executed in an existing test environment. The major steps in this procedure involve importing requirements into a SysML modeling tool, creating a SysML state machine to model the expected behavior of the system-under-test, utilizing open source tools to traverse the model to generate a test suite containing abstract test cases, tying the abstract test cases to concrete, executable test cases, and exporting the test suite in a format digestible by the test environment. This approach promotes greater test coverage and more efficient test case generation for DoD systems.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

55145 - A Metrics-based Software Tool to Guide Test Activity Allocation

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jacob Aubertine; Kenan Chen; Vidhyashree Nagaraju; Dr. Lance Fiondella		

Abstract: Existing software reliability growth models are limited to parametric models that characterize the number of defects detected as a function of testing time. However, the amount and types of testing effort applied are rarely considered. This lack of detail regarding specific testing activities limits the application of software reliability growth models to inferences such as the additional amount of testing required to achieve a desired failure intensity, mean time to failure, or reliability (period of failure free operation).

This presentation provides an overview of an open source software reliability tool implementing covariate software reliability models [1] to aid DoD organizations and their contractors to quantitatively measure and predict the reliability improvement of software. Unlike traditional software reliability growth models, the models implemented in the tool accept multiple discrete time series corresponding to the amount of each type of test activity performed in each interval as well as relevant metrics. When applied to testing data, the parameters of each activity can be interpreted as the effectiveness of that activity to expose reliability defects or security vulnerabilities. Thus, these enhanced models provide the structure to assess existing and emerging techniques in an objective framework that promotes thorough testing and process improvement, motivating the collection of relevant metrics and precise measurements of the time spent performing various testing activities.

References
[1] Vidhyashree Nagaraju, Chathuri Jayasinghe, Lance Fiondella, Optimal test activity allocation for covariate software reliability and security models, Journal of Systems and Software, Volume 168, 2020, 110643.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

56848 - Using a "Pick-Up" Game to Assess New Technology Operational Requirements

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Terrance J. McKearney, FS		

Abstract: Military research and development (R&D) efforts need the engagement and input of actual operating forces to guide their engineering and prototyping efforts. However, involving the operating forces in the R&D process has always been a challenge: it is difficult to get engineers and scientists across the table from actual "operators" who have limited time. It is also difficult to draw serving operational personnel out of their immediate concerns for their reflections on applications and systems that might benefit them in the future. The author, supporting an Office of Naval Research (ONR) Innovative Naval Prototype (INP) project, developed the concept for using a wargame methodology tailored to a short two day session where operational personnel would be asked to respond to a scenario in a series of moves using a new technology. INP engineers and management participated in the event by briefing their concepts prior to "game play" and observing the operators' moves as the scenario developed. This presentation will describe the methodology used in this "pick-up game," the challenges in executing the event, and the data collection and analysis process that captured the input of the players for incorporation in technology design.

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

56665 - Developing an Analytical Framework for the Joint Warfighting Concept

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr Troy Russell; Michael Roy Neary		

Abstract: The purpose of this presentation is to illustrate the analytical framework used in the first iteration of the Joint Warfighting Concept (JWC) lifecycle, a concept directed by the Chairman of the Joint Chiefs of Staff (CJCS) to examine how the Joint Force should operate in 2030. In 2019, the Secretary of Defense directed the Joint Staff, in coordination with the Services (JCS), Combatant Commands and the Office of the Secretary of Defense, to develop and provide a JWC by December 2020 that would guide the Department's future force development and design to ensure that the right people, equipment, training and doctrine are in place to win a future conflict. Traditionally, a Joint Operating Concept (JOC) takes 2-3 years of development before completion. It follows a structured linear process prior to final signature, as discussed in CJCSI 3010.01E. Adhering to a shorter timeline to develop the new warfighting concept and introducing a new governance structure, consisting of a wider set of DoD stakeholders (i.e. all COCOM's, Services and OSD) produced new challenges for JWC development team. Creating new processes and procedures required a higher level of coordination with senior leaders and action officers from numerous agencies, and quick turn analysis output. Under these conditions the JWC team could not follow traditional concept development pathways. With greater scope of analytic partners, the new approach to concept analysis and assessment was required reinforcing the importance of structure and traceability in the development of observations and insights. The core Analysis and Assessment (A&A) Team consisted of analysts from Joint Staff J7's Joint Warfighting Directorate. The A&A team focused its efforts on assessing the Effectiveness, Viability and Robustness (EVR) of the ideas described in the concept. The team crafted the JWC Assessment Framework to map out the relationships between the evolving concept's hypotheses, assertions, and assumptions in the form of task-effect relationships. Decomposing the concept in this manner guided data collection, organization, and analysis for events (i.e. TTXs, wargames) and ensured outputs leading to the identification of new perspectives on the operational approach, including potential strengths, weaknesses, and unanticipated consequences of its employment within a conflict scenario. Along the pathway to approval, the results inform senior leader briefings (DEPOPSDEPS/OPDEPS, JCS Tanks, Tri-Chair, DMAG, NDS-I,).

Classification: UNCLASSIFIED
Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

57146 - Stochastic Model for Analyzing Combat Strategies (SMACS)

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Suzanne Marie DeLong; Adwoa Gyekye; Adam Patterson		

Abstract: Combat modeling can be a labor intensive, time consuming and expensive venture. SMACS was developed to analyze combat capability packages in a "back of the envelope" way through probabilistic calculations based on the functions of Blue systems stimulating, sensing, and striking Red targets. While initially developed as a spreadsheet Monte Carlo Simulation, SMACS grew into a Python simulation model that allows for the analysis of simple combat scenarios, exploring Blue system characteristics while varying Red target level of importance and engagement priority strategies. SMACS applies Monte Carlo simulation to decision trees to generate a success score based on the success of destroying the red targets conditional upon stimulating, sensing, and striking the red targets. Design of experiments is employed to conduct course of action analysis of multiple scenarios to gain insight into the Blue system parameters as well as how to weight and prioritize red system targets. SMACS is demonstrated with the use of future Blue combat systems where system

parameters are not readily available, but rather are experimented with to help define combat system requirements to inform science and technology system goals and parameters.
Classification: UNCLASSIFIED Working Group:WG 24 Test and Evaluation (T&E) and Experimentation

57208 - Simulated Neyer Testing and Analysis to Determine the Reliability and Safety Related Design Objectives of a Low Energy Exploding Foil Initiator

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Melissa Jablonski		
Abstract: The Low Energy Exploding Foil Initiator (LEEFI) is a recently developed fuzing sub-component that is part of an Electronic Safe and Arm Device (ESAD). Within a munition, the ESAD is the component that must ensure both the safety and reliability of the arming process, i.e. it is responsible for reliably arming the munition during a gun launch event and keeping it safe and unarmed during other events such as rough handling or exposure to temperature extremes in storage. An ESAD has many advantages over traditional mechanical Safe and Arm (S&A) devices, but its detonator, the LEEFI, must be tested in a statistically rigorous way to ensure it meets both safety and reliability requirements. For safety requirements, this means never initiating at low stimulus levels (below 500 Volts), and for reliability requirements, this means always initiating at high stimulus levels (the level designed into the fuze firing train). This involves conducting a go/no-go sensitivity test to determine reliability and safety metrics including the minimum voltage that one can expect a reliable initiation and the maximum voltage that one can expect a safe no-initiation. This paper presents the results of a simulation study conducted to determine the design requirements for a LEEFI detonator device to meet those all fire and no fire voltage requirements. It considers the results of thousands of simulated Neyer sensitivity tests to determine the probability of meeting the testing metrics for a given LEEFI mean go voltage and standard deviation. From the results, we find that in order to meet the no fire safety requirements in 90% of testing situations, the designed mean voltage should be 12 standard deviations higher than the 500 Volt no fire stimulus level. The exact value of mean and standard deviation can then be chosen based on the all fire reliability requirements. In addition, there is indication that increasing the test size beyond the n=30 number that has historically been used will allow for a higher probability of meeting the design criteria with the obvious trade-off of requiring more resources for testing. Classification: UNCLASSIFIED Working Group:WG 24 Test and Evaluation (T&E) and Experimentation		

WG 25 AoAs and Capability Development

57131 - Improving Government Effectiveness, Efficiency, & Affordability: Accounting for the Human Domain in the Market of Public Goods

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Lisa Oakley-Bogdewic; Ms. Emaan Osman		
Abstract: This brief leverages landmark literature in the social, political, and biological sciences to present the importance of accounting for the Human element in the complex decision-making space that is "the Government." Specifically, we will discuss why results in the market of public goods are generally not affordable, efficient, and effective, and what can be done to improve decision-making,		

operations, and outcomes. Key terms: Affordability, Effectiveness & Efficiency, Principal Agent Problem; Arrow's Impossibility Theorem; Tragedy of the Commons; Theory of Second Best; The Theory of Bureaucracy.
Authors: Dr. Lisa Oakley-Bogdewic and Emaan M. Osman

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56864 - Analysis pipeline for comparison of simulated combat effectiveness between Land Combat Vehicle Systems

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jessica Penfold; Dr Andrew Gill		
Abstract: Force-on-force closed-loop combat simulation modelling is frequently used to investigate the performance of alternative land combat systems in the context of realistic military operations. This simulation modelling can aid decision-makers in acquisition and capability decisions. However, the comparison of a number of different alternatives can be challenging to analyze with standard simulation analysis procedures and often produce complex and difficult-to-interpret results. Accordingly, it is important to develop robust analysis techniques and present the results of simulation analysis in an informative and interpretable format for readers without a statistical or data analysis background. This talk details an exploratory analysis pipeline developed to compare performance of alternative land combat systems against a number of simulation metrics. A number of analytical techniques and presentation formats are produced in order to provide robust and informative results to a non-technical audience to assist in capability decision-making.		
Classification: UNCLASSIFIED Working Group:WG 25 AoAs and Capability Development		

56368 - Building Innovative Partnerships in Driving the Transformational Science & Technology Portfolio with Decision-Quality Analytics

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Kathleen M Bauman; David J. Myers, Ph.D.		
Abstract: Released in April 2019, the Air Force (AF) 2030 Science and Technology (S&T) Strategy calls for an AF that dominates time, space, and complexity in future conflict across all operating domains to project power and defend the homeland. Objective one of this strategy serves as a call to action for the development of five strategic capabilities and the creation of a transformational S&T component within the AF. In September 2020, the Air Force Research Laboratory (AFRL) Transformational Capabilities Office (TCO) had reached initial operating capability. One of the tenets of the TCO mission is to drive its transformational S&T portfolio with decision-quality analytics. The TCO mission scope includes the execution of AF Explore investments which is initially addressing three transformational challenges including in-flight rearming & refueling, personnel recovery kit delivery, and vehicle tracking in commercial imagery. This presentation will discuss the approach that the TCO is executing to utilize analytics in building the business cases for taking these transformational capabilities forward. The strategic intent for this AF Explore call was to demonstrate an approach that is broadly accessible by the entire national technology ecosystem. Since this approach may result in non-traditional DoD partners for the technical concept developers, establishing an innovative partnering approach for conducting the analytics to support the business case development was		

needed. The current partnering approach will be discussed along with how the strategy may evolve for conducting analytics to drive the decisions for the transformational portfolio.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56897 - Capabilities Based Assessment Tool for Rapid Problem Framing

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Michael Balthazar		

Abstract: In the current environment of flat budgets, force modernization, and the focus on great power competition instead of the counter-insurgency operations, decision makers must find a way to maximize the effects of their platforms for a given cost. To answer this question effectively, decision makers must first ensure they are addressing the correct problem. The Capability Based Assessment Tool (CBAT) is a deterministic model that uses a greedy algorithm to assess the effectiveness of every unique combination of capabilities the user can define. These capabilities are tested against a set of requirements that are generalized to allow for rapid analysis and runtimes on the order of minutes to one hour depending on the number of capabilities selected. The simplified definitions of capability and requirement attributes allows for quick integration of emerging and future technologies. The iterative nature and flexibility of CBAT allows the decision maker to frame the problem and explore the right questions that drive more accurate, detailed analysis. The speed at which runs can be completed allows multiple users to collaborate and provide their own perspective on the requirements and capabilities which widens the aperture to ensure that the correct details come into focus. CBAT can model operational scenarios but can also address more general cost-benefit problems such as the selection of a new fleet vehicle for a delivery service. Costs for the various capabilities can also be defined by the user and can include a wide variety of measures such as development cost, network bandwidth, or interdependency.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

57022 - Creating Transformational Change, One Small Decision at a Time

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr RICHARD HENCKE		

Abstract: An often heard adage is that big transformational change requires bold leadership, who are willing to take larger risks. Lean-Agile methods take a different tact, recommending small actions to iteratively pick your way through a highly uncertain problem/solution space. Military transformation is a high uncertainty exploration of new ways and means to solving hard warfighting problems. Traditional approaches that frame capability development deficiencies in the context of current warfighting concepts are ill-suited to identifying and developing warfighting concepts that are based on a new way of fighting.

This presentation describes ongoing work at the HAF A5/7 to develop new capability development methodologies to recognize when transformation is needed, and to identify and develop transformational solutions. Through the application of lean-agile methods and model-based systems engineering, this approach attempts to better understand ill-structured problems, identify early solution constraints and required capabilities, and analyze system functional requirements; resulting

in fully scoped future warfighting concepts and functional descriptions useful for technology development and system specification.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56895 - Kinematic Performance Analytics using CWS

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Christopher Jarvis; Andrew Crete		

Abstract: Kinematic performance analytics is a critical decision support element in every stage of munition development from specific technology to full system evaluation. The broad range of environments ranging from subsonic to hypersonic flight and incorporation of advanced technologies and novel algorithms requires the kinematic simulation tool to be modular and robust. Furthermore, to fully characterize a capability across a vast set of engagement conditions requires the tool to be fast and parallelizable.
To achieve all this, AFRL/RW has developed the CADAC++ Weapon Simulation (CWS) Engagement level simulation framework. CWS is a robust simulation framework enabling rapid development and evaluation of kinematic performance for a wide variety of munition concepts using Flat or Ellipsoidal (WGS84) Earth models and an arbitrary number of 3DoF or 6DoF weapon entities against stationary, moving or maneuvering targets.
This presentation will provide an overview of CWS and a live demonstration of capabilities using example data, scenarios and python scripts that are included to assist new users with model development and evaluation.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56819 - Making Robust Lifecycle Decisions (MRLD): A Tool for Applying Multi-Attribute Tradespace Exploration (MATE) Methodology

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: James Dzwonchyk; Brett A Stanley; David Quick		

Abstract: Multi-Attribute Tradespace Exploration (MATE) is a scalable analytic methodology rooted in Value-Focused Thinking (VFT) for multi-criteria decision making in complex decision problems with multiple stakeholder perspectives, changing conditions over time, and uncertainty in evaluations of costs and benefits. Like VFT, it begins with stakeholder value and identification of value-creating attributes of potential solutions. Modeling the performance of and value delivered by potential solutions then allows mapping of benefits to costs, populating the decision tradespace. Visual analytic techniques enable exploration of tradeoffs across many potential solutions, contexts, and stakeholders. This presentation will demonstrate how the MATE methodology is being built into a new software application, Making Robust Lifecycle Decisions (MRLD), across three layers of activities: Define, Generate, and Explore.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

57030 - Prioritizing Strategic Guidance for Concept and Capability Development

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Andrew Billyard; Dr. Brad Gladman		
Abstract: In an environment where focus is shifting from counter-terrorism and counter-insurgency operations to larger-scale warfare against near-peers, there is a real need for each nation to ensure the development of concepts and capabilities that meet domestic requirements and which compliment those of coalition partners. This requires analytical support to decision making that assists in the determination of where to focus limited resources. The method presented is a novel approach combining strategic analysis and operational research multi-criteria decision support to determine appropriate strategic guidance as influencing factors to delineate and prioritize focus areas for decision-makers. Classification: UNCLASSIFIED Working Group:WG 25 AoAs and Capability Development		

57023 - Resource Decision Making Across an Enterprise Capability Portfolio - A Digital Engineering Approach

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr RICHARD HENCKE		
Abstract: Capability resource decision making across a complex and varied capability development portfolio continues to be a challenge for the Department of the Air Force. A decision-making framework that could mathematically trace overarching enterprise goals to investment decisions would provide a sound, evidence-based approach to making capability development decisions across a large and diverse portfolio. This presentation describes ongoing work at the HAF A5/7 to develop capability development assessment methodologies that use a common model-based systems engineering framework and supporting digital tools to provide mathematical traceability between desired mission outcomes and key solution parameters such as technical system performance and cost. This methodology, instantiated in a capability portfolio analysis tool, is envisioned to allow decision makers to assess the impact on an enterprise capability release profile from the selection of alternative enterprise investment strategies. Classification: UNCLASSIFIED Working Group:WG 25 AoAs and Capability Development		

57005 - Truth or Dare: Do an AoA in 9 Months

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Harry W. Conley		
Abstract: The 2020 National Defense Authorization Act requires AoAs be completed within 9 months of study initiation. For complex AoAs, this is a challenging requirement. The Office of the Secretary of Defense, Cost Assessment and Program Evaluation issued DoD instruction 5000.84 as policy to implement the statutory requirements. A key focus area of the new policy is how study teams will demonstrate their readiness to successfully accomplish an AoA in just 9 months.		

This paper highlights the challenges of completing a thorough AoA in 9 months, and discusses the specific policy elements that are designed to ensure study success. Classification: UNCLASSIFIED Working Group:WG 25 AoAs and Capability Development

56919 - Understanding International Treaty efforts which impact Electromagnetic Spectrum (EMS) effectiveness in permissive environments

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Jerome Foreman; Isis Culver; Torri Preston		

Abstract: Freedom of action in cyberspace and the electromagnetic spectrum (EMS) is a key enabler to 21st century Joint Force operations. Furthermore, it is the goal of the Department of Defense to dominate this environment through conducting Electromagnetic Spectrum Operations (EMSO) across all domains. Efforts such the Naval Tactical Grid, the Army's Project Convergence, and the Joint All Domain Command and Control (JADC2), are dependent upon cyber and EMS environments as the bedrock for overlaying future networks to fight our Nation's adversaries. These architectures all map out dependences on EMS for sensing, communicating, or exploiting the environment and providing a Commander's running estimate through a Common Operation Picture (COP).

This means seeking EMS dependent capabilities that meet National Strategic objectives, may not always consider our Nation's Economic Strategies. As our nation strives to work harmoniously between Federal and Non-Federal assured access of radio frequency (RF) spectrum, our adversaries do not see the divide. Some of our adversaries see electromagnetic spectrum (EMS) and RF spectrum as a single resource, unified under one holistic strategy. Our adversaries will use diplomacy to enhance its status in the economic world while securing capabilities for its military in a single strategic act. As our nation seeks economic growth in 5th Generation (5G) technologies in the race against other countries globally, inadvertently we may relinquish critical domestic RF spectrum that could equate to a temporary loss of DoD capabilities for our nations warfighters in future conflicts.

Every four years the International Telecommunications Union (ITU) hosts a World Radio Conference (WRC) to gain consensus on treaties supporting radio frequency (RF) allocations and the use of particular frequency bands. The establishment or modification of these treaties do not necessarily align spectrum use to support global harmonization. Depending on the agenda, treaties are established to support specific regional goals within the world if an international consensus is reached. As countries shape RF to support technical advancements with strategic implications, this consequently can impact how the DoD accesses spectrum both National and International on a permissive basis.

The key concept of this paper is to bring about the call for a deliberate process to analyze trends in spectrum policy, identify cost effective ways to shape policy with a strategic goal, and expand the long-term vision of developing requirements survivable in a policy shaped EMS constrained environment.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

57211 - AF Futures Analytic Management Process and Tools (UPDATE)

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Christian Cordy; Patrick O'Connor; Mr. Matthew T Sampson		

Abstract: Analytic Management in Air Force Futures consists of a Process and Tools that were introduced in 2020 at the Virtual Symposium by the Air Force Warfighting Integration Capability (AFWIC). Since that time, AFWIC has been subsumed into Air Force Futures and, despite COVID impacts, there has been continuation of effort and significant progress made in Analytic Management on the following fronts:

•Concept Decomposition in Support of Futures and Concepts has continued with numerous new decompositions or updates completed – this provides the Analytic Framework within the Concept and benefits Concept Development and Removing Uncertainty.
•Analytic Repository of documents "relevant" to AF Futures has grown to over 300 entries (all on SIPR, 80 on NIPR) – each abstract provides 4 W's and "So What?" for each document
•NIPR Title and Keyword "Search" capability (all 300+ holdings) developed to facilitate collecting a list of studies on NIPR and then accessing some on NIPR and all on SIPR.
•Analytic Planning and Execution Tool developed in Microsoft Access on NIPR and ported to SIPR for tying it all together and developing User-Defined Queries as new tasks are given.
•Natural Language Processing (NLP) enhancements developed in R on NIPR and ported to SIPR for conducting more robust abstracting, searching, relevance determination and inter-document correlation.

Accordingly, the presentation will recap the essence of Analytic Management and focus on the changes, enhancements and linkages to other efforts.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

57240 - Early Lifecycle Prediction of Reliability

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Tevari James Barker; Dr. Randy Buchanan; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Mr. James Richards; Christina Rinaudo		
Abstract: Traditional reliability approaches require extensive knowledge of a system and are used in later design stages as well as operational test and evaluation. The critical role of reliability in acquisition program performance, cost, and schedule has motivated the need for improved system reliability models in early design stages. The U.S. Army Engineering Research and Development Center seeks to integrate reliability, performance, and cost models in a trade-off analysis framework in the Pre-Systems acquisition stages. We are developing models to estimate reliability Pre-Milestone A and assess the impact on performance and cost models for the system concepts. Our research estimates system reliability of Unmanned Ground Vehicles using knowledge and data from similar systems. We propose three approaches for estimating reliability based on the type of system to be developed: all new system designs, systems with a mix of existing and new subsystems, and systems integrating existing subsystems. The integrated model will inform decision-makers on the impact of reliability before they choose a system concept for further development.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development | | |

56390 - Development of a Tactical Airfield Site Selection Toolbox

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Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr Dylan Pasley; Matthew Hiett; William Fields; Max Foltz; Noah Garfinkle		

Abstract: Tactical airfield site selection is a critical and complex problem in austere environments which lacks a contemporary solution. Engineers require information on geographical characteristics in order to effectively plan where airfields can or should be located. However, compiling and analyzing geospatial data to support airfield site selection is a complex task. The current processes proves to be very time intensive and laborious which inherently carries an increased risk associated with completing airfield siting tasks. Adding to the technical obstacles of developing a robust solution is the challenge of proper integration of the solution into the operating environment. The research and development of this solution took the scope of use into careful consideration when designing a response to the stated issues. As a result , we developed a platform agnostic application to automate the process of compiling relevant information to inform the site selection process. The proposed solution is one of many tools that belong to a suite of geospatial analysis applications and was designed to operate independently or in concert with similar remote assessment and planning tools This begins with compiling geospatial data. Guided by the appropriate military doctrine and publications, as well as airfield subject matter experts, we identified key characteristics that establish a proper airfield site. We then developed approaches for efficiently scoring potential airfield locations through moving window analyses, assessment of glide paths that minimize terrain obstructions, and an approach for calculating cut/fill on a plane. These tools are demonstrated with sample data. The application resulting from this research has been incorporated into the newest forthcoming release of the Joint Construction Management System. The site selection component of JCMS 5.0 makes this tool accessible to a wider audience which spans the joint forces and offers a focused and united solution to a broad issue.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56984 - Modeling Autonomous UAV Swarms in AFSIM

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Joseph Limber		

Abstract: An SPA team is developing an Advanced Framework for Simulation, Integration, and Modeling (AFSIM) model to evaluate heterogeneous and homogenous swarms of UxVs. Our SESU model takes an innovative approach to model low-level swarming and autonomous behaviors by leveraging concepts from biology and Artificial Intelligence (AI). This model leverages research on swarms in nature to provide low-level autonomy for members of the UxV swarms. In this type of model, each individual actor is guided by a limited set of rules that it can implement without explicit orders from another member of the group. These rules are inherently nonlinear; mixing them introduces chaotic behaviors. At the same time, they include negative feedback that keeps the group dynamics ordered. The result is life-like group behavior.

Our AFSIM model extends this concept, adding rules that enable the UxVs to exhibit coordinated behavior aligned to operational objectives without the need to control each member of the swarm directly. This approach diverges from a strongly hierarchical Command and Control (C2) approach often used for UxV control and enables evaluation of simple C2 structures to control complex architectures with many participants. It also creates a system that degrades gracefully in the face of individual losses and does not present critical nodes to be exploited by an adversary.

The inputs from these rules are integrated within this model in a manner that is analogous to a vector implementation of neuron activation in a Deep Neural Net. Different behaviors, appropriate for

different mission phases, can be developed by tuning the parameters of the potential fields and activation functions instead of by writing new software. In the current model, these parameters are manually tuned, but in the future, we hope to be able to use Deep Reinforcement Learning techniques to tune them based on mission success criteria.

Classification: UNCLASSIFIED // FOUO
Working Group:WG 25 AoAs and Capability Development

56657 - Counter – Small Unmanned Aerial Systems (C-sUAS) Basis of Issue Sprint

Start Date: 6/24/2021	Start Time: 12:00 PM ET	End Time: 12:30 PM ET
Authors: Kristofer Dean Fosmoe		

Abstract: Friendly forces and installations are under threat from small unmanned aerial systems, which have increased drastically in their capabilities and proliferated widely due to decreasing costs. Consequently, the Department of Defense established the Joint Counter – small Unmanned Aerial Systems Office (JCO) to provide oversight and acquisition of capabilities to overmatch this emerging threat.
Following a JCO selection of eight initiatives from across the Services, Army leaders directed The Research and Analysis Center (TRAC) to conduct a rapid analysis to inform programming and budget decisions for an optimal set of capabilities. The study team was given 4 weeks to conduct this sprint analysis. Consequently, the analysis was focused at the United States Army Division echelon.
The study team engaged intelligence analysts, warfighters, observer/trainers, and program managers to analyze the attributes of each C-sUAS initiative in large scale combat operations. Warfighters and observer/trainers provided information on priority protection assets across both heavy and light divisions. The study team created 4 threat vignettes, and identified over 15 unique candidate protection assets that were combined into a generic Division template.
Ultimately, the study team synthesized this information to provide a range of procurement options of C-sUAS equipment.
This presentation discusses the study approach for identifying C-sUAS capability requirements and lessons learned.

Classification: UNCLASSIFIED
Working Group:WG 25 AoAs and Capability Development

56776 - High Energy Laser (HEL) Directed Energy Utility Concept Experiement (DEUCE)

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr. Joseph Allen Aldrich; Mr. Douglas W. Horne; Dr Garrett Darl Lewis		

Abstract: This briefing presents the methodology and initial findings from the High Energy Laser (HEL) Directed Energy Utility Concept Experiment (DEUCE), conducted by the Air Force Research Laboratory Directed Energy Directorate's Wargaming and Simulation Branch (AFRL/RDMW). In January 2020, RDMW brought together F-16 pilots, an F-15 pilot, F-15E weapon systems officers, and an Airborne Warning and Control System (AWACS) air battle manager to evaluate the capabilities of directed energy (DE) for the future battlefield. DEUCE exposed the visiting warfighters to airborne laser weapon systems and how they might be used to counter threats to accomplish air base air defense and platform protect missions. AFRL engaged the warfighters in several battlefield scenarios. The warfighters provided excellent assessments, identifying where there is potential military utility of DE weapons. The DEUCE provided valuable operator inputs and engagement tactics to supplement

technical analysis. Together, they provide critical information to the Air Force in evaluating how to implement new technologies, support investment decisions, and also gives warfighters insight into emerging technologies and how they may be used.

Classification: SECRET NOFORN
Working Group:WG 25 AoAs and Capability Development

WG 26 Cost Analysis

57156 - Stochastic Preemptive Goal Programming of Air Force Weapon Systems Mix

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: zach butcher; Dr. Mark A. Gallagher, FS		

Abstract: We demonstrate a new approach to conducting a military force structure study. We apply the stochastic preemptive goal program approach, described by Ledwit et al (2020), to balance probabilistic goals for military force effectiveness and the force's cost. We use the Bayesian Enterprise Analytic Model (BEAM), as described in Gallagher et al (2021}, to evaluate effectiveness, expressed in terms of the probability of achieving campaign objectives, in three hypothetical scenarios. We develop cost estimates along with their uncertainty to evaluate the force's research and development, production, and annual operating and support costs. Our summary depicts how the tradeoff between various prioritized goals influences the recommended force.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56567 - Costs and Benefits of Physical Therapy Program Implementation for Air Force Fighter Pilots

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Christian Erneston		

Abstract: Air Force fighter pilots face risks associated with neck and spine injuries sustained while operating fighter aircraft. Studies from the flying and medical communities indicate that muscle-strengthening prehabilitative care may decrease the risk of flying related injuries in high performance aircraft pilots. For this reason, the U.S. Air Force provided $24.9M to implement the Optimizing the Human Weapon System (OHWS) program. The program provides physical therapy and strength training to fighter pilots in participating units at twenty-one Air Force bases with the intent of reducing injury rates and time out of the cockpit. From a healthcare perspective there is interest in the effectiveness of the program in injury reduction. From a funding perspective there is interest in the potential for a positive net present value (NPV) of the OHWS investment. This research utilizes injury data obtained from the Force Risk Reduction (FR2) tool to analyze injury rates, injury types, physiological injury locations, as well as medical and non-medical injury costs to form an NPV estimate for the OHWS program. The research finds that the OHWS program provides a large positive NPV given the potential effects on injury reduction and fighter pilot separations from active duty service that the program provides.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

57154 - Early Lifecycle Prediction of Reliability

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Tevari James Barker; Dr. Randy Buchanan; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Mr. James Richards; Christina Rinaudo		
Abstract: Traditional reliability approaches require extensive knowledge of a system and are used in later design stages as well as operational test and evaluation. The critical role of reliability in acquisition program performance, cost, and schedule has motivated the need for improved system reliability models in early design stages. The U.S. Army Engineering Research and Development Center seeks to integrate reliability, performance, and cost models in a trade-off analysis framework in the Pre-Systems acquisition stages. We are developing models to estimate reliability Pre-Milestone A and assess the impact on performance and cost models for the system concepts. Our research estimates system reliability of Unmanned Ground Vehicles using knowledge and data from similar systems. We propose three approaches for estimating reliability based on the type of system to be developed: all new system designs, systems with a mix of existing and new subsystems, and systems integrating existing subsystems. The integrated model will inform decision-makers on the impact of reliability before they choose a system concept for further development. Classification: UNCLASSIFIED Working Group:WG 26 Cost Analysis		

56576 - Forecasting and Optimizing Spares Inventory under Changing Demands and Capabilities

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: John Hagood; Kyle Morgan		
Abstract: Over half of all costs of DOD programs are associated with operations and support of the program. For aircraft, a large percentage of that cost is directly related to the acquisition and repair of spare parts. Improperly allocated purchases run the risk of short-falls of certain items – bringing about operational delays; while others sit on shelves indefinitely— consuming funds that could have been used more effectively. Accordingly, accurately predicting stock levels and demand over the life cycle of the system is of utmost importance when trying to minimize waste while maximizing operational effectiveness. Our approach to this problem is two-fold, first predicting demand and expected short-falls in stock, then optimizing against these stock levels to suggest order frequencies and quantities. Predictions of demand and short-falls in the Total Inventory and Forecasting (TIAF) model take into account all aspects of the support structure, including squadron stand-up schedules, current inventory levels, deployment requirements, operational requirements, and OEM/Depot repair capabilities. We then utilize various optimization techniques to provide a schedule of orders and quantities which will ensure demand is met for the given life cycle. We will discuss the capabilities of our prediction model and the process of selecting an optimization method which provides the right balance of accuracy and usability. Classification: UNCLASSIFIED Working Group:WG 26 Cost Analysis		

56561 - HMMWV Lifecycle Cost Analysis and Decision Support

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Abe Payne		

Abstract: The Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA(ALT)) participates in decision-making with other Army Senior Leaders regarding the funding of the procurement of new systems. The Army must manage the balance between the Army's modernization efforts and readiness of the current systems. The ability to identify and analyze economic tradeoffs and the impact of resourcing decisions on the modernization and readiness of the Army is a specialized study and difficult effort. The lack of data-driven decisions in these areas negatively impacts the ability of the Army to accomplish its vision of having the best equipped Army that maintains the technological advantage and capabilities against any threat in any environment. This study facilitates data-driven decisions and provides analysis that can be expanded and applied to other vehicles in the ground mobility fleet. This effort targets the Army's ground mobility fleet, with an initial focus on the High Mobility Multipurpose Wheeled Vehicle (HMMWV). This study provides data analysis and visualization of the lifecycle of the HMMWV to inform the ASA(ALT) and facilitate decision-making. This study also develops a model to project the economic impact of the current HMMWV fleet using Monte Carlo simulation. Monte Carlo simulation allows for the accounting of the uncertainty inherent in military operations and the variability in the use of the fleet. Additionally, this work highlights the development of a decision support tool to evaluate potential readiness and modernization alternatives. This decision support tool allows for the analysis of potential excursions for lifecycle development decisions and optimality of when to make those decisions.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

57155 - Truth or Dare: Do an AoA in 9 Months

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Harry W. Conley		

Abstract: The 2020 National Defense Authorization Act requires AoAs be completed within 9 months of study initiation. For complex AoAs, this is a challenging requirement. The Office of the Secretary of Defense, Cost Assessment and Program Evaluation issued DoD instruction 5000.84 as policy to implement the statutory requirements. A key focus area of the new policy is how study teams will demonstrate their readiness to successfully accomplish an AoA in just 9 months.

This paper highlights the challenges of completing a thorough AoA in 9 months, and discusses the specific policy elements that are designed to ensure study success.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56790 - An Analysis of Stability in Software Resource Data Report (SRDR) Computer Software Configuration Items (CSCI)

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Trevor Violette; Jonathan Ritschel; Lt Col Scott Drylie; Edward D. White, III		

Abstract: This research studies cost and schedule stability in programs that utilize Software Resource Data Report (SRDR) reporting standards. We find software programs at the Computer Software Configuration Item (CSCI) level show much lower levels of stability than previously published DoD stability research that focused on aircraft. A comparison of software development methods found little to no difference between Agile and Plan Driven methodologies. Critical Success Factors (CSF)

were identified from prior literature and used to examine CSCIs from the SRDR dataset. Focusing on schedule or cost resulted in different variables showing significance. A CSCI is more likely to remain on budget when using a team with a low level of average experience and being judicious in your contractor selection. A CSCI is more likely to finish on schedule when a team has an average level of experience and Boeing is used as the primary contractor. A CSCI is more likely to remain on budget and on schedule when Lockheed Martin is the lead contractor and the CSCI is programmed in any language other than C. This research can be used by program managers and cost analysts to identify the critical success factors that can be utilized in the Department of Defense software environment to create trade off space between cost and schedule.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56587 - Analyzing the Current State of Air Force Agile Cost Estimation

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: James Goljan; Dr. Jonathan Ritschel; Lt Col Scott Drylie; Dr. Edward White		

Abstract: The research objective is to compare the predominant literature on Agile cost estimating techniques against the methods utilized within Agile Air Force organizations. The study identifies a sample of 83 empirical sources regarding best practices for Agile cost estimation. Utilizing responses from 11 Air Force Software Factories, the study examines how the Department of Defense (DoD) has adapted cost estimating techniques in an Agile environment. Statistical analysis demonstrates two takeaways on Agile cost estimating in the DoD. First, comparing the two data sets reveals that contrary to the predominate literature supporting the advancement of more complicated cost models that incorporate machine learning with Data-Based techniques, Air Force Software factories employ simplified Engineering Build-up Capacity Based estimating supplemented by Non-Algorithmic techniques. There are no instances of Data-Based techniques currently employed in the Air Force, contrasting to 48 of the 83 sources (57.83%) in the literature which recommend their application. Second, the findings highlight a movement away from source lines of code (SLOC) as a metric for cost estimation by both the literature and Agile Air Force organizations. Two out of 11 Air Force Software Factories in addition to 11 of the 83 literature sources utilize SLOC as a sizing metric. The results highlight that the Air Force has taken strides towards modernizing its cost estimating processes; however, continued adaptation is necessary to remain relevant according to the predominant literature.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56757 - CASREP Addback Analysis

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Ben Levinson		

Abstract: How much money would it cost to decrease the amount of CASREPs onboard United States Navy ships? Exactly how many CASREPs can we expect to reduce, and what is the average optimal investment per ship in respect to CASREPs reduced and fiscal feasibility? To answer these questions, a simulation using R was created to reproduce the NAVSUP Weapon Systems Support (WSS) current CASREP "Addback" process. This analysis was performed to validate NAVSUP's current CASREP Add-back policy, one which supplements allowances for material with reoccurring demand. Tasked with

determining the efficacy of each existing condition, our goals were to determine the optimal CASREP Addback parameters and to provide the Fleet with a wide range of investment options to decrease future CASREPs.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56509 - Integrating Cost as a Decision Variable in Wargaming

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Joshua Reese; Jonathan Ritschel; Brent T Langhals; Mr. Ryan Engle		

Abstract: The Integrated Sustainment Warfighter Analysis Toolkit (ISWAT) represents a technological step forward in wargaming capabilities. To further advance ISWAT, wargamers sought to include cost as a decision variable in wargaming. This research represents the first steps toward this goal. For our research we focused on cost per flying hour of 81 aircraft, 23 munitions, unexploded ordnance removal, and runway damage repair. The key focus of our research is maintaining a high degree of flexibility in our cost models to match the wide variety of scenarios available in wargaming.

This research represents the first inclusion of cost in wargaming and thus many challenges were faced. The largest of which is the lack of an authoritative centralized unclassified repository for deployed flying hours. Thus, precluding wargaming flying hour costs from being calculated in the same manner as the US Air Force currently calculates peacetime flying hour costs. However, we leveraged the Office of Secretary Defense – Cost Assessment and Program Evaluation's Operating and Support Cost element structure to identify the relevant operating costs necessary to establish a wargame cost per flying hour. This includes a method to delineate peacetime and wartime expenditures through regression analysis. In addition to the development of a wargame cost, this research provides a framework to assess the trade space between wargame effectiveness and cost. The analysis provided by this research is aided by the development of cost visualizations with key cost performance indicators for analysis. During beta testing of our cost model in ISWAT, we received positive feedback from senior leaders in Air Force Material Command A4. While the results are tailored for implementation in ISWAT the implications can be easily integrated into other US Air Force wargames.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

55301 - Masters and Certificate Program in Cost Estimating and Analysis at NPS

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Karen Richey Mislick		

Abstract: Abstract: This presentation provides an update to the Master's Degree offered at the Naval Postgraduate School. NPS is meeting the need for a distance learning master's program in the cost estimation field by offering a two-year, 16 course curriculum with 194 graduates so far. There is also a four-course certificate program that encompasses one course per quarter for 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 program, achievements to date, research undertaken by current students, possible teaching opportunities for MCEA, and lessons learned from our experience so far in this innovative and challenging program. We commenced our eleventh cohort in March 2021 and look forward to you joining us in March 2022! Upon graduation, all students will meet all training requirements to be DAWIA Level I, II and III complete in the DAU Business-Cost Estimating (Business-CE) career field.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56811 - Modernizing a DoD Environmental Estimating Tool

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Willie Brown; Dr. Jonathan Alt; Dr. Simon R. Goerger; David Griggs; Matieu Lagarde		

Abstract: The DoD environmental cost estimating community employs parametric cost-estimating models to estimate environmental investigation and cleanup costs. They make use of a 30-year-old desktop application with users across multiple government agencies, and a workflow analysis revealed that different agencies use the tool differently. Although some agencies only use parametric cost-estimating models for out-year budgeting and appropriations, other agencies use them throughout the projects' lifecycle. Given the size of the user community and the different workflows used in the cost estimating process, the system design process was employed to develop requirements for a parametric environmental cost estimating capability. During the requirements elicitation process, the team identified that the currently-employed parametric cost estimating models require validation, verification, and accreditation (VV&A) prior to inclusion in the new enterprise software. This briefing will provide an overview of the methodology used to elicit and prioritize requirements from this broad community and discuss some of the challenges that the VV&A effort must address.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

57326 - Investment Value Management: Post-Investment ROI-Based Performance Management

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Kevin Buck		

Abstract: The MITRE Corporation has created a Return-on-Investment (ROI) -Based Post - Investment Value Management Capability to optimize the selection, potential elimination, and on-going balancing of investments based on priorities, costs, benefits, uncertainties, and risks. The idea is to apply the very same techniques leveraged for selecting investments in the first place to then manage those selected investments on an enduring basis throughout the investment lifecycle. The capability answers the questions "are we continuing to realize our initial value expectations from a government investment on a continual basis? If not, why?"
The Investment Value Management Capability includes:
(1) A detailed 5-step ROI management process guideline for training purposes and to maximize benefits from the techniques and tools that are intrinsic to this capability.
(2) An intuitive ROI Analysis Model (RAM) for selecting and monitoring selected investments over time (based on comparisons of actual performance relative to initial ROI expectations).

(3) An early warning system to automatically trigger course correction recommendations for investment decision-makers and metrics owners based on degree and duration of performance variance between initial investment expectations and actual results.

While the academic underpinnings of this capability derive from commercial industry ROI techniques, they have been significantly tailored to address the unique circumstances for government agencies. The creation of this capability is the culmination of over two decades of government-funded research and experience supporting DoD sponsors. This capability has been prototyped for DoD, civilian, and Intelligence Community government enterprises.

Investment decision-makers often define ROI quite differently, and the RAM incorporates four different ROI metrics that address various aspects of investment attractiveness, including Net Present Value (NPV), Benefit/Cost Ratio (BCR), Internal Rate of Return (IRR), and Discounted Payback Period (DPP). These directly monetizable calculations can be prioritized and are reported separately from other investment implication assessments. Non-monetizable implications are also reported separately, along with a series of DoD-compliant risk matrices that illustrate risk vulnerability for various investment assessments. Decision makers control which, and how significantly, investment implications will affect their decisions regarding initial investment selection and, subsequently, how to most effectively manage investments if selected.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56774 - Finding the Story in Your Data

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
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.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56956 - Understanding the trade-offs of performing cost analysis pre–Milestone A

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET

Authors: Mr. James Richards; Dr. Jonathan Alt; Mr. William Leonard; Christina Rinaudo
Abstract: Tension exists between efforts to increase pre-Milestone (MS) A program life cycle cost analysis requirements to ensure rigorous evaluation while also minimizing analysis time and increase the speed of the acquisition process. At the heart of this apparent conflict is a fundamental question: does sufficient system information exist pre-MS A to allow useful life cycle cost estimation to enable informed system, program, and portfolio decisions? When a system is in early concept development, very few design decisions have been made and the understanding of mission, Concept of the Operations (CONOPS), and requirements are still developing and evolving. However, significant programmatic foundations, such as affordability goal, contingency budget, and program strategy originate during this formative stage of the life cycle. This research seeks to characterize the relationship between pre-MS A program cost and technical knowledge and the cost success of historical DoD acquisition programs. This presentation identifies gaps and opportunities for early cost model integration with computationally intensive conceptual design modeling and simulation for system understanding and performance prediction. Classification: UNCLASSIFIED Working Group:WG 26 Cost Analysis

56717 - Data Visualization for Cost Estimation

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Parker B Mulholland		

Abstract: Problem: Organizations rely too heavily on dated methods of data presentation/visualization. While programs like PowerPoint and Excel are still highly essential and useful tools, there are other means of more effectively presenting data, such as Microsoft Power BI. The government cost estimation space can leverage data visualization software to develop more dynamic cost models and meaningful visualizations.

Approach to solving: Power BI is a business analytics software that is used for creating interactive dashboards and finding essential insights from data. This software has incredibly useful tools catered towards simultaneously manipulating data as well as effectively presenting it. Power BI dashboards can serve as a huge time saver for cost model reviews and other presentations, especially in times of a virtual work environment. One refined dashboard could encapsulate 20+ PPT slides and dozens of excel based visuals. It is only a matter of taking the step to learning how to use the software and using the correct data visualization methodology.

Techniques used: In my first steps to learning the software I used an old excel cost estimate and formatted the data in excel to work with Power BI. I created tabular data tables so that the import into the software would work and I was able to create a dashboard for an old torpedo estimate. From here I was able to demonstrate how useful the software can be in presenting data, and finding new trends/correlations. I continued to work with the software and became familiar with Power Query and new techniques like slicer panels and bookmarks. This allowed me to simply upload any existing cost model into the software, and transform it into a dynamic dashboard without actually changing the original data set. This technique is what I want to show off in my demo as I believe it is one of the most useful parts of using Power BI.

Challenges: With any new software, there are always challenges. The first challenge will come about right when you want to upload your data set/cost model. The program reads data differently than the

average person or even excel might. There is a formatting data tables need to fit to work effectively with the software, this is called a flat table. Learning about the correct visuals to use based off your data is another challenge, that requires an data analytics mindset.

Conclusions: It is easy to stick to the programs you understand and know will work. However, with the rate technology is growing and moving, it is important to constantly be re-thinking and re-learning to stay up to date. Power BI still may seem as a relatively new visualization method, but in reality it has now been around for 7 years, but still does not see enough use, especially within the government space.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56499 - Best Practices in Decision Analytic Presentations to Influence Action

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Erika Garcia-Boliou		
Abstract: As a data professional, it is imperative that when we communicate our findings, we not only do it in a lucid manner but also in a way that will influence action. Our analysis has more value when we can help organizations make decisions and more importantly, ACT on those decisions. Classification: UNCLASSIFIED Working Group:WG 26 Cost Analysis		

57012 - Improving Decision-Making for Major Defense Acquisition Programs: Establishing a Reference Class

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Jeffrey Michael Voth; Mr. Maxwell C. Moseley		
Abstract: Cost and schedule performance for major weapon system programs remains a challenge, leading to an average capability delivery delay of more than two years, according to the Government Accountability Office's 2020 annual assessment. In a recent Proceedings article, Senate Armed Services Committee leadership denounced DoD's dismal track record of "absurd acquisition debacles that have set back the country tens of billions of dollars and delayed necessary weapon systems for years" (Inhofe & Reed, 2020). To enhance analysis, multi-disciplinary teams must de-risk design and development schedules through data-driven approaches based on realized prior program histories to prevent optimism bias, which has contributed to significant cost growth and key capability delays. Previous efforts to estimate weapon system schedules have attempted to regress schedule durations against programs' technical characteristics to develop parametric schedule estimating relationships (SERs). Despite methodical and rigorous regression analyses, the high variability in program schedules, even for similar programs, precluded the development of any statistically meaningful SERs. While no trends for schedule durations exist across programs, technical characteristics, or timelines, these past program schedules, taken as a whole, can serve as analogies for future programs to provide a more data-driven approach to schedule estimating. Using datasets of major milestone dates and schedule durations for multiple commodities produced as part of the SER development efforts, the authors will discuss how operations research		

professionals can advance the current practice for schedule and performance/risk uncertainty analysis by (a) identifying an analogous reference class of past, similar programs; (b) establishing a probability distribution from selected programs for the schedule duration being forecast; and (c) comparing specific programs with analogous reference class distribution in order to establish the most likely outcome for the specific program. Ultimately, the use of comprehensive, curated datasets and descriptive statistics will provide insights within the MORS community regarding the implications of schedule dependencies and refine parsimonious models to more accurately forecast schedule performance for programs integral to the future force structure.

Within this presentation, the authors will critically analyze 116 Major Defense Acquisition Programs (MDAPs) across six commodity classes using Flyvbjerg's (2008) Reference Class Forecasting (RCF) method to mitigate optimism bias while more accurately assessing the uncertainty associated with critical capability delivery.

WG Topic: Advances in cost, schedule, and performance risk/uncertainty analysis

Reference
Flyvbjerg, B. (2008). Curbing optimism bias and strategic misrepresentation in planning: Reference class forecasting in practice. European Planning Studies, 16(1), 3-21.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

57001 - UNDERSTANDING QUANTITATIVE DIMENSIONS OF BEHAVIOR – WHY IT MATTERS IN DATA ANALYTICS

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Kenneth W. Lewis		

Abstract: In 2021 and beyond, Data Analytics & Big Data continue to be the new poster-boy buzzwords that add excitement and sparkle to the otherwise drab topics of statistics, operations research, quantitative methods, data analysis and management science. Sometimes our young or inexperienced analysts will use the wrong measurement or dimension of the behavior they are studying. They might mistakenly think they are studying the frequency of that behavior, when in fact they should actually be studying the magnitude, longevity or cost of that behavior. Understanding exactly what type of dimension of behavior the analyst is studying provides clarity and validity to the research study process. It determines the type of analysis that the research project requires. If you see the recorded data point of (7), what does it mean? Kenneth Lewis, who has taught operations research, quantitative methods and educational research methods for over 36 years, will connect some of the dots of what to measure, how to analyze and how to interpret the results.

Keywords: Data Analytics, Dimensions of Behavior, Research Methods, Computer Technology, Research Action Verbs

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

56785 - Data and AI help contracting officers free up funds for high-priority projects

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Joseph Troy Morgan; Jacob Scanlon		

Abstract: In March 2020, Army Vantage and the Army Contracting Command (ACC) began working together to address a seemingly simple set of questions: How much funding is currently on a contract, and when does that funding expire? Without easy situational awareness of the amount of excess funds on a contract, contracting officers (KOs) and financial managers often were unable to identify excess funds until they had expired and were no longer available to use for other Army priorities.

Army Vantage, ACC, and DataRobot planned and developed a way to address this challenge, integrating multiple data sources into one cohesive data layer. Together, the partnership designed an ULO identifier tool to sit atop the data foundation. The ULO identifier tool, which employs DataRobot's artificial intelligence to predict which Army contracts are most likely to have excess funds, rapidly surfaces how much money is outstanding on them and, crucially, when that money expires. This allows KOs across the Army to much more efficiently sort through and identify contracts they may wish to deobligate. A screenshot of this tool is available at www.army.mil, "Army Vantage helps contracting officers free up funds for high-priority projects". This tool allows KOs across ACC to much more efficiently sort through and identify contracts to analyze.

According to ACC officials, the results from the tool's use have been outstanding financially. Furthermore, the ULO tool has resulted in more efficient use of human capital, maximizing the impact of contracting officers' limited time.   According to ACC officials, the results from the tool's use have been outstanding. From March 1 to September 30, 2020 specifically, usable deobligations were more than $2.7 billion, versus ~$1.5-$2 billion in past years. The Army can now redeploy those deobligated funds for more effective purposes. Perhaps even more important, as a reflection of DataRobot's mission focus to build DoD AI capacity, the project now serves as an exemplar development and deployment roadmap for future DoD AI projects to follow.

Classification: UNCLASSIFIED
Working Group:WG 26 Cost Analysis

WG 27 Decision Analysis

56671 - Corona Virus 2019 (COVID-19) Support to 9th Hospital

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Danielle Monique Aldrich		

Abstract: The COVID-19 pandemic continues to strain the medical system beyond the normal standards and levels that the healthcare system in the United States is prepared to handle. In the early days of the COVID-19 pandemic, the epicenter was in New York City (NYC), NY. In late March 2020, the 9th Hospital, a Joint task force made up of medical personnel from all services, was deployed to operate an alternate care site (ACS) at Jacob Javits Convention Center in Manhattan, NY. The Javits Center was originally designed to temporarily reduce the burden of non-COVID-19 illnesses on area hospitals but quickly transitioned to taking on only COVID-19 positive patients. Soon after deployment, the 9th Hospital reached out to The Research and Analysis Center (TRAC) for analytical assistance to help optimize its response to the COVID-19 outbreak.
TRAC's study team utilized a discrete event simulation model to create a baseline that represented the activities and experiences that the 9th Hospital's staff experienced during their time in NYC. Variations of the baseline were used to conduct predictive analytics and pave a path forward to

mitigate some of the challenges faced by the study sponsors and help shape future deployment efforts.

The study found that there are multiple ways of increasing efficiency throughout the deployed hospital while also decreasing the total number of patients requiring treatment at any one time. The team also highlighted changes that reduced staff burnout and potential re-infection rates.

This presentation will cover the methods, models, and tools used by the TRAC study team to inform 9th Hospital concerns, key results, and how these results can be utilized to inform medical responses the Army can implement at ACS in infectious disaster situations.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

57215 - A Data Analytic Environment to Enable Senior Leader Decision Support - United States Central Command Use Cases

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Anita Rice Adams; Jim Soehlke; Carlius Mapp; Austin Pearson

Abstract: The vision from the December 2020 DoD Data Strategy is "DoD is a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency". One of the three initial focus areas in the strategy is Senior Leader Decision Support, which aims to "accelerate the Department's transition to using live, interactive data in place of static slides to inform strategic outcomes". This paper describes efforts in support of United States Central Command (USCENTCOM) to realize the goals of the DoD Data Strategy and the Senior Leader Decision Support focus area.

Daily, USCENTCOM collects, integrates, visualizes, and analyzes tremendous amounts of data in support of ongoing operations and to maintain AOR-wide battlespace awareness. The data comes to the Command from partner nations; other Combatant Commands; Component Commands; Services; military, government, and law enforcement agencies; as well as news, social media, and other publicly available information sources. Most of this data arrives as unstructured data such as email text, MS Office products such as PowerPoint and Word, and chat. Structured data - such as locations of entities, and inventories of munitions, supplies, and personnel - are embedded in the unstructured feeds and are manually extracted to produce static dashboards in Power Point. This process is effective but is slow, does not easily scale, and does not provide the repository of machine-readable data required for advanced analytics including machine learning. USCENTCOM's goal is automated data integration and analysis to support faster and better operational decision making.

The MITRE Corporation, in collaboration with the USCENTCOM J3 and J6, developed a conceptual architecture for a data analytic environment (DAE) to support USCENTCOM's goal. The DAE describes the end-to-end pipeline from the authoritative data source, the acquisition, integration and storage of the data, access to the data by analytic tools, and enterprise data management across the lifecycle of the data to ensure its provenance and quality. The team prototyped the DAE and analytic dashboards for two use cases: Commander's Daily Briefing, and the COVID Crisis Action Team Daily report. This paper describes the DAE conceptual architecture, the use case prototypes, and lessons learned.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56468 - Balancing Quality and Quantity in an Innovative Pilot Training Pipeline

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Brian Morrison		
Abstract: Critical to meeting the Air Force's annual pilot requirements is a balanced pilot production, absorption and sustainment system. The pilot production pipeline produces pilots at undergraduate pilot training (UPT), flows them to formal training units, and then absorbs them into operational units. Increasing pilot production requires consideration of several factors including, amongst others: (i) quality of student training; (ii) management of instructor pilots (IPs); and (iii) plant capacity (number of available aircraft, maintenance, runways/airspace, etc.) to produce pilots. The Air Education and Training Command's Studies and Analysis Squadron (AETC SAS) conducts studies assessing pilot training initiatives aimed at transforming UPT training through innovative learning methods. SAS also develops tools aimed at providing insight into IP workload/stress while providing this training. Limited plant capacity and time constraints add to the problem of producing quality pilots at an acceptable quantity. The objective of this brief is to provide case examples of how SAS tackles these issues, including a deep-dive into a modelling and simulation study aimed at increasing quality of student pilots while maintaining production and plant capacity. These efforts provide decision makers insights into advancing next-generation training for ~1.5K students per year while improving the management of ~1.1K instructor pilots. Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis

56706 - Analyze Complex High Dimensional Data using Topological Data Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Amy Bednar		
Abstract: Topological Data Analysis (TDA) is a growing area of Mathematics that uses fundamental concepts of Topology to analyze complex high dimensional data. The data is represented by a topological network and TDA uses the network to look at the shape of the data to identify features in the network which correspond to patterns in the data. These patterns are important to understanding the data. TDA provides a framework to advance machine learning in order to understand and analyze large complex data. This presentation provides background information and examples using TDA. Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis

56968 - Rapid Web Scraping and Natural Language Processing Towards New Methods for Identifying Interdependencies and Interoperability Relationships

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: 2044891464 Michael Petryk; Dr. Kendall Wheaton		
Abstract: In the case of major capital projects, the analysis of interdependencies can help to ensure the proper selection and sequencing of projects that depend upon one another, thereby reducing the risk of losses or inefficiencies. In the case of the Department of National Defence, the relationships between projects and capabilities are likely to have an impact on defence plans and strategies. Further, interoperability with Allies is an important consideration in prioritizing investment decisions so as to maximize interoperability and to minimize any negative impact on any interoperability by

new projects and investments. The ultimate goal of this research is to be able to rapidly and with minimal user input identify interdependencies and interoperability relationships.

Increasingly data analysts are struggling not to find data, rather, the struggle is one to turn ubiquitous data sources into a distillation of concise (and useful) facts and relationships. To this end Defence Research & Development Canada's Centre for Operational Research and Analysis has assembled a suite of software tools and methods to enable the rapid ingestion of data (e.g., with web scrapers), the automated processing of data into facts and relationships (using natural language processing, or nlp, to create knowledge graphs), and the display and analysis of the resultant processed data in a graph database.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56842 - Improving Decision-Making for Major Defense Acquisition Programs: Establishing a Reference Class

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET

Authors: Mr. Jeffrey Michael Voth; Mr. Maxwell C. Moseley

Abstract: Schedule performance for major weapon system programs remains a challenge, leading to an average capability delivery delay of more than two years, according to the U.S. Government Accountability Office's 2020 annual assessment. In a recent Proceedings article, Senate Armed Services Committee leadership denounced DoD's dismal track record of "absurd acquisition debacles that have set back the country tens of billions of dollars and delayed necessary weapon systems for years" (Inhofe & Reed, 2020). To enhance analysis in national security applications, multi-disciplinary teams must de-risk design and development schedules through data-driven approaches based on realized prior program histories to prevent optimism bias, which has contributed to significant cost growth and key capability delays.

Previous efforts to estimate weapon system schedules have attempted to regress schedule durations against programs' technical characteristics to develop parametric schedule estimating relationships (SERs). Despite methodical and rigorous regression analyses, the high variability in program schedules, even for similar programs, precluded the development of any statistically meaningful SERs. While no trends for schedule durations exist across programs, technical characteristics, or timelines, these past program schedules, taken as a whole, can serve as analogies for future programs to provide a more data-driven approach to schedule estimating.

Using datasets of major milestone dates and schedule durations for multiple commodities produced as part of the SER development efforts, the authors will discuss how national security professionals can advance decision analysis practice by (a) identifying an analogous reference class of past, similar programs; (b) establishing a probability distribution from selected programs for the schedule duration being forecast; and (c) comparing specific programs with analogous reference class distribution in order to establish the most likely outcome for the specific program. Ultimately, the use of comprehensive, curated datasets and descriptive statistics will provide insights within the MORS community regarding the implications of schedule dependencies and refine parsimonious models to more accurately forecast schedule performance for programs integral to the future force structure.

Within this presentation the authors will critically analyze 116 Major Defense Acquisition Programs across six commodity classes using Flyvbjerg's (2008) Reference Class Forecasting (RCF) method to mitigate optimism bias while more accurately assessing the uncertainty associated with critical capability delivery.

WG27 Topics: Innovations in DA Practice and Theory; Modeling Risk and Uncertainty in Decisions; Acquisition Applications Of DA and Risk Management.

Reference
Flyvbjerg, B. (2008). Curbing optimism bias and strategic misrepresentation in planning: Reference class forecasting in practice. European Planning Studies, 16(1), 3-21.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56590 - A Multi-Criteria Decision Making Approach to Prioritizing Chemical Biological Defense Program Gaps and Activities

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Ms Shawn Davies		

Abstract: The Chemical Biological Defense Program (CBDP) Joint Strategic Portfolio Analysis Review (JSPAR) is an annual planning process during which the military Services review their strategy and prioritize activities to fill capability gaps in chemical and biological defense. The CBDP Executive Agent (dual hatted through Assistant Secretary of the Army Acquisition, Logistics and Technology (ASA(ALT)) and Headquarters Department of the Army G8) has helped the Services mature the process since its inception in 2017, and tasked the Joint Chemical, Biological, Radiological, Nuclear Defense Program Analysis and Integration Office (PAIO) with developing and facilitating a repeatable, defensible approach to conducting the review and prioritizing the activities in 2019. PAIO organized the JSPAR into three phases: gap prioritization; capability strategy review; and research, development and acquisition (RDA) activity assessment. The updated approach is the first time that Services were able to document their Service-specific operational context for Joint Requirements Oversight Council-approved gaps and prioritize those gaps using a multi-criteria decision making (MCDM) methodology according to national strategic objectives, joint force risk, and Service needs. The gaps now serve as a foundation for the capability strategy review, in which the Services review when RDA activities are planned. PAIO generates integrated master schedules showing all planned CBDP RDA activities and conducts detailed alignment analysis for the review. These products enable the Services to discuss activity alignment across the acquisition lifecycle (from requirement generation through sustainment and divestment) and identify capability development strategy to inform the joint staff and programming efforts. The JSPAR process culminates with a second MCDM assessment of how well the RDA activities mitigate the gaps and operational risk. The results represent the first time CBDP RDA activities are able to be traced directly to Service-specific gaps and operational plans. The first full iteration of this approach was completed in December 2020. The Services appreciated the collaborative approach used to document and assess gaps and CBDP RDA activities. The results are being used to inform the development and prioritization of decision packages during the programming phase to develop the CBDP Program Objective Memorandum.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56950 - Optimized scheduling of constrained DoD resources: a MIP optimization implementation

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Matthew Liljenstolpe; Joe Litko, P.h.D.; Joseph E Schoenbeck		

Abstract: The Center Scheduling Optimization Module (CSOM) is a customized, deterministic optimization tool utilizing Mixed Integer Programming (MIP) that provides automated and efficient scheduling of constrained DoD resources for the Air Force. CSOM quickly builds a "90% solution" to maximize the utility of high-cost, low-density resources (e.g., weapons systems, ranges, airspace, etc.) CSOM is seamlessly integrated into a well-established and robust enterprise scheduling platform. It utilizes commercial off-the-shelf (COTS) optimization software (Gurobi) as the solver engine within a Microsoft .Net environment and is currently authorized on a DoD network.

Complicated scheduling problems require a dedicated team of experienced scheduling practitioners to think tactically about executing each mission in the face of a complex set of interconnected resource conflicts and strategically to design the best overall schedule that safely optimizes quality throughput. Traditionally, complex scheduling problems are handled serially in a manual scheduling environment, which results from a human's inability to balance potentially millions of interconnected relationships simultaneously. This serial approach creates a recursive process whereby schedulers fix a conflict downstream and then must backtrack to discover the resource constraints subsequently broken upstream. Ultimately, this "two steps forward, one step back" process wastes valuable personnel time. More importantly, this results in inefficient utilization of our limited resources. Modern computer processing power, optimization software, and Operations Research (OR) practitioners can largely mitigate these inefficiencies. A computer-assisted scheduling tool, utilizing MIP, can simultaneously view the entire solution space and select the best solution from an impossible to visualize web of interconnected constraints. CSOM aims to ease scheduling teams' burden with a robust and optimal starting point produced in minutes versus multiple person-days. Thus, it enables the scheduling team to focus on improving quality and safety from a myriad of ever-changing, contextual, and unwritten rules.

A tool supported by a MIP structure has additional benefits: high-quality analysis of alternatives (AoA) as schedulers can iterate through multiple solutions with varying inputs and priorities; and sensitivity analysis from the strategic to tactical levels of scheduling. The potential for new scheduling tools built around modern OR methods that can deliver better utilization of our resources is enormous if implemented at the enterprise level. It is possible now; CSOM proves that. Adopted holistically, advanced resource management tools will enable our services to utilize their resources to a much higher level of efficiency.

Other applications of this methodology include constrained transportation networks, scheduled-maintenance schedules, and enterprise-wide force management.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56498 - Best Practices in Decision Analytic Presentations to Influence Action

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Erika Garcia-Boliou		

Abstract: As a data professional, it is imperative that when we communicate our findings, we not only do it in a lucid manner but also in a way that will influence action. Our analysis has more value when we can help organizations make decisions and more importantly, ACT on those decisions.

56679 - Multiplicative Trade Studies

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET

Authors: Mr. James M. Eridon

Abstract: MULTIPLICATIVE TRADE STUDIES
James Eridon
General Dynamics Land Systems, Sterling Heights, Michigan

  Combat vehicle design necessarily involves trade studies that attempt to balance varying performance criteria against associated burdens, such as weight, cost, and risk. Typically, trade studies quantify the value of different options by evaluating each on individual criteria and then generate a weighted sum score. In the method described here the score is generated multiplicatively rather than additively. Also, the importance of each evaluation criterion is used to generate utility scores for that criterion. This improves the trade study process in two significant ways. First, making the overall score multiplicative greatly reduces the "compensation" problem, where good performance in some criteria can outweigh exceedingly poor performance in others. With a multiplicative method, only balanced solutions can score well. Second, using importance weights to establish utility scores for criteria simplifies the process, making it easier to conduct trades and evaluate the sensitivity of the results.
  Trade studies normally calculate an overall score as a weighted arithmetic average of individual utility scores and the importance weights. This paper proposes the use of a multiplicative score based on the geometric mean, so that the overall score is calculated as the root of the product of the individual utility scores. This eliminates the problem where an unacceptable option can still score quite well. In this approach, any option that has unacceptable performance on any criterion will score zero overall, and any option with very poor performance on any criterion will suffer a severe penalty relative to other options, and is unlikely to fare well.
  Note that the multiplicative formula described above does not include any importance weighting for the various criteria. However, if the importance of various criteria are ranked on a scale of 0 to 10, it is a simple matter to generate utility curves that result in a trade study in which it can be shown that the sensitivity of the results is directly proportional to the importance of each factor.
  This approach to trade studies can quickly identify the most likely options, provide head-to-head comparisons between any two, and generate sensitivity charts that show the robustness (or lack thereof) of the choice. The results of the study make it easy to distinguish which options have unacceptable (or nearly unacceptable) performance on any key criteria, which is one of the significant advantages of this method over the conventional weighted sum approach.

Topic – Innovations in DA Practice and Theory

Reference
David Strimling, "Use of Multiple Criteria Decision Analysis in the Marine Corps Advanced Amphibious Assault Vehicle (AAAV) Program", 67th MORS Symposium, 1999.

55308 - Assessing Value of Information for Multiobjective Decisions in Set-Based Design

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: LTC Nicholas Shallcross; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Dr. Simon R. Goerger		
Abstract: Engineering complex systems is an exercise in sequential multiobjective decision making under uncertainty. One method for handling this complexity and uncertainty is set-based design (SBD). SBD is a concurrent engineering and management methodology that develops, analyzes, and matures numerous design options, reducing risk and delivering higher value to the stakeholders and end users. SBD accomplishes this through controlled design space convergence, that resolves uncertainty and prevents premature design decisions. While SBD has been the subject of numerous scholarly articles, there is limited research providing quantitative methodologies informing decisions enabling design maturation and convergence. We therefore present a value of information (VOI) based methodology addressing this SBD knowledge gap. We apply Bayesian decision models and information value to multiobjective decisions to inform modeling and design maturation decisions. Research contributions include 1) a framework integrating VOI into the SBD process, 2) a multiobjective VOI index assessing a higher-resolution model's ability to resolve uncertainty, and 3) a means of informing modeling decisions by comparing multiple HR models, given their usage cost and their potential to deliver information value.		
Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis		

57021 - Assessment of Structures and Systems for Enterprise Tradeoffs (ASSET)

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: William Brandon Fangio; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Kayla Cotterman; Christina Rinaudo; Dr. Richard Cody Salter; Mr. William Leonard; George Edward Gallarno; Kathleen Staebell		
Abstract: The project uses decision analysis techniques to inform infrastructure asset management decision making at multiple levels within the United States Army Corps of Engineers Civil Works program (USACE-CW). USACE-CW has eight business lines, each relating to different missions and specific asset management decisions. Each business line currently has a process for making work package funding decisions. However, given the complexity of asset management funding decisions, there is a need to analyze and potentially augment the existing business line metrics in order to support the decision making process. We have developed a unified decision context that applies to all business lines and allows to better understand the similarities and differences of business lines and the role of current or new metrics. Our proposed value models build on each other. At the lowest level, value models help rank the work packages in each business line. At the next level, we develop value models to evaluate performance of each business line. The final value model evaluates the overall asset management program. The project goal is to improve the availability of information and metrics to inform asset management decisions within USACE-CW.		
Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis		

56862 - Analytics: Hedging vs. Prediction

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Tovey Chaim Bachman		

Abstract: Analytics: Hedging vs Prediction

Businesses and Government are increasingly relying on predictive analytics to support decision-making--Artificial Intelligence (AI) and Machine Learning (ML) being two of the most sought- after forms. Such predictive methods train algorithms on one set of data, validate on a second set, and if successful, apply the algorithms to make predictions on new data. But significant disruptions have occurred over the last year or two, such as COVID-19, trade disputes, and political instability. Sudden changes in the operating environment, whether due to a virus, or changes in the geopolitical situation, can render existing data and assumptions irrelevant—invalidating data used to train algorithms, or revealing weakness in the algorithms themselves.

Such disruptions in the operating environment have led to a debate about the effectiveness of predictive analytics in a turbulent environment. Some say that organizations must become even more reliant on predictive analytics, to support an agile response to changing conditions. Others say that analytics are ineffective in the face of disruptive phenomena, and that decision-makers should fall back on human judgment. Both points of view have problems. It is unclear that algorithms' assumptions and logic can be adapted rapidly enough, and that new training data emerges in a timely fashion. On the other, hand human judgment has limited ability to handle complexity and suffers from inherent biases.

What determines the most effective type of analytics for decision-making is the underappreciated time element—the time between a decision and when its impact is felt. If that time to impact is short (e.g. days), agility may succeed, if timely data is available and the algorithm can handle it appropriately. If the time to impact is long (months to years), the operating environment may have changed radically by the impact point, rendering the results of the decision ineffective, or even disastrous.

When the time to impact is long enough that the operating environment can significantly and abruptly change, what is needed is a form of prescriptive rather than predictive analytics, based on a hedging strategy. Hedging algorithms, using simulations and high-powered computing platforms, now within reach of many organizations, can test the effects of a potential decision for robustness against thousands of possible future operating scenarios. We describe a successful application for the Defense Logistics Agency, and discuss other potential applications, such as planning for the work force of the future, or managing a portfolio of research projects.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

57214 - The intersection of data visualization and desirability in set-based design, tradespace analysis and multi-objective optimization

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr Douglas M Ray		

Abstract: Decision analysis methods play an integral part in systems engineering trade studies. Tradespace analyses make use of utility functions which transform objective measures into value or utility scores. These are analogous to desirability functions employed for the purpose of multiple response optimization in an industrial engineering and product development context. Existing desirability functions do not adequately address unique needs of the system engineering trade study. In addition, reliance on optimization algorithms to solve trade study problems can present some challenges such as difficulties in interpretation, and result in point-predictions within the decision

space or tradespace which provide little visibility with respect to the broader near-optimal solution spaces within the tradespace. This challenge is analogous to the limitations of point-based design approaches versus set-based design methodologies.

The purpose of this paper is to (1) propose a new composite desirability approach which can be generalized to a variety of trade study problems, including those with many decision attributes (input dimensions) and multiple objectives with different priorities, and (2) demonstrate the value of data visualization methods in augmenting set-based design, decision analysis, and optimization problems. The methodology is adapted to two DoD system design case-studies. A strategy is employed which addresses common challenges encountered in complex decision spaces, such as high dimensionality, nonlinearities, and competing objectives. The emphasis is to simplify the decision space and aid in interpretation of results by interdisciplinary audiences and project stakeholders to compel informed decision making. The results illustrate the effectiveness of the proposed approaches at identifying distinct and globally feasible design configurations relative to KPP's. A validation study serves to illustrate the effectiveness of the proposed approach.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56880 - Power Laws Break Things: Performance Projection Errors Induced by Ignoring Power Law Behavior in an M/G/1 Queue

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Kenneth Comer		

Abstract: Power law or Pareto distributions have been observed in numerous populations in the 120 years since Vilfredo Pareto first articulated the phenomenon. System analysts, however, often ignore the possible presence of heavy-tailed, power law distributions in existing systems. A simple examination of the difference between expected behaviors of an M/G/1 queue when the service rate is assumed to be exponential but is, in fact, power law shows that performance projections can be wildly inaccurate. Over 40% of the simulated power law-driven queues experienced mean cycle times greater than the expected three standard deviations from an M/M/1 queue. And, 33% would experience mean cycle times beyond the six-sigma point – commonly accepted as system failure. This presentation includes data diagnostic techniques that help identify the presence of power-law behavior and how to parameterize the simulation of such behavior when it is present.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

57212 - Wargame Facilitation in a Virtual Environment

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: MAJ Harvey Clark Smith, III; Claire Fisher; Dr. Adam Patrick Shilling		

Abstract: Title: Wargame Facilitation in a Virtual Environment
Keywords: Wargaming, virtual, distributed, facilitation, moderation
Author Information: MAJ Harvey C. "Trey" Smith III, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, (703) 806-5681, harvey.c.smith2.mil@mail.mil
Distribution Statement A: Approved for public release.
Abstract: As many wargames shifted to virtual platforms in 2020, wargame facilitators have also adapted their styles and methods for facilitation. In virtual wargames, a few unique challenges and

opportunities arise, in addition to different possibilities for overall discussion management. In terms of challenges, the facilitator's ability to "read the room" without seeing faces and body language is impacted, and initiating a free-flowing conversation requires managing the risks of participants talking over each other. On the other hand, chat functions easily capture sidebar discussions, and hand-raising mechanisms can allow participants to feel comfortable signaling their desire to talk. Facilitators need to make design and facilitation choices depending on the methodology, participant types, and topics. Free-flowing discussions with occasional prompting questions may work well for some wargames, but for others, a structured speaking order may elicit more engagement and insightful discussion.

This unclassified presentation will outline some of the challenges, opportunities, and experiences from facilitating multiple virtual wargames for the Center for Army Analysis. The intent is to have a discussion with other wargamers and facilitators about their experiences facilitating and participating in virtual wargames.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56620 - Evaluating Checkpoint Value in Afghanistan

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr Joseph L Stallings, Jr		

Abstract: (U) The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to defeat Improvised Threats, to include Improvised Explosive Devises (IEDs), as weapons of strategic influence. Additionally, the Trends Branch conducts analysis support Command Assessments and Operational Decision-making.

(U) There are over 6000 checkpoints reported by the Afghan Security Force Commands. Checkpoints may be used to secure key terrain, limit enemy freedom of movement, protect civilian populations, or monitor traffic along key commercial or tactical routes, among other things. Despite perceived value for each, it is not feasible to man and maintain all reported checkpoints. As a result, the Resolute Support (RS) Command has been searching for a methodology to assess the value of checkpoints reported by the Afghanistan Security Forces in order to prioritize resourcing activities.

(U) The problem was approached as a Multi-Criteria Decision Analysis (MCDA). The dynamic decision environment and challenging utility assessment make this discussion noteworthy. The discussion will examine the selection of metrics that captured the utility of each checkpoint to the Afghan Security mission. Additionally, the discussion will address the development of a utility curve for each metric that could be used to determine a utility value for each checkpoint relative to each metric. Having established metrics and utility curves, it was possible to determine a "Contribution to Security" value for each checkpoint and rank order the checkpoints accordingly.

(U) Additional analysis was provided to assist in developing a discussion with Provincial leadership with respect to resourcing justifications. The logic behind the MCDA supported a starting point for discussions that would reveal new perceptions of utility and a basis for revisiting the MCDA process.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56654 - Project Convergence (PC): Longitudinal Data Analysis

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: MAJ Anthony Wrench		

Abstract: Project Convergence (PC) is the Army's new campaign of learning, designed to run on a year-by-year cycle, to aggressively advance and integrate our Army's contributions to the Joint force. It is the Army's contribution to Joint All Domain Command and Control, and it informs Joint All Domain Operations. PC ensures the Army, as part of a Joint and multinational force, can rapidly and continuously integrate or "converge" effects across all domains through intelligence gathering, data sharing, interoperable systems to decide and act more rapidly against adversaries in competition and conflict.

Approximately 2 months out from the execution of PC20, the Army Futures Command (AFC) tasked The Research and Analysis Center (TRAC) and the Data and Analysis Center (DAC) to lead the development and execution of an overarching analysis plan. PC20 provided the opportunity to develop an initial approach to integrating data collection and analysis under a single analytic framework and inform capability development stakeholder learning demands. Later, AFC tasked TRAC to lead, in collaboration with DAC, Joint Modernization Command, and the Army Evaluation Center, the development and execution of data collection and analysis (DC&A) for PC21. This will inform Army and Joint senior leader analytic questions and align PC21 stakeholder learning demands DC&A efforts with PC21 analytic questions. These require an integrated approach to data collection, data management, and data analysis executed by disparate DC&A teams across the analytic community.

This presentation will provide an overview of the original approach for PC20 data collection and analysis, lessons learned from PC20 and their application to PC21, and a description of the challenges and opportunities associated with informing the AFC's PC campaign of learning initiative.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

55317 - Understanding the Tradeoff Space, Risk Preferences, and Sequential Decisions for Intelligence, Surveillance, and Reconnaissance Path Planning

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Mary Frame; Anna Maresca; Dr. Bradley Robert Schlessman; Dr. Amanda Christensen		

Abstract: Collections managers must plan and adapt collection routes in operational intelligence environments. Often there is a long list of required information to collect but a limited number of assets that can be leveraged to glean the information at the pace of the mission. There are also tradeoff decisions that must be made regarding the requirements and the assets used to collect them. For example, a remotely piloted drone may only have sufficient fuel to collect 70% of the collections requirements that are needed using that particular drone's sensors. The operator can choose to either collect a limited number of requirements based on top priority, or must collect a portion of the list, return and re-fuel, and then collect the remainder. There are also numerous hazards that may be present during ongoing operations, such as inclement weather or enemy threats. Some risks may be capable of destroying a collection asset, like a surface to air missile, or may merely be inconvenient, such as cloud cover that blocks an imagery sensor temporarily. The risk that these hazards present may be estimated in terms of probabilities (e.g. 20% chance of a storm over the third target) or may be entirely unknown. In our study, we tested how individuals make sequential decisions and plans in environments with known versus unknown threats. Knowledge of

consequences and probabilities may induce more risk averse or risk-seeking behavior, which can have beneficial or detrimental impacts on mission success. We tested collection planning decision making with tradeoffs to determine how individuals prioritize different critical factors and measured risk behaviors as they pertain to partial or complete knowledge of the mission environment.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56621 - Decision Centric Warfare: Philosophy, Application and Risks

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Michael Woudenberg; William Buppert		
Abstract: As the DoD begins to shift from network-centric toward decision-centric warfare as envisioned by DARPA's Mosaic construct it is valuable to consider the implications to traditional tools and techniques used by operations research analysts. This presentation will consider the implications to the Observe Orient Decide and Act (OODA) loop, the role of cognitive biases on data interpretation, and the risks of big data to decision making. With these considerations in mind, new philosophies, application tools and risk reduction recommendations will be made for an analyst to provide impactful insights to complex and adaptive warfare. Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis		

56809 - Making Robust Lifecycle Decisions (MRLD): A Tool for Applying Multi-Attribute Tradespace Exploration (MATE) Methodology

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Brett A Stanley; James Dzwonchyk; David Quick		
Abstract: Multi-Attribute Tradespace Exploration (MATE) is a scalable analytic methodology rooted in Value-Focused Thinking (VFT) for multi-criteria decision making in complex decision problems with multiple stakeholder perspectives, changing conditions over time, and uncertainty in evaluations of costs and benefits. Like VFT, it begins with stakeholder value and identification of value-creating attributes of potential solutions. Modeling the performance of and value delivered by potential solutions then allows mapping of benefits to costs, populating the decision tradespace. Visual analytic techniques enable exploration of tradeoffs across many potential solutions, contexts, and stakeholders. This presentation will demonstrate how the MATE methodology is being built into a new software application, Making Robust Lifecycle Decisions (MRLD), across three layers of activities: Define, Generate, and Explore. Classification: UNCLASSIFIED Working Group:WG 27 Decision Analysis		

56805 - Practical Independent Evaluation of Development Processes

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Joseph Olah		
Abstract: This paper suggests a practical method to independently evaluate whether a development processes is adequate.		

The author believes that any development process can be measured, and if measured, can be improved. Given a set of development traits, the evaluator presents a set of concerns for each one, determines the action taken to address each concern, and assesses the rigor of the action. The assessment allows sponsor, program manager, developer, and customer to see whether the process is addressing their objectives.

Process traits with their concerns are given with example actions. An appraisal format is suggested to illustrate the assessment of actions to address concerns of each trait. From the appraisal, the stakeholders can collaborate to improve the process.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56647 - Terrain Shaping Operations: Decision Analysis

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: LTC Christopher Collins		

Abstract: The Terrain Shaping Operations (TSO) Sprint is an Army Futures Command (AFC) directed sprint, or a 90-day quick turn study to determine and evaluate the conceptual options, not constrained by near-term technologies, for shaping the land domain beyond 2035 in multi-domain operations. The Terrain Shaping Strategy and the Dominating Mobility through Terrain Shaping and Engagement Initial Capabilities Document serve as the impetus of the TSO Sprint. Advocating a desired endstate of the TSO Sprint, the documents define an enduring capability to rapidly shape the terrain by emplacing reinforcing obstacles in the land domain throughout the depth of the battlefield and throughout all phases of the campaign.

The Research and Analysis Center (TRAC), as the analytical lead for the sprint, developed, implemented, and executed the analytical approach for the effort. The analytical process incorporated a multi-phase approach that included mission analysis, measurement space development, analytical framing, assessment, and integration of results. The deliverable bridged the terrain shaping linkages to ongoing and future modernization efforts across the Army and Joint Enterprise.

This presentation will detail the analytic and assessment approach TRAC applied to capture and catalog subject matter expert (SME) evaluation of industry and Joint science and technology (S&T) TSO Options (TSOO). Specifically, the iterative process of collecting disparate concepts, research, and S&T across 23 Army, Joint, Department of Defense, and industry partners will illuminate the concatenation of terrain shaping options, applying concepts to create TSOO combinations. Parlaying the "what" that the TSOO combinations provide, the characteristics are used to assess how effectively each TSOO supports or enables the desired operational endstates. Development of the attributes characteristics, easily differentiable between the TSOO combinations, was derived in a structured manner, stressing SMEs input to frame and prioritize the evaluation criteria.

Assessment of the tactical implications of each TSOO was conducted through an SME panel workshop, at varying depths and Joint Planning Phases. The input was amalgamated and processed through the application of two multi-criteria decision making processes: the Analytical Hierarchy Process and weighted averages. Normalization of the attributes alleviated some of the inconsistencies in the ordinal ranking from the assessment, thus the TSOO combinations were ultimately tiered to mitigate lower associated confidence levels.

The layered, future TSOO combinations provide a range of decision space detailing the S&T that make up each option. The linkages aim to support the development and integration of these and

subsequent S&T roadmaps with the potential to spur future directed sprints. Thus, the tactics, techniques, and procedures captured in this sprint will inform future AFC and TRAC efforts.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

57157 - Enterprise Knowledge Sufficiency and Prioritization using Concept Maps

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Travis J Goodwin		

Abstract: Designing a military force in the age of information is complex. We can consider the design of a military force at the enterprise level as being a set of concepts which describe the various capabilities necessary for a service to accomplish its mission in a given environment. One possible way to evaluate these concepts and determine the efficacy of the proposed concepts is to apply analytic models. These models could be designed to answer the question, "Can this concept be successfully implemented?" More specifically, the output from the models should measure the relative risk a decision maker would need to accept should they decide to train, man, and equip their forces to fight the manner prescribed by the concepts, given the information currently available to the decision maker. Furthermore, these models could be leveraged to then optimize additional exploration of the concepts. The primary goal of such optimization is, given a set of concepts which have yet to be classified as viable, how do we prioritize our analytic efforts to best move towards knowledge sufficiency, and reduce the risk associated with these uncertain decisions? We propose a solution to such problems through the use of concept maps. Concept maps are a relatively simple tool used to build a taxonomy of knowledge. By defining operational concepts in concept maps, then using the defined network of relationships within and in between concepts, knowledge sufficiency can be effectively measured. Fuzzy algebra operations are used to quantitatively measure "sufficiency", the results of which are then used to optimize the allocation of constrained resources to most effectively move toward sufficiency. Many qualitative benefits are also realized through the implementation of such techniques. This work is primarily concerned with the modeling of risk and uncertainty in decisions.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56948 - Military Entrance Processing Station Workload Balance and Capacity Rationalization

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr Chad W Seagren; Dr. Kenneth H. Doerr, Ph.D.		

Abstract: The U.S. Military Entrance Processing Command (USMEPCOM) is charged with screening all applicants for enlistment into the U.S. Armed Forces according to the qualification standards of each of the four services. These applicants are screened and processed at one of 65 Military Entrance Processing Stations (MEPS) distributed throughout the United States, to include Alaska, Hawaii, and Puerto Rico. Archived data exists that describes the daily work each site has experienced in the broad categories such of medical, testing, and processing. The workload between stations can vary widely, as certain sites serve areas with denser populations of applicants. The workload at each station also tends to exhibit seasonal variations due to the fact that recruiting effort is more intense in the summer months. This workload variability at and between MEPS presents unique challenges for deciding on optimal capacity levels. We consider three general ways to mitigate the problem of over-

utilization at the MEPS we identify. The first is to add capacity at the affected MEPS. The second is to add capacity in the general vicinity like a Remote Processing Unit (RPU). The third is to move an existing MEPS from one location to another. Our analysis identifies the stations most in need of mitigation and enables MEPCOM to decide how best to address those challenges.

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

56990 - Selection/Promotion Boards - Evaluating Performance

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 12:00 PM ET
Authors: Nicholas E Alvarez; David Hickman		

Abstract: Talent management can be characterized by three major functions: Accessing, Developing, and Retaining (promoting) the best fully qualified officers. Our team has developed a method to evaluate the degree to which selected officers' education, experience, and performance match the community values that define "best and fully qualified", which can be used to improve the Developing and Retaining (Promoting) functions. Using decision analysis techniques, the team has produced a value model of the desired officer characteristics at the next grade – and used that model to calculate a composite (whole person) score for each promotion-eligible officer. This score can be used to: Determine if board-selected officers reflect a "best available at that position" across the cohort of eligible officers.
Provide a meaningful metric to understand board results, as well as improve board performance.
Enable officers and mentors to compare an officer's performance, experience, and education to community benchmarks – allowing the identification of officer strengths and weaknesses, which can then be used to improve the quality of assignment decisions

Classification: UNCLASSIFIED
Working Group:WG 27 Decision Analysis

WG 28 Advances in Modeling and Simulation Techniques

56921 - (U) A Markov chain approach to inform organizational decisions to balance the risk to workforce health and mission capacity during the COVID-19 pandemic.

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Nikesh Kapadia		

Abstract: (U) In March 2020 and the spread of the Coronavirus Infection Disease 2019 (COVID-19) in the United States, organizations were challenged to balance two objectives- protection of their employees and maintaining mission responsibilities. Organizations implemented policies to sharply reduce the number of employees in office locations. On the other hand, organizations were still responsible for maintaining employees onsite to sustain mission functions.

Existing computational models for infectious diseases are limited in two ways. First, existing models focus on the spread of an infectious disease without articulating the tradeoffs on other goals. Second, existing models study population dynamics and offer limited insight on factors relevant to organizational decisions.

The operations research/system analysis team within the Defense Intelligence Agency adapted existing computational models to develop a decision support tool to inform organizational leadership in balancing the two competing objectives. The new approach illustrated the effects of specific

organizational decisions, in order to inform long term planning and policy development. Future work is focused on improving organizational adoption of similar tools into larger decision making processes.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56931 - A Flexible and Configurable Modeling Framework for Counter-UAS Wargaming

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Matieu Lagarde; Mr. William Leonard; Christina Rinaudo; Dr. John Richards; Mr. James Richards; Dr. Jonathan Alt; Kayla Houte; Dr. Simon R. Goerger

Abstract: The rapid development of Unmanned Aerial Systems (UAS) as an emerging threat necessitates the creation of software tools to better analyze offensive and defensive capabilities of UAS and counter-UAS systems. The creation of powerful and highly configurable agent-based modeling (ABM) frameworks targeted specifically at UAS can help to lower the barrier of entry to creating additional models, by providing a strong base through additional configuration and processing according to user need. This research developed a UAS-focused ABM framework with a high degree of configurability, allowing for analysis of a larger number of types of UAS and counter-UAS systems via simulation. The designed configurability allows for easier manual and automated generation of scenarios for testing, providing a high degree of flexibility in the design of experiments. Mobile agents within the ABM use a boids-like algorithm for swarming behavior with multiple configurable parameters, which has the ability to produce configurable emergent behavioral properties for the UAS. Stationary agents within the simulation are capable of exhibiting the degradation of defensive capabilities as damage effects occur. This framework also provides a viable base for UAS ABM by lowering the barrier to entry to development of additional models; it is able to ingest and produce structured data for ease of integration into larger models, is capable of testing techniques such as specific optimization strategies for system placement, and is designed to assess survivability of assets in a UAS and counter-UAS wargaming scenario. This presentation describes the capabilities and method of operation of the ABM framework as well as the applicability for potential integration into simulations to support defensibility analysis of the evolving UAS threat.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56444 - Statistics and Visualizations of SUMO Scenario Runs

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET

Authors: Mr Mark Anthony Cowan

Abstract: n this presentation we take up the task of generating statistics and visualizations of SUMO traffic scenarios. We kick off the SUMO scenario from the command line via the python tool TraCI and construct XML-formatted output files holding the floating car data (abbreviated as FCD and applicable to both vehicles and pedestrians). We will generate and parse a series of SUMO output files that will be used to populate PosrgreSQL database tables for vehicles and pedestrians.

The database tables serve as a complete reservoir of all events occurring within the SUMO simulation runs. Careful probing of the results can release vast amounts of information, but SQL queries can be abtruse, requiring extreme care to derive actionable results. Also, simple tabular output to queries may not be fully adequate to draw out patterns and conclusions that can become obvious with proper

visualization tools. This presentation focuses upon building a large catalog of queries useful to military decision-makers, scaling up from very simple to much more complex, and providing the rudiments of descriptive statistics and mapping tools.

We will also show example Jupyter notebook codes to visualize a SUMO traffic simulation's time series results with python's seaborn and folium modules. There are two primary modes to access the simulation's output data---first by reading a text file of results and then later via an SQL query to database tables. The first is elementary, while the second involves the use of an additional python library and the forwarding of authentication tokens to initiate the handshake with the database. Examples of both are provided, with a heavy bias toward the latter. Among the list of speed visualizations we have developed are: basic lineplots, histograms (binned optimally with an implementation of the Freedman-Diaconis rule), kernel density estimations, lineplots bounded by sampled 95% confidence intervals at the same timestep, jointplots (including highlighting sample intensities with hexagons and gradiated KDE contours), and then proceed into using heatmaps to describe vehicle counts and average speeds in the aggregate, and lastly tracing paths for single vehicles. Our presentation will show a sample of these techniques.

Our scenario encompasses much of the Muscatatuck Urban Training Center (MUTC) grounds near Butlerville, Indiana, with light traffic composed of cars, trucks, and pedestrians. Our queries and resulting visualizations can be made to accommodate both Lagrangian and Eulerian frameworks, but the primary focus here will be Eulerian.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56704 - Accounting for Uncertainty within Model Design

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Matthew Gallagher; Mr Kenneth T Rebstock; Matthew Dickinson		

Abstract: The DoD and private industry have developed deterministic models to help program managers develop support plans for complex systems at least cost.   However, most deterministic models assume a steady-state environment and use point estimates when describing performance characteristics.   While these simplifying assumptions are needed when developing optimal support plans, they often fall short providing the risk associated with the proposals. To address this shortfall, Systecon has developed a Monte-Carlo simulation, that complements optimization models, to better assess risk and predict system performance.   This paper illustrates the benefits of using both techniques to ensure that robust support plans are developed that will meet expectations.   The level of risk with different estimation and distribution methods will be explored.   Best case, worst case, and expected case results are to be presented. These results show how real-life events can be incorporated in models and the impacts on model predictions. Ultimately, we show how to bring modeling closer to reality and lower the risk of undesirable performance outcomes.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56441 - Advances in Graph-Based Modeling and Simulation Architectures and Computation in Python

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Melonie Richey		

Abstract: Mission-relevant applications of modeling and simulation techniques often require the development of spatially explicit simulations in software packages or natively in a programming language. For example, simulations intended to model and predict the movement of commodities across geographic terrain are used for the movement of people, ships, resources, and illicit items. The purpose of this presentation is to overview an agent-based model (ABM) written in Python that contributes two methodological advances to the body of existing scholarship. The first contribution entails the use of a large-scale location graph to construct a simulation environment representing any real-world spatial extent in seconds. This location graph provides a flexible, scalable simulation environment for quick-turn simulation projects and also provides an architecture that supports the implementation of several important features such as distance-decay functions for cost of movement and methods to weight destination locations against a variety of criteria. The second contribution is in the form of lessons learned from parallelization of large-scale ABMs using CPU. Parallelization techniques apply to social simulations run on the bespoke location graph with up to 25M agents and include metrics that provide insight into the impact the parallelization effort has on the runtime of the overall simulation.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56668 - Application of an Optimization Model to Inform Short-Range Air Defense (SHORAD) Formation Compositions within the Context of the SHORAD Study

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr Richard Walden		

Abstract: The Army is modernizing its SHORAD capabilities to support ground forces conducting large-scale combat operations. This involves developing platforms and defeat mechanisms specific to the protection of maneuvering forces and fixed/semi-fixed sites against future air and missile threats. Among these new capabilities are developmental extended range missiles and direct energy systems to replace or complement existing interceptors (e.g., Stinger and Hellfire). The Army required a trade space study on emerging capabilities to identify resource-informed mixes in priority theaters. TRAC was tasked to determine the optimal, feasible, and affordable short range air defense mixes of material and non-materiel approaches to mitigate operational gaps for the defense of maneuver forces. Assessed mixes focused on Maneuver-SHORAD and Indirect Fire Protection Capability formations.
Assessments involved two models: an optimization model to identify initial high-payoff mixes and an air defense simulation to determine formation saturation levels. The study team engaged intelligence analysts, area of responsibility subject matter experts, and capability managers in developing the operational environment, attributes of each SHORAD system, and other critical model inputs. These engagements provided quantitative assessments of risk, employment options, and apportionment of threat assets to United States forces. With these inputs, the study team developed a General Algebraic Modeling System model whose objective function reduced maximum risk at minimal overall cost. Analysis of the optimization results allowed the team to down select from hundreds of potential mixes to a manageable level for follow-on higher fidelity assessments. Furthermore, the optimization model provided initial insights into the trades between cost, logistical implications, and residual air and missile threats by mix.

This presentation addresses the following challenges associated with implementing the optimization model and applied modeling methodology: objective function formulation, data collection, comparison of mixes, and synthesis of analysis into overall study findings.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56817 - Assessing C-UAS Detection and Defeat Capabilities Against Adversarial Intrusions

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET

Authors: Mr. William Leonard; Christina Rinaudo; Mr. James Richards; Matieu Lagarde; Kayla Houte; Dr. Jonathan Alt; Dr. John Richards; Dr. Simon R. Goerger

Abstract: The emerging threat of intrusions by Unmanned Aerial Systems (UAS) near critical assets within secure perimeters necessitates analysis to inform the development and employment of counter-UAS (C-UAS) capabilities to detect and interdict these intrusions. This research leverages sensor and defeater selection and placement optimization to analyze potential interdiction capabilities against intruding Group 1 and Group 2 UAS within an agent-based model (ABM). The model workflow incorporates intruder routing preferences, sensor modalities, and feasible sensor-site locations to understand system performance. Routing preferences guide intruding UAS toward target locations while maintaining swarm cohesion, and a mixed-integer program provides optimal sensor modalities and locations in a geospecific region. The ABM incorporates methods to represent the effects of potential damage from intruding UAS, whether the intrusion is non-kinetic (such as intelligence, surveillance, and reconnaissance) or kinetic (e.g., involving munitions). To assess the effectiveness of C-UAS capabilities, the model produces outputs of survivability against adversarial actions and the damage incurred as a result of UAS infiltrations based on a nearly orthogonal Latin hypercube experimental approach. This modeling framework could facilitate analysis to inform the design and employment of C-UAS systems against a variety of threat capabilities. This presentation provides an overview of the overall modeling framework and experimental approach, including an example use case, to evaluate and counter UAS threats.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56736 - Bayesian Enterprise Analysis Model (BEAM): Allocation Optimization

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET

Authors: Stephen Sturgeon; Dr. Mark A. Gallagher, FS; Dr Brad Guthrie

Abstract: The Bayesian Enterprise Analysis Model (BEAM) is a low-resolution campaign model. The responsiveness of the tool allows for a rapid tradespace assessment across domains, force structures, and strategies, identifying potential challenges or attractive solutions to more efficiently employ the higher resolution models to perform more detailed analyses. Allocation of assets to missions is perhaps the most critical algorithm within BEAM to achieve the computational efficiencies. We will discuss recent algorithm advancements to include work on a Defender-Attacker-Defender (DAD) allocation algorithm. We will also discuss data-format that enable rapid evaluation of a low-resolution campaign. This briefing is meant as a technical discussion of the algorithms undergirding the model.

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.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56977 - Building a Fully Integrated Global Constructive Model

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr. Charles D Burdick		

Abstract: When I first began working on combat simulations, we used the concept of "slices of the battlefield." But no matter how well that worked, we were always faced with the question, "what are the impacts of external events." I also worked with early DIS and had hopes that we could federate combat models that operated at the same level of detail, e.g., engagement or mission models as a theater model. However, I am now convinced that horizontally linking various models by different contractors, many using different software, architectures, and "standard" protocols will not produce an integrated model.

According to GAO, the available analysis community campaign models still fall short of portraying in a single model a fully integrated Multi-Domain theater environment with supporting C4ISR and Logistics; and cannot simulate a complex global operation with multiple Allies, adaptive enemies, pre-war competition, and multi-modal communications and transportation networks.

In 1995, Congress and DoD recognized the need for an integrated joint model and established the Joint Analytical Model Improvement Program (JAMIP) allocating multi-year funds to build the Joint Warfare System (JWARS) theater campaign model with the ability to provide "improved C4ISR and balanced joint warfare representations." Regardless, of how you believe the JWARS program went, nine years later it successfully simulated a complete Major Combat Operation (MCO), later called a Strategic Scenario, and demonstrated multi-level federation with the JSAF mission model using HLA. JFCOM J9 took responsibility for the model after the JWARS Office closed and renamed it the Joint Analysis System (JAS), but the two models were identical. JFCOM used JAS for simulation-supported wargaming, while at OSD/CAPE, JAS successfully ran two more MCOs with multiple excursions.

JFCOM closed in 2010 and when CAPE ceased campaign modeling in 2011, it called in all copies of JAS and its supporting material and archived them. In its archival message CAPE praised JAS as "one of its strategic campaign tools [used] in numerous key Departmental studies and [were] very satisfied with the results it provides, its functional robustness, and the agility and usability of the model." CAPE also promised that users, then defined as government agencies and government -sponsored industry, FFRDCs, and academia would, "still be able to request and continue to use JAS software." However, to date no copies have been released since approval was incrementally tightened until only Federal employees had access.

It's now been ten years, since JAS was archived, but whether or not you believe JWARS/JAS was worth the effort, the unclassified JAS development documents are a potential goldmine of information on how to build a constructive model from the top-down and avoid the pitfalls of its early development. This presentation also covers some hard lessons learned and provides recommendations for the future of constructive modeling.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56659 - Development and Applications of High-Fidelity M&S Environment For Autonomous Vehicular Systems

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Peilin Song		

Abstract: Modeling and simulation (M&S) tools play an important role in developing autonomous unmanned ground vehicles (UGVs). One of the significant aspects for the M&S of autonomous systems is the modeling and perception simulation of environments of ever-increasing complexity, which fall in the domain of expertise of ERDC/GSL.   While the modeling effort of environments is reported in another MORS presentation, this presentation addresses the high fidelity modeling and simulation of perception for autonomous systems at ERDC .
ERDC have been engaging in development of high-fidelity sensor modeling and simulation program VANE for years. Coupled with ERDC's environment modeling means, VANE provides unprecedented capabilities in modeling and simulation of both environments and perceptions of sensors.   ERDC has integrated VANE with other M&S components (such as AI and vehicle dynamics) to create a complete M&S environment of high fidelity.   This presentation will elaborate the details in the integrations of VANE into M&S environment for high fidelity simulation of autonomous systems and their applications in support of active development programs.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56539 - Execution Of Combat Model Experimentation on DoD HPCs

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Charles Timm		

Abstract: In this presentation, The Research and Analysis Center (TRAC) provides an overview of the execution of experimentation for two combat models (Combined Arms Analysis Tool for the 21st Century (COMBATXXI) and One Semi-Automated Forces (OneSAF) on DoD High Performance Computing (HPC) assets. Increasing TRAC mission requirements and reduced study timelines prompted the organization to seek additional classified computing resources to serve as an additional experimentation platform to meet study execution demand. The effort included a team comprised of personnel from TRAC-White Sands Missile Range, TRAC-Monterey, and Army Research Laboratory (ARL) to explore methods of effectively and efficiently running combat models on supercomputing resources. Project results indicated significant time and resource savings by harnessing the power of DoD HPC assets through dynamic load balancing, which has potential implications for how TRAC will conduct future studies.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56626 - How high should the flood waters rise? Controlling water coverage in randomly generated terrain

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr Gordon Cooke		

Abstract: Randomly generated terrain can be useful when conducting simulations with high run counts. But, too much randomness could render the result meaningless due to excessive noise. Modelers must choose appropriate values for parameters that control the terrain generation to create geotypical terrain that meets the needs of a given simulation. One method of quickly generating terrain is the Diamond-Square Algorithm. This is a fractal-based method of generating a

heightmap. Bodies of water can be represented by "flooding" all areas (cells of the heightmap) with elevations below a designated value after generating the heightmap. This raises a question for the modeler: if you want the terrain maps to have a certain percentage of water coverage, what value should you flood to? One will also need to understand the possible influence of the roughness parameter used to generate the terrain. This talk presents the results of generating 90,000 heightmaps with a range of roughness values from 0.5 to 5.0 and a range of flood levels from 0.1 to 0.9. The percentage of water coverage was calculated and analyzed to understand the relationship to input parameters. A regression model is presented to guide model creation. Due to the Brownian noise inherent in this method, most values for flood level have a 50% prediction interval of about +/- 8% and a 95% prediction interval of about +/- 21%. Roughness values above 1.0 have no impact on water coverage, but roughness values less than 1.0 do.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56443 - How To Commandeer An Ego Car In SUMO

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr Mark Anthony Cowan		

Abstract: While SUMO is explicitly designed as and predominantly used as a microsimulator platform of traffic (vehicular, pedestrian, and multimodal), nothing in its programming forbids its use for other related purposes. In fact, its open source code actively encourages extensions of its original design and implementation. Generally, the input files have been so defined to give each vehicle and pedestrian an origin, a destination, and a calculated primary (and sometimes a secondary and tertiary alternative) route between the two. By design, it is a simulator. In short, its inputs are defined, it is run over a fixed time period, its results are collected, and they are then analyzed according to the purposes for which the simulation has been run. Overall, it is rather "stand-offish" from user input while the simulation runs. However, using the TraCI interface to the binaries and making a couple of clever calls during the simulation run, one may actually commandeer a vehicle and drive it along the network. Other vehicles can see and react to the commandeered vehicle's activities, just as they would if the vehicle were solely under the control of the simulator and not an outside driver. The SUMO simulator consequently becomes a video game of
sorts, and a driver can determine the direction and speed of his vehicle.

Of course, this possibility raises a series of questions: Why would anyone want to turn SUMO into a driving game, rather than using it as a simulator? What could be the ultimate purpose? Admittedly, the graphics do not really lend much entertainment value. There is no discernible scoring mechanism, and there is little to no likelihood of competition. As a driving game, SUMO with a controllable ego car would be a miserable bust. Where then is the value added by coupling a real-time controller to the SUMO simulation software? Using SUMO's APIs that report back object positions over the course of the simulation, it is possible to link the SUMO into a three-dimensional gaming engine (such as the popular Unreal Engine 4) to create, in effect, a virtual reality (VR)/augmented reality (AR) driving simulation with real-time dynamic and responsive vehicular and pedestrian traffic. This linkage raises the value of driving a SUMO ego car considerably. Of course, it could be counterargued that the world is full of driving simulators, many very good. Why should one go to the trouble of chaining together many of these codes to drive around a three-dimensional scene with vehicles and pedestrians? Unlike others, SUMO permits changes to the vehicle's configuration that affects the underlying physics of vehicular response, so functional parameters meeting military specifications can be introduced into

the simulation and the vehicular behavior tracked during and analyzed after simulation runs. Additional metrics have been built into SUMO, including noise levels and particulate pollution levels accompanying urban traffic situations.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56607 - Joint All Domain Operations Modeling, Simulation and Analysis

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Mr. Richard K. Null		

Abstract: Joint All Domain Operations (JADO) focus on leveraging cross-domain interactions to increase combat effectiveness. Lockheed Martin has developed a discrete event modeling and simulation approach to investigate and analyze warfighting performance of JADO concepts. The simulation uses a "sense, decide, act" framework to characterize Intelligence, Surveillance and Reconnaissance (ISR); Battle Management Command and Control (BMC2) and Offensive Fires functions. The simulation utilizes the ExtendSimtm commercial software and is scenario-based offering analytic insights to JADO stakeholders, architects and decision makers. The presentation will review the simulation operation and offer sample analysis cases.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56964 - Weapon System Inventory Planning and Policy Evaluation: A Paired Optimization-Simulation Approach

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Kyle Cunningham; Dr. Jonathon Leverenz; William Garcia; Derek Roy Shortt, Jr		

Abstract: Maintaining weapon system availability at a consistent level is critical to sustaining military operational effectiveness. Doing so requires careful planning - often over a multi-decade time horizon – of component production, assembly into final product, deployment, testing, and disposal. It is particularly important to manage inventory levels during critical times of legacy system expiration and new system deployment, where maintaining minimum levels for mission requirements is sensitive to a variety of policies. An analysis tool can help decision makers understand the interacting consequences of policies related to production, deployment strategy, and testing combined with system design parameters such as component lifespan.
The Serial Inventory Model for Planning and Logistics Evaluation (SIMPLE) was developed for a Department of Defense client to measure the high-level impact of different policies related to production, inventory, and deployment during critical times of transition from legacy weapon system expiration to new system deployment. SIMPLE is a Python-based tool that pairs discrete event simulation and optimization models to illustrate and analyze how particular inventory and deployment plans will impact system availability over time. This modeling approach helps inform long-range planning as it tracks individual components as they age through the system's life cycle. This presentation focuses on how the optimization and simulation components of SIMPLE integrate critical inventory supply and demand factors, policies, and platform schedules to study system

availability over a multi-decade planning horizon. After a validation against a historical dataset, model results and findings are presented, and planned future work is reviewed.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56677 - Optimization Modeling with Time Component for Strategic Fires Study

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Matthew Harder		

Abstract: Army Futures Command (AFC) and the Army G-8 directed The Research and Analysis Center (TRAC) to conduct the Strategic Fires Study (SFS) to identify solutions to critical shortfalls in the ability of the Army to address operational and strategic targets with surface-to-surface fires. Without a solution, the United States could lose competitive advantage against near-peer threats and the Army may fail to support the Joint force. The SFS team identified a gap in a mid-range fires capability, leading to an urgent need for analysis of several mid-range capabilities with different attributes in an extremely compressed timeline, in order to inform timely funding decisions.
The study team utilized an optimization model to select the most cost-effective mixes that could accomplish mission goals for further analysis in a high-fidelity combat model. Area of responsibility subject matter experts and capability managers were engaged to develop the operational environment, attributes of each strategic fires system, and other critical model inputs. These engagements provided quantitative assessments of risk, basing options, and apportionment of Threat targets to Army fires.
The study team developed a General Algebraic Modeling System optimization model that used time as a factor for assessing different capability mission cycle times, capacity, and unit sizes. This played an important role in the down selection of mixes for more time-consuming and higher-fidelity combat modeling, allowing the study team to meet deadlines.
The study had immediate and profound impacts on the United Sates Army and AFC. The Army reallocated funding to support recommendations from the SFS, and the analysis underpinned the Secretary of the Army's decision to field a new fires capability. Lastly, the innovative processes used by the study team established a framework for AFC to emulate in future analytic endeavors.
This presentation discusses the challenges associated with implementing the optimization model, including objective function formulation, a time-based approach, and the analysis approach challenges.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56902 - Predicting Future Program Health Assessments

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr Brad Guthrie; Dr. Greg H. Gehret		

Abstract: Air Force acquisition programs currently are assessed a health score in five different areas (cost, schedule, performance, funding, overall); these assessments are reported in the MAR (Monthly Acquisition Report). A classification-based prediction model (using XGBoost in Python) was constructed to predict future MAR assessments up to 24 months in the future utilizing >200 attributes related to program health. Further, techniques such as sentiment analysis, topic modeling, and web-scraping were used to derive several of these program attributes. The model provides several

capabilities to decision makers, including: (i) a probabilistic forecast of future MAR assessments for individual programs, (ii) factor analysis to understand how each program attribute contributes to each prediction and (iii) what-if analysis to determine the effect of improving factors for individual programs on forecasted MAR assessments.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56698 - Rapid Exploratory Agent Based Modelling

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr Mark William Gould; Joshua Wiser; Mr Carl Turpie		

Abstract: Agent Based Modelling (ABM) is a useful and well proven technique but has been limited in its utility because ABM remains in the domain of relatively few skilled experts and requires access to either expensive ABM software or knowledge of ABM development and coding skills. However, recent developments from the Open Source Software (OSS) community have made it possible for anyone with moderate knowledge of the Python programming language and ABM paradigms to create these models on demand in relatively short order.

Dstl and Frazer-Nash Consultancy have worked together to develop the Python Mesa package for ABM and created a framework and set of reusable components to support rapid exploratory agent based modelling in order to enable analysts to quickly establish which factors in a problem space are important and should therefore be considered for further analysis. Complex problem spaces often need to be explored before committing to a thorough analytical study which can deliver insights with higher confidence. However, robust and highly developed models with their substantial data and training burden can be expensive to operate purely for exploratory purposes and so analysts typically make use of existing analysis or simple 'spreadsheet models' to inform the development of more thorough analysis. The Rapid Exploratory Modelling (REM) toolset aims to provide analysts with access to ABM capabilities that can be used in a matter of hours or days to complement existing rapid analysis methods. By introducing this auditable and rigorous toolset we help to ensure analysis is focussed on the aspects of a problem space in which it can deliver the most value to customers allowing us to make the most effective use of our more developed modelling capability. In addition, the REM toolset is being developed to provide an OpenAI gym style interface to allow early development and training of AI agents prior to their continued training and use in more computationally expensive models.

A case study on the generation of a model of Integrated Air Defence Systems (IADS) has been conducted and the results of the initial exploratory analysis and the use of a deep reinforcement learning agent to control the IADS are presented as a demonstration of the REM toolset.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56442 - Using SUMO to construct Dynamic Urban Modeling Scenarios

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr Mark Anthony Cowan		

Abstract: SUMO (Simulation of Urban MObility) is a microscopic simulator of continuous multimodal vehicular and pedestrian traffic along large urban road networks. First released in 2001 by Berlin's Institute of Transportation Systems, SUMO has been used to investigate the effects of vehicle pollution and noise, to generate traffic forecasts during large athletic events, and to model in-vehicle telephony to assess performance of traffic surveillance devices. A SUMO scenario can quickly be initiated by importing street network topologies from OpenStreetMap (OSM), a freely-available, constantly updated, crowd-sourced and -tagged mapping service. With the OSM network as a foundation, one can easily add, delete, modify traffic lanes and the timing of traffic lights to explore the effects upon local traffic over time as the populace attempts to route between its origin and destination pairs, making adjustments to their routes as necessary. The tags within OSM add the possibility of choosing origin-destination regions for the motorists and pedestrians based upon city zoning, from which we can likely infer some features of the demographic layout and thereby add more realism to the traffic simulation.

In this presentation, we will focus on building these scenarios for military transport across large urban areas and collecting the results across many runs of the SUMO software, varied by the random seeding of the model and changing the open/close times of some important lanes. While limited visualization tools exist for single runs, we will fortify these with a more global view and summarize the analytic results for military decision-makers, enabling them to anticipate potential traffic bottlenecks that could interfere with their mission and to choose optimally among alternate routes on-the-fly as new information arrives.

Keywords: Military transport, scenario, mobility, simulation, SUMO, urban, data analysis

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56929 - The challenges faced by a new service branch and combatant command in establishing a Modeling & Simulation enterprise tailored for Space Domain warfighting.

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Mr. Charles I. Bennett, V; Evan F Mize		

Abstract: Space has until only recently been occupied by an exclusive club of major global powers, where no adversary could menace on-orbit assets. That construct has slowly evolved as Space has evolved into a hotly contested and congested combat arena. Space-enabled warfighting capabilities are no longer assured. Current wargames and exercises conducted to develop future tactics, techniques, and procedures don't reflect this reality. Doctrine that establishes how the Space Domain is portrayed in multi-domain wargame and exercises is needed.
A former AFSPC Commander noted that current lines of effort are insufficient for a robust Space Domain modeling and simulation (M&S) enterprise that supports both the Service and combatant commands. He also noted that additional policies and space-specific doctrine are required to facilitate exercises and readiness for current and future threats. This doctrinal gap is supposed to be resolved with the creation of both the United States Space Force (USSF) and United States Space Command, but challenges lie ahead.
Current M&S architectures that were developed during the Cold War (and are still in use today) don't properly replicate modern conflict in the Space environment. The Joint Theater-Level Simulation (JTLS) simulation/wargaming environment portrays Space capabilities as mere services that can be

'turned on or off' (simulating signal degradation) and in-domain activity simulations (direct-ascent and co-orbital anti-satellite attacks) are not supported at all.

Over-classification has been a problem that has plagued Space for years. Since its inception, technologies related to Space have warranted the most stringent protections as critical national secrets. To this day, the highest classification levels protect anything related to military Space. Over-classification has resulted in compartmentalization and stove-piping where space-related M&S innovations are not shared with the broader M&S community. Breaking down these classification walls and fostering sharing these once-cloistered M&S technologies, tools, architectures, and developments is a significant challenge.

The final challenge is building it in such a way that it is adaptive and responsive to technology change. Space is vitally dependent on constantly evolving technology. Space is more than just a service that can be turned on or off in a conflict; it is a complex and inconstant warfighting domain. In wargames and exercises today Space is often 'white-carded', to the detriment of warfighter readiness and preparedness.

Updating and changing doctrine and policies, and providing access to stove-piped capabilities are vital to preparing warfighters for the next crisis. We need M&S Space Domain doctrine and policies that allow for agile and interoperable capabilities. Continued development of Space Domain doctrine, policies, and innovative technologies will enable Joint Space Warfighters and USSF Guardians to ensure there's NEVER A DAY WITHOUT SPACE!

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56687 - Symmetry Methods to Deduce the Victory Condition of Lanchester Models of Warfare

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Joshua Gill; Dr Andrew Gill; Jessica Penfold		

Abstract: Nestled between Frederick Lanchester's famous, but symmetrical, direct-fire and area-fire models of combat from over a century ago sits Seymour Deitchman's asymmetrical guerrilla warfare of the 60's. These models were particularly useful in that they admitted an analytical victory condition – typically a lower bound on the initial force ratio of the combatants as an explicit function of the parameters of the model that was both necessary and sufficient to ensure victory for one side. The so-called Lanchester 'square law' and 'linear law' (and Deitchman's 'mixed law') thus allows analysts insight into trade-off between quantity and quality factors in differing battle types. The analytical route to the victory condition may follow either (or possibly both) solving the second-order differential equation governing one side's force trajectory explicitly, or integrating the time-independent first-order differential equation to obtain a conserved quantity involving both force trajectories.

Moshe Kress, around a decade ago, provided a framework that generalised Deitchman's guerrilla warfare model by proposing an intelligence or situational awareness function that was bounded by area-fire from below and direct-fire from above. Only the conserved quantity route to the victory condition appears tractable and is explicit depending on the integrability of the intelligence function. Kress's intelligence function provides a linear interpolation between direct-fire and area-fire while much earlier, COL Thomas Schreiber considered a curvilinear model of command and control effect on intelligence, both permitting analytical victory conditions.

Non-autonomous direct-fire and area-fire Lanchester models, whereby the weapon effectiveness parameters are allowed to vary with time, were studied analytically by James Taylor and Jerry Brown from the mid-70's. The explicit inclusion of time in the differential equations appears to result in a step-change in complexity and required the development of bespoke, or partially approximate, analytical methods to reaching the victory condition.

This presentation reports on initial investigations of the potential of symmetry methods to arrive at the victory condition of various Lanchester models of warfare. Symmetry methods were chosen as they appear to offer systematic analytical paths to either the explicit solutions or conserved quantity of ordinary differential equations, however the authors are not aware of any prior application to Lanchester models. In particular, a non-autonomous generalised Deitchman model, by allowing Kress's interpolating parameter to vary with time, investigated numerically by Marvin Schaffer in the mid-60's, will be examined.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56781 - System of Systems Study of Sensors for Border Security

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: Mr. Joseph Sartini; Dr. Gregory S. Parnell, FS; Dr. Edward A. Pohl; Dr. Randy Buchanan; Mr. William Leonard; Mr. Joshua Jensen

Abstract: The United States perimeter of 7,479 miles must be monitored for illicit cross-border activity such as illegal migration, contraband, and threats to national security through these regions. In support of the Engineer Research and Development Center's Institute for Systems Engineering Research, we developed an integrated sensor modeling framework and optimization algorithms to propose sensor suites and locations to improve the current CBP Border Security Systems Architecture for a specified region. We used notional sensor performance and cost data. We developed three models: the Intruder Preference Model (IPM) and the Sensor Selection and Placement Model (SSPM). The IPM considers multiple intrusion scenario characteristics to create spatially distributed intruder preferences. Based on these preferences, intruder routes are predicted using least cost algorithms to maximize intruder route preferences from the border to release points. For a given budget, the SSPM determines the optimal sensor recommendation to improve the mission performance and then determines the optimal placement of those recommended sensors. The study found that the IPM and SSPM can provide insights on the most efficient sensor suite improvements for a specified border region of interest.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56494 - Staff and Equipment Modeling with Process Simulator

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET

Authors: Erika Garcia-Boliou

Abstract: There are many concerns when opening up a new site. Process Simulator was used to best guide Operations in how large their staff should be and how many pieces of equipment they should purchase in order to handle their desired throughput.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

57390 - Discussing Flexibility and Resilience Achieved through Leveraging Emerging Technologies

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr. Christopher J McGroarty; Scott Gallant; Dr. Joseph McDonnell; Ms. Lana E. McGlynn, FS; Mr. Christopher J. Metevier		

Abstract: 2020 has taught, and in some cases forced, us to be flexible and resilient. We have been challenged to employ both existing and emerging technologies in new and creative ways. While many technology advancements have occurred outside of the Modeling and Simulation (M&S) Community of Interest (COI), the opportunity for leverage is great. Our job as M&S practitioners is to be smart in evaluating how to best adopt these advances to the benefit our stakeholders, while considering interoperability with existing tools, data reuse, and standardization.

This presentation will introduce the Simulation Interoperability Standards Organization (SISO) Exploration of Next Generation Technology Applications to Modeling and Simulation (ENGTAM) Standing Study Group (SSG), which focuses on technology adoption, technology application metrics, interoperability, and technology areas, such as cloud-first operating systems for distributed simulation, digital twins for M&S engineering, disruptive gaming technologies, big data analysis, and metaprogramming for M&S models. It will discuss insights from recent meetings of the SSG and solicit input on how the SISO community can continue to foster the innovative use of technology.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56758 - The Koopman Operator, Disjunctive Programming, and Multi-Level Optimization: Complementary Computational Methods for Modeling Critical Infrastructure

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Craig Bakker; Arnab Bhattacharya; Dr. Samrat Chatterjee; Ethan King; Matthew Oster; Feng Pan; Casey Perkins		

Abstract: Cyber-Physical Systems (CPSs) consist of computing and communication devices integrated with physical components. Critical infrastructure, such as the power grid, provides key examples of CPSs. Solvability (predicting future behavior), operability (meeting performance goals), and security (anticipating and mitigating threats) are then three core challenges in running these systems, and mathematical modeling has been widely used to address those challenges. However, critical infrastructure systems are often too complex for closed-form, bottom-up modeling approaches. To produce computationally tractable representations, it has historically been necessary to make simplifying assumptions. One type of simplifying assumption has been to consider only the continuous dynamics of systems that are actually mixtures of continuous and discrete components. Another type of simplification has been to ignore any adversarial activities present in the CPS; control strategies and consequence scenarios have not considered adversaries that could be strategic and adaptive in their behavior. The nonlinearity and nonconvexity of CPSs have also often created an optimization dilemma. Convex approximations of the original system (and linear approximations in particular) can be solved rapidly and provide guaranteed optimal solutions. Those approximations, however, may neglect key properties and behaviors of the actual system. General nonlinear optimization solvers, on the other hand, may suffer from convergence issues and cannot, in general,

guarantee global optimality for any solution they return. Here, we use examples from the power grid to show how analytical and computational advances in disjunctive programming, the Koopman operator, and multi-level optimization can be leveraged to produce tractable and scalable computational methods that do not rely on those simplifying assumptions. Together, these methods provide a set of disparate but complementary tools for dealing with solvability, operability, and security challenges for CPSs in general and critical infrastructure in particular.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

57049 - The Soldier and Squad Trade Space Analysis Framework

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Mr. Ronald Anthony Bowers		

Abstract: The U.S. Army is seeking to accelerate the development of systems to counter near-peer adversaries in a multi-domain environment. To do so, the Army plans to leverage modeling and simulation (M&S) to help guide its research, development, engineering and acquisition efforts. One particularly difficult modeling problem is estimating Soldier performance in a combat environment. Models and simulations that address part of this problem have been developed but these models are not integrated and cannot provide a realistic estimation of Soldier performance given arbitrary Soldier equipment and operating in an arbitrary environment. Consequently, the ability to model the Soldier at sufficient resolution to enable using modeling and simulation to guide the development of Soldier equipment does not exist.

To provide the required capability, the U.S Army Combat Capabilities Development Command Data and Analysis Center (DEVCOM DAC) is developing the Soldier and Squad Trade Space Analysis Framework (SSTAF). SSTAF is a software infrastructure system for integrating multiple human performance and other models to provide a unified representation of Soldier state, capability and behavior. SSTAF models the Soldier as a system where the results of one model can affect the results of other models and both the positive and negative effects of Soldier equipment can be captured. The ultimate goal of SSTAF is to provide an architecture that enables the development of digital twins for specific Soldiers. These digital twins can be used not only for material trade space analysis but also for interactive training and mission planning.

The key capabilities of SSTAF are:
- Model Soldier state and capability, update the state according to simulation events and modify the behavior of integrated models according to the current state.
- Support flexible anthropometric, human performance and equipment configurations to enable modeling at multiple levels of resolution to include modeling specific individual Soldiers.
- Provide an extensible Application Programming Interface (API) usable for both interactive systems and force-on-force models.

This paper will present the design and capabilities of SSTAF. It will provide an overview of the human models and other features that are available currently and those that are under development. It will also discuss future capabilities for SSTAF and SSTAF-compliant models including applications beyond trade space analysis of Soldier equipment.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

56815 - UNCERTAINTY QUANTIFICATION MEASUREMENT OF THE ADVANCED JOINT EFFECTIVENESS MODEL (AJEM)

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Craig Andres		
Abstract: h). These values estimated in AJEM for various components, scenarios, loss of capabilities, or summary conditions. The Pk|h is our primary estimate of interest, and quantifying how changes in model inputs affect the value of Pk|h. We found what we believe to be useful statistic from the risk analysis discipline called the relative effect, which we modified for symmetry (SRE). The symmetric adjustment standardizes the measure to have the same value from both the lethality and survivability perspective. We believe that this measure provides a practical context for stakeholders. We will provide that context and illustrate using graphical and tabular examples. Classification: UNCLASSIFIED Working Group:WG 28 Advances in Modeling and Simulation Techniques		

56884 - Applied Uncertainty Quantification for Verification and Validation of Strike Weapon Simulations Using SOFA

Start Date: 6/25/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Aaron Allen; Justin Mooney; Robert Reaney		
Abstract: New strike weapon concept capability can be estimated via parameterized computer simulation models using an iterative process of Uncertainty Quantification and visualization. Appropriate input trade spaces and simulation error/crash regions may be quickly identified, and final capability metrics such as the weapon's effectiveness zone (WEZ) can be derived efficiently through statistical analysis. Verification and Validation (V&V) of newly developed simulation models can also be achieved by comparing response trade spaces for existing models, test data, and the new model across similar input domains. This talk will overview the process and results of such an analysis for a newly-developed AFSIM 6DOF aerodynamics model, built on the legacy CADAC Weapons Simulation (CWS) 6DOF model used by AFRL, using the Simulation of Federated Applications (SOFA) software environment to perform large-scale parallel batch simulation, post-processing, and visualization via automated workflows. Classification: UNCLASSIFIED Working Group:WG 28 Advances in Modeling and Simulation Techniques		

56676 - Automated Adversary Threat Generation Tool

Start Date: 6/25/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Tyler A. Clark; Dr. Steve S. Sin; Dr. Thomas R. Guarrieri		
Abstract: Attacks involving the use of chemical, biological, radiological, nuclear, and high yield explosive (CBRNe) agents/materials pose a potential threat to U.S. citizens and service members. Early detection of such agents/materials and devices made from them are critical to national defense and law enforcement. The Defense Advanced Research Projects Agency's (DARPA) SIGMA+ program, expanding on the SIGMA program's advanced capability to detect illicit radiological and special nuclear materials		

through the use of networked sensors, calls for the development of highly sensitive detectors and advanced intelligence analytics to detect minute traces of various substances relevant for CBRNe threats. SIGMA+ will use a common network infrastructure and mobile sensing strategy. The SIGMA+ CBRNe detection network will be
scalable to cover a major metropolitan city and its surrounding region.

One of SIGMA+ program's goals is to develop a capability to identify adversary activities from a world of existing data. To develop this capability, a large set of synthetic adversary attack data are needed to train the advanced intelligence analytics algorithms. The Unconventional Weapons and Technology Division, National Consortium for the Study of Terrorism and Responses to Terrorism (START/UWT) of the University of Maryland developed the Automated Adversary Threat Generation tool (AATG) to generate realistic CBRNe threat scenarios (i.e., realistic red team scenarios) at a scale that can be used to train the advanced intelligence analytics' search algorithms. At present, the AATG is able to generate 17 realistic CBRNe threat scenarios per minute.

AATG utilizes START's CBRNe Attack Cycle (CBRNe-AC) and the CBRNe Activity Repository (CBRNe-AR) to generate realistic CBRNe adversary threat scenarios in the form of storyboards. Derived from the terrorist attack cycle, the CBRNe-AC describes activities specific to CBRNe attack planning, weapon acquisition, weapon construction, and attack execution. Walking through the CBRNe-AC from beginning to end, the AATG algorithm stochastically samples relevant adversary activities from the CBRNe-AR. The activities contained in the CBRNe-AR are threat activities identified through historical events, red teaming scenarios, and subject matter expert (SME) elicitations. Once the realistic CBRNe adversary threat scenario storyboards are generated, they are then mapped into a corresponding graph structure that represents a list of dependent queryable constraints on how such activity would appear in real world datasets. Currently, these graphs are used to train the advanced intelligence analytics algorithms searching for adversary activity.

Classification: UNCLASSIFIED
Working Group:WG 28 Advances in Modeling and Simulation Techniques

WG 29 Computational Advances in OR

56694 - A SIMULATION FRAMEWORK OF MULTI-OBJECTIVE EVOLUTIONARY ALGORITHMS AND SURROGATE-BASED OPTIMIZATION FOR GUIDED WEAPON DESIGN

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr. Andrew Lawrence Kaminsky; Mr. Isaac Wolf; Dr. Yi Wang; Seong Hyeon Hong; Dr. Kapil Pant; Dr. Rhoe A. Thompson; Christopher Jarvis; Kathryn Flynn		
Abstract: The design of guided air-to-air weapon systems typically features high-dimensional, multi-system design spaces, complex relationships between design parameters and design objectives, and competing design objectives. In combination, these factors have made guided weapon design a discipline that has conventionally relied heavily upon the prior experience of subject matter experts. However, this trend is ripe to change as increased availability and reduced costs of computational resources as well as the maturation of modeling and simulation capabilities lend themselves to automated, systematic, high-throughput evaluation of guided weapon systems. Recognizing this opportunity, AFRL is developing an efficient, robust, systematic, and generalizable optimization approach to enhance guided weapon concept design decisions.		

Evolutionary algorithms are well suited to the challenges of guided weapon design since they can be employed to systematically explore heterogeneous design spaces in a gradient-free manner to identify global optima. Their sole drawbacks are that they typically require significantly more evaluations than their gradient-based counterparts to identify optimal design(s), and it is hard to know which evolutionary algorithm heuristic will work best for a given problem. We have sought to address these issues, by developing surrogate models to map the relationship between the design variables and objectives from data as it is collected. These surrogate models, based on fast-to-evaluate elementary functions, are then employed to provide insight to tune the evolution heuristics and reduce the number of evaluations. This coupling of surrogate models and evolutionary algorithms creates surrogate-assisted evolutionary algorithms that significantly accelerate design optimization.

In this presentation we will outline the development of these surrogate-assisted evaluation algorithms and their coupling to high-throughput guided weapon performance evaluation tools within our multi-objective evolutionary algorithms for design of weapons (MEADOW) framework. MEADOW will be demonstrated for design studies concentrating on expansion of projected launch acceptability regions for air-to-air missiles compatible with strike fighter internal stores.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56887 - Applied Uncertainty Quantification for Verification and Validation of Strike Weapon Simulations Using SOFA

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Aaron Allen; Justin Mooney; Robert Reaney		

Abstract: New strike weapon concept capability can be estimated via parameterized computer simulation models using an iterative process of Uncertainty Quantification and visualization. Appropriate input trade spaces and simulation error/crash regions may be quickly identified, and final capability metrics such as the weapon's effectiveness zone (WEZ) can be derived efficiently through statistical analysis. Verification and Validation (V&V) of newly developed simulation models can also be achieved by comparing response trade spaces for existing models, test data, and the new model across similar input domains. This talk will overview the process and results of such an analysis for a newly-developed AFSIM 6DOF aerodynamics model, built on the legacy CADAC Weapons Simulation (CWS) 6DOF model used by AFRL, using the Simulation of Federated Applications (SOFA) software environment to perform large-scale parallel batch simulation, post-processing, and visualization via automated workflows.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

57139 - Strategic Planning and Analysis of Satellite Data Transmit and Receive Networks Using Mathematical Optimization

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr August G Roesener; Christopher Wishon		

Abstract: Since the launch of the first man-made satellite in 1957, satellites have become an integral part of the daily lives of many people in the world. Unfortunately, satellites are not stand-alone systems that function without interaction with terrestrial systems. As a result, satellite control

ground networks exist which transmit new instructions, check subsystem health, and download critical data from the satellites. Within the US Department of Defense (DoD), one such ground network is the Air Force Satellite Control Network (AFSCN) which does not own any satellites but acts as a service provider for communications with other agencies' and departments' space assets. The AFSCN is a network of antennas spread across 7 sites throughout the world that manages 100s of satellites with over 500 communication requests daily. Scheduling the AFSCN is a known NP-Hard integer programming problem as it needs to be updated to handle current demands, must abide by orbitology physics, and has numerous binding constraints which limit scheduling flexibility. This presentation provides an overview of the problem, nuances into the difficulties in solving an instance of the formulation, and a detailed discussion of the multiple optimal and heuristic based solution methodologies currently utilized to solve the problem. The presentation will also discuss the impact of Operations Research on the operational and strategic planning of the AFSCN and similar networks.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56732 - USAF Flight and Maintenance Scheduling Optimization

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Doug Altner		
Abstract: This talk presents an integer programming model for simultaneously optimizing field-level maintenance scheduling and tail-to-mission assignments for USAF aircraft. Our model contains a much larger medley of constraints and considerations compared to many previous approaches. This presentation will also discuss challenges that arise in prototyping an optimization-based decision support system in addition discussing challenges related to formulating and testing the model. Classification: UNCLASSIFIED Working Group:WG 29 Computational Advances in OR		

56836 - USAF Tanker Planning Optimization

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Doug Altner; Major Andrew Armstrong		
Abstract: This talk presents an in-advance planning optimization model, developed in partnership between Kessel Run and MITRE, for assigning tankers to receivers for aerial refueling while also factoring in a large list of operational constraints and considerations. Also discussed will be the additional challenges and opportunities with developing an optimization-based decision support system for USAF tanker planning as well as "man vs. machine" results highlighting the substantial potential benefits of optimization-based planning. Classification: UNCLASSIFIED Working Group:WG 29 Computational Advances in OR		

56752 - Combining Machine Learning and Traditional Optimization Approaches to Solve Reconnaissance Mission Planning Problem

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Mr. Prashant Sankaran; Dr. Katie McConky; Mr. Moises Sudit		

Abstract: A key aspect of the Reconnaissance Mission Planning (RMP) involves determining the routing of a fleet of recon assets to multiple target sites with different information quality and threat levels to maximize the total information gained subject to resource constraints. The problem thus described is a variant of the popular Team Orienteering Problem, which is solved to optimality using Discrete Optimization (DO). However, exact approaches to DO problems involve an exponentially growing decision space, which often make such problems intractable. Hence, practitioners rely on inexact solution approaches such as hand-crafted heuristics and metaheuristics. Although these inexact approaches are tractable in comparison to exact approaches, they are at best sub-optimal. Recently, advances in Machine Learning (ML) approaches, following their success on a wide array of real-world tasks, have shown promise for solving DO problems. Moreover, ML approaches have shown to yield better solution quality at a relatively low computational cost in comparison to traditional inexact approaches. However, ML approaches, like any inexact approach, do not provide a measure of solution quality, i.e., optimality gap.

To address the drawbacks inherent with traditional DO approaches and ML, we propose a novel Hybrid Learning-Optimization Solver (HyLOS) dynamic framework, which combines the capabilities of three independent DO solution approaches, namely, end-to-end ML, Metaheuristics, and Traditional Mixed Integer Linear Programming (MILP) Solver to collaboratively accelerate the solution process and yield the user desired solution quality. In the current work, we first present the HyLOS framework. Next, we share the performance of our ML approach to scale to unseen problem instances in comparison to traditional heuristic approaches on different RMP problem configurations. Lastly, we present the benefits of using ML to initialize MILP Solvers in comparison to other Heuristics approaches to solve RMP problems.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56910 - Multi-agent Air Combat Tactics with Self-Attention Reinforcement Learning in AFSIM

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET

Authors: Samuel Swanson; Mackenzie Lau; Dr. Michael Steffens; Professor Dimitri Mavris

Abstract: Reinforcement Learning (RL) has developed rapidly in recent years, and the technique shows promise for the automatic generation of vehicle tactics. The objective of RL is to find a policy function that maps state observations to actions in a way that maximizes total reward throughout a sequential decision-making process. This function usually takes the form of an artificial neural network (ANN). Traditional feedforward ANNs map one input vector of fixed dimensions to an output vector of fixed dimensions. In multi-agent air combat scenarios, this can be limiting for several reasons. The number of entities (e.g. aircraft or missiles) that the policy function needs to take into consideration can change as the scenario unfolds. Additionally, the ideal policy function should be able to reason about relationships between entities in the environment, which traditional ANNs do not explicitly do. Finally, the policy function should be permutation invariant, such that the ordering of the entities in the input does not affect the output. This research seeks to address the limitations of traditional ANNs through the use of self-attention mechanisms, which are a form of ANN commonly used in natural language processing. Self-attention mechanisms are permutation invariant, able to learn about the relationships between entities, and can generalize over a varying number of entities. Additionally, this work employs techniques for learning from demonstration behaviors to increase the speed of learning and remove the need for the excessive reward engineering often required for effective RL. The Advanced Framework for Simulation, Integration, and Modeling (AFSIM) is used to develop a multi-agent air combat scenario in which reinforcement learning is applied. Initial results

have shown that an agent can learn to capture multiple moving targets, both improving on the demonstration behavior and successfully responding to new situations in which there are significantly more targets than were seen in training. The final air combat scenario under development is a many-vs-many air combat scenario. This presentation will focus on the techniques required to achieve this learned behavior, including the implementation details specific to performing RL in AFSIM.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

57006 - Min-Max Task Assignment and Sequencing with Heterogeneous Unmanned Vehicles

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Sivakumar Rathinam; Jarett Battistini; Richard Tatum		

Abstract: This article addresses a planning problem for a team of heterogeneous, unmanned surface vehicles whose time costs are attributable to either transiting or task execution costs. Given a set of target regions and a team of unmanned vehicles, the Heterogeneous Multi-vehicle Planning Problem (HMPP) aims to find a tour for each vehicle such that each target is visited at least once by some vehicle and the maximum mission cost of any unmanned vehicle is minimized. The mission cost incurred by each unmanned vehicle in this work includes its travel costs as well as the costs involved in performing the tasks in the regions visited by the vehicle. This problem is a generalization of the single vehicle Traveling Salesman Problem and is NP-Hard. We develop a fast approximation algorithm that provides a feasible solution with a bound on the cost of solution found and improve on it further through variable neighborhood search heuristics. We also present numerical results to corroborate the performance of the proposed approaches.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56725 - Achieving Multi-Resolution Campaign Modelling In AFSIM

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Matthew A C Guckenberger; Nathan S Simon; Dr. Alicia Sudol; Professor Dimitri Mavris		

Abstract: This work is a continuation of the efforts presented at the 88th MORS Symposium with continued evolution of the methodology and expansions to the scenario. The interconnectedness of military systems requires the aggregation of information across different fidelity levels as system design is impacted by both the system's technologies and the composition/layout of the system of systems in which it is fielded. At the campaign-level, hierarchical aggregation can provide efficient top-level analysis while also providing further depth at the physics, engagement, and mission levels. The magnitude of data produced by such an aggregation requires the utilization of large-scale data visualization and exploration techniques to inform decision makers. The Advanced Framework for Simulation, Integration and Modeling (AFSIM) provides an open-architecture that has been shown capable of modeling at different levels on the modeling & simulation pyramid (specifically the physics, engagement, and mission levels). This work looks at AFSIM's applicability to campaign analysis and the aggregation of results from multi-fidelity modeling with a focus on different modeling and analysis techniques to overcome the runtime versus fidelity paradox. The notional campaign modelled for this work includes space, air, and land components with a dynamic campaign commander to determine the next steps within the campaign. The resulting analysis looks at the effectiveness of different force structures and system-level technologies on mission and campaign-level metrics. A successful

campaign is achieved when the strike targets are destroyed, and metrics like loss rate, cost of campaign, and time to completion are monitored for each case. Agent creation is handled on-demand throughout the campaign based on mission needs and where appropriate surrogate models are assessed to reduce the model complexity. Both steps provide a better usage of runtime based on study needs.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

55337 - High-Dimensional Data Reconnaissance using Snakes

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Thomas Reed Willemain		

Abstract: High-Dimensional Data Reconnaissance using Snakes
Thomas R. Willemain and Adam G. Petrie

Data that are either meant or assumed to be uniformly distributed may in fact have regions of high and low density. Graphical displays are either inadequate to detect the presence of clusters or could be supplemented for additional insight. The Snake is a new analysis tool that can detect the presence of clusters and estimate their number. Snakes provide a unique and readily interpreted visual depiction of the structure of high dimensional data.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56792 - Visualizing Multi-Resolution Campaign Analytics from AFSIM

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Alicia Sudol; Matthew A C Guckenberger; Professor Dimitri Mavris		

Abstract: The data output from a design of experiments in AFSIM provides a sizeable amount of data which can be difficult to provide useful and timely analytics to decision makers. This work looks at techniques of visualizing and providing new insights to a campaign scenario. A decision-making environment is presented to better visualize and capture the aggregated results. This dashboard provides a decision maker with quick insights into the results, trends, and visualization files calculated during a force structure comparison. The force structure comparison analyses the effectiveness of force size and force composition on the campaign length, cost, and effectiveness. Due to runtime limitations, it is uncommon for an entire design space to be explored (full-factorial), therefore a limited data set was run and surrogates have been fit to visualize the entirety of the design space. The concept allows a limited number of case data to provide trends in a much larger design space. The different dashboard tabs are capable of comparing specified force architectures or exploring the entirety of the design space. Links between the AFSIM visualization output and the dashboard allows run data and campaign progression to be seen by the decision maker. The dashboard provides a new way of visualizing data, however, the second effort of this work sought to provide new analytic insights by applying time-to-event analysis. Time-to-event analysis breaks down each campaign event to determine its effect on the campaign's outputs. In example, how did the disabling of the SAM network by the 3rd day effect a run with a small force architecture versus a large architecture? These analytics enable decision makers to understand the evolution of a campaign from a high-level, rather

than solely the end effects. Overall, this effort demonstrates a new method for visualizing large data sets and providing additional analytic insights to an AFSIM campaign force comparison.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56726 - Remembering the Operator in Partially-Automated System Analysis

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Matthew A C Guckenberger; Dr. Alicia Sudol; Professor Dimitri Mavris		

Abstract: With the increasing integration of automation technologies, the role of the operator is changing from sole actor to a shared supervisor/actor role. This change requires new modeling techniques in operational studies to provide the analytics for assessing system performance. Studies on unmanned ground vehicle operators and recent crashes being partially blamed on automation technologies demonstrate the need to measure and assess operator awareness and workload. Overcoming these challenges requires an assessment early in the design cycle for operator awareness and workload. This modeling methodology integrates concepts from cognitive engineering into operations analysis to better capture and analyze the effectiveness of increasingly automated systems. An agent-based model is created using Operational Event Sequence Diagrams and concepts from situation awareness research to guide agent formulation. The agent rule set is then mapped to the NASA Task Load Index scales to provide a dynamic output throughout the simulation. A traffic model is built in AFSIM to compare the mental workload associated with city versus highway driving. The dynamic workload measurement is the first step in a framework which will enable automation technologies to be traded during the conceptual design phase. The diligent mapping of actions between the automation and operator, along with these new awareness and workload metrics, is required if operation's models are expected to provide decision makers with the analytics necessary for assessing heavily automated systems.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56965 - Rapid generation of information fusion architecture alternatives through algebraic graph transformations

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: John Robinson		

Abstract: Emerging concepts for defense systems such as mosaic warfare focus on the composition of novel, unpredictable systems of systems comprised of many platforms, rather than relying on a smaller number of highly performant multi-role systems. The combinatorial space of solutions to mission problems afforded by this new approach is vast, and there is a desire to engineer these systems-of-systems on the fly at a more rapid cadence than traditional SoS engineering cycles. Proper engineering of the information fusion (IF) architecture of these SoSs is critical to maintain capabilities in the face of the systems confrontation approach adopted by near peer adversaries. This presentation outlines the use of algebraic graph transformations (a mathematical tool with past application to tasks like compiler optimization and computational chemistry,) as an enabling tool for the generation of arbitrary, but physically and logically coherent, IF architectures, by means of non-deterministic rule application on a typed attributed graph. The typed attributed graphs generated by this method represent both physical and logical architecture descriptions, from which transformation

into both MBSE models or executable simulations will be demonstrated. As a result, this approach provides engineers a useful tool for rapid, on-demand generation of sets of architecture alternatives from which those best suited for a particular mission can be selected.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

56762 - Active Set Prediction via Recurrent Neural Networks for Power Grid Optimization

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Ethan King; Arnab Bhattacharya; Dr. Samrat Chatterjee; Craig Bakker; Feng Pan; Matthew Oster; Casey Perkins		
Abstract: Operational decision-making problems in the power grid, such as the Economic Dispatch (ED) and Unit Commitment (UC), aim to maximize economic efficiency while satisfying demand and required safety margins. However, uncertainty and variability in renewable generation and demand, requires the optimal dispatch set-points to be updated frequently in response to observed realizations and near real-time forecast updates. To address the challenge of computing frequent real-time updates to the optimal solution, we propose the use of a machine learning approach that learns the mapping between uncertainty realizations and the set of active constraints of the optimization model. A key novelty of our approach is the use of long short-term memory (LSTM) neural networks to learn the active set in problems with non-linear system dynamics and temporal constraints. As opposed to directly learning the optimal solutions (called end-to-end learning), our approach can provide significantly better solution quality and provide better feasibility guarantees. The learnt neural-network model can be then used to predict solutions in real-time. We will demonstrate the efficacy of our approach for the Economic Dispatch problem with generator dynamics, which is tested on a 9-bus test system. Our approach will be compared to traditional optimization and existing end-to-end learning approaches

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR | | |

56751 - Characterizing the Local Curvature of Convolutional Neural Network Basins with Gaussian Paths and Quality Engineering

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Benjamin Morris		
Abstract: Due to the complexity of deep neural network loss surfaces, training a deep neural network through optimization routines can sometimes yield very poor solutions and hard-to-generalize results. Characteristics of the loss surface are inherently impacted by the architectural choices that a model-builder must make while designing a neural network instance. Identifying architectural components that yield favorable conditions for optimization is an active area of research, with theoretical results often making several simplifying, layer-specific assumptions, and empirical results often focusing primarily on known state-of-the-art architectures or much smaller architectures with grid-search methods employed for later analysis. One characteristic often assumed to exist for neural network loss surfaces is Beta-Smoothness, a means of bounding local curvature. We seek to address the problem of holistically identifying network architectural components that most impact Beta-Smoothness through empirical evidence found by applying a quality engineering approach, Design of Experiments (DOE).		

| Classification: UNCLASSIFIED |
| Working Group:WG 29 Computational Advances in OR |

56794 - Reinforcement Learning Approach to Intelligent Battle Manager

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Dr. Alicia Sudol; Loren Isakson; Professor Dimitri Mavris		

Abstract: Applied reinforcement learning presents a unique challenge when developing robust solutions in environments where optimal decision making is paramount. This presentation explores the application of deep q-learning to a novel air defense scenario simulated in AFSIM (Advanced Framework for Simulation, Integration, and Modeling). The goal is to train an agent to manage geographically separated assets capable of defending against incoming threats. Aircraft, armed with air-to-ground missiles, attack the base from all directions. Time sensitive decisions are necessary to prevent the loss of the battle manager agent or its subordinates, rendering the agent incapable of defending itself. Steps are taken to investigate ways of generalizing the policy in the interest of practicality.

Classification: UNCLASSIFIED
Working Group:WG 29 Computational Advances in OR

WG 30 Wargaming

56483 - Virtual Wargaming Methodology via SIPR

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Claire Fisher		

Abstract: How does an analyst shift a massive, in-person wargame into a virtual, distributed event? What can an analyst do to maintain momentum on a series of wargames that started in person but must continue now online? Which previously unexpected factors does an analyst consider when designing and planning a virtual wargame? Since April 2020, the Center for Army Analysis has designed and run several wargames with a focus on balancing analytic returns and participant/analyst health and safety. This unclassified presentation will discuss the methodologies for three virtual wargames in a case study format, with the intention of sharing lessons learned and best practices developed. There will be a focus on the wargame design implications and considerations for different secure internet protocol router network (SIPRNET) platforms (Defense Collaboration Services (DCS), Global Video Service (GVS), and secure video teleconference (SVTC)/file sharing). The first case was a heavily adjudicated wargame originally designed as a large in-person event. The in-person event was canceled and the methodology modified to be a distributed event facilitated by SVTC and SharePoint. The second wargame utilized DCS as the platform to continue an in-progress wargame series. The third wargame was a standalone seminar-style table-top exercise held over GVS.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56645 - Distributed Data Collection Events

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Lisa Colelli

Abstract: As part of the Army Futures Command's (AFC) Top-down Future Development Process, The Research and Analysis Center (TRAC) is responsible for conducting an annual Capstone Wargame to analyze the key concepts and modernization capability priorities. The 2020 Capstone event included two coordinated events.

TRAC conducted the European Command and Indo-Pacific Command capstone wargames to assess the suitability of recommended Force Packages and Calibrated Force Postures to inform Army Modernization efforts. These wargames are historically conducted onsite, enabling fluid collaboration among players. However, due to the novel coronavirus outbreak of 2019, TRAC conducted these 2020 wargames in a distributed environment, bridging the lack of in-person attendance with remote virtual sites. For these distributed wargames to be successful, the TRAC team developed a data collection management plan (DCMP) suitable for using a suite of tools hosted in a cloud-computing environment. This enabled event participants and study analysts to share information, collect data, and observe real-time trends remotely. The DCMP and primary, alternate, contingency, emergency (PACE) plans required a unique type of coordination among the study team, players, and information technology to overcome technological, communication, and data collection challenges that occurred throughout the game. These challenges included common and consistent network access to Secret Internet Protocol Router Network and Global Video Services collaboration and resource availability, among others. The team was able to use a suite of data analysis tools for study analysts to visualize and understand trends in the responses of the observed real-time events of the wargame to facilitate cross-functional area discussions that aided in identifying key insights.

This presentation will show the approach used to tackle the problem, the obstacles faced, and how they were dealt with by applying a distributed approach to data collection. Additional insights on data management methods, capturing results, and the analysis approach during this distributed event will also be presented.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56463 - Modeling Space, Cyber, and Electronic Warefare Operations in Center for Army Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: LTC Min K Choi

Abstract: When conducting operational wargames, space, cyber, and electronic warfare (EW) operations can often be overlooked or poorly represented. Modeling space, cyber, and EW operations can range from detailed tactical-level representation to simple, generalized "ballpark" estimates. The detailed tactical-level modeling of space, cyber, and EW functionality can be overly time and labor intensive to execute and is often poorly suited to providing operational-level insights when conducting an operational wargame. The simple, generalized "ballpark" estimate approach tends to neglect critical impacts of particular space, cyber, and EW operations.
The Center for Army Analysis (CAA) has developed a module inside of the Center for Army Analysis Accelerated Wargame System (CAAAWS) that seeks to model the critical operational impacts of space, cyber, and EW operation without bogging down by replicating the specific tactical actions required to achieve operational effects. During a wargame, commanders execute space, cyber, and EW operations that either degrade their opponent's combat capabilities or enhance their own. These capabilities include command and control functions; Intelligence, Surveillance, and Reconnaissance

(ISR) detection and target acquisition; air defense systems effectiveness; and deep strike capability, to name a few.
This presentation covers how CAAAWS models the operational impact from space, cyber, and EW operations and seeks to facilitate a discussion among wargaming practitioners.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56825 - Wargames as Data: Addressing the Wargamer's Trilemma

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Andrew Reddie; Dr. Ruby Booth; Dr. Bethany Goldblum; Kiran Lakkaraju, Ph.D; Jason Reinhardt		
Abstract: Policymakers often want the very best data with which to make decisions—particularly when concerned with questions of national and international security. But what happens when this data is not available? In those instances, analysts have come to rely on synthetic data generating processes (DGPs)—turning to model and simulation tools and survey experiments. In the cyber domain, where empirical data at the strategic level is limited, this is no different—with wargaming quickly becoming one of the important methods for both exploring and analyzing the national and international security challenges posed by state and non-state actors in cyberspace. In this paper, we introduce the wargamer's dilemma and use it to examine the design of existing cyber wargames before comparing wargaming methods against other established synthetic data generating processes. Then, we outline the potential of the method to examine some of the most difficult aspects of the cyber domain, paying particular attention to the potential of the method to measure various aspects of cyber deterrence.		
Classification: UNCLASSIFIED Working Group:WG 30 Wargaming		

56854 - Gaming Cyber Deterrence: Modeling Clandestine Capabilities

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Andrew Reddie; Mika Armenta; Dr. Ruby Booth; Kiran Lakkaraju, Ph.D; Jason Reinhardt		
Abstract: Much has been written by policymakers and academics regarding whether deterrence is possible in cyberspace and, if it is, whether its dynamics are similar or different the dynamics in other domains. Yet we remain no closer to moving beyond a theoretical debate concerning its existence. To address this gap in the literature, we model a constituent characteristic of the cyber deterrence challenge—the trade-off between revealing and concealing clandestine cyber capabilities—using both survey and wargaming methods. In this presentation, we examine the state of the field, present a proposed game design to study cyber deterrence, and analyze survey experiment data used as the basis of game design.		
Classification: UNCLASSIFIED Working Group:WG 30 Wargaming		

56584 - Integrating Cost as a Decision Variable in Wargaming

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET

Authors: Joshua Reese; Mr. Ryan Engle; Brent T Langhals; Jonathan Ritschel
Abstract: The Integrated Sustainment Warfighter Analysis Toolkit (ISWAT) represents a technological step forward in wargaming capabilities. To further advance ISWAT, wargamers sought to include cost as a decision variable in wargaming. This research represents the first steps toward this goal. For our research we focused on cost per flying hour of 81 aircraft, 23 munitions, unexploded ordnance removal, and runway damage repair. The key focus of our research is maintaining a high degree of flexibility in our cost models to match the wide variety of scenarios available in wargaming.

This research represents the first inclusion of cost in wargaming and thus many challenges were faced. The largest of which is the lack of an authoritative centralized unclassified repository for deployed flying hours. Thus, precluding wargaming flying hour costs from being calculated in the same manner as the US Air Force currently calculates peacetime flying hour costs. However, we leveraged the Office of Secretary Defense – Cost Assessment and Program Evaluation's Operating and Support Cost element structure to identify the relevant operating costs necessary to establish a wargame cost per flying hour. This includes a method to delineate peacetime and wartime expenditures through regression analysis. In addition to the development of a wargame cost, this research provides a framework to assess the trade space between wargame effectiveness and cost. The analysis provided by this research is aided by the development of cost visualizations with key cost performance indicators for analysis. During beta testing of our cost model in ISWAT, we received positive feedback from senior leaders in Air Force Material Command A4. While the results are tailored for implementation in ISWAT the implications can be easily integrated into other US Air Force wargames.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming |

56872 - War (Computer) Games: Utilising commercial software for iterative analytical wargaming

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr Ben Collins		
Abstract: This presentation will describe the usage and utility of one of several Commercial Off-the-Shelf (COTS) computer wargames that the UK's Dstl has adopted and had modified for analytical research wargaming In order to answer Army force development questions. Flashpoint Campaigns (FPC) is a combined arms Battlegroup to Brigade-scale land wargame which also represents fires, air, ISR & C2. It provides a rapid analytical wargaming capability that complements Dstl's existing Operational Research (OR) toolset. Additional features and tools added to FPC including data logging, umpire gameplay controls and deeper access have been added to the underlying mechanics in order to provide the required analytical capability. The model provides a fast, iterative wargaming capability that enables a first-look assessment of land forces at a significantly lower cost than the more detailed simulation models operating at the same scale - with the managed caveats of model confidence that using an externally-developed tool from the commercial gaming industry brings. This tool can help refine the capability questions to be explored, informing the study's focus and hence design, often saving time and money. The use of COTS wargames such as FPC will be discussed through the example of a series of analytical vignettes carried out remotely in 2020 as part of a broader research project to explore current and aspirational force structures for the British Army.		

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56959 - Gamifying Acquisitions for Assessing Impact on Military Strategy of Nation States

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr. James Richards; Mr. Joshua Church; Dr Megan E Gonzalez; Dr. Alicia Ruvinsky; Dr. Richard Cody Salter		

Abstract: Complex Systems in which humans play a role, namely Human-Integrated Complex Systems (HICS), can be difficult to model or simulate due to the uncertainty introduced by the human component. Military acquisition often manifests as a multi-faceted and complex process, implemented by large enterprises, with the purpose of managing national investment towards a national security strategy. As such, the military acquisition process can be characterized by (1) processes and protocols, (2) asset(s) being acquired (i.e., problem), and (3) national security characterization of a nation (i.e., context). The goal of this work is to build situational awareness and knowledge of how military acquisitions are executed by various nations, and understand how and when situational factors impact the probability of success of an acquisition strategy. We aim to evaluate military acquisitions in this way by building a game based on rigorous investigation into a historical perspective of the interaction of process, problem, and context of military acquisition initiatives undertaken by different countries. This historical perspective will be used to extrapolate a framework for evaluating the aspects of the 3-dimensional space that contribute or detract from successful acquisition initiatives.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

57147 - Stochastic Model for Analyzing Combat Strategies (SMACS)

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dr. Suzanne Marie DeLong; Adwoa Gyekye; Adam Patterson		

Abstract: Combat modeling can be a labor intensive, time consuming and expensive venture. SMACS was developed to analyze combat capability packages in a "back of the envelope" way through probabilistic calculations based on the functions of Blue systems stimulating, sensing, and striking Red targets. While initially developed as a spreadsheet Monte Carlo Simulation, SMACS grew into a Python simulation model that allows for the analysis of simple combat scenarios, exploring Blue system characteristics while varying Red target level of importance and engagement priority strategies. SMACS applies Monte Carlo simulation to decision trees to generate a success score based on the success of destroying the red targets conditional upon stimulating, sensing, and striking the red targets. Design of experiments is employed to conduct course of action analysis of multiple scenarios to gain insight into the Blue system parameters as well as how to weight and prioritize red system targets. SMACS is demonstrated with the use of future Blue combat systems where system parameters are not readily available, but rather are experimented with to help define combat system requirements to inform science and technology system goals and parameters.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56849 - Long Duration Logistics Wargaming (LDLW): Resilience Analysis Toolkit

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Zachary Shannon		

Abstract: The Air Force (AF) relies on logistics networks to support bases and other operating locations during both peacetime and contingencies. Because of its global mission, the AF's logistics networks can be extremely large and complex leading to inherent vulnerabilities that threaten the effectiveness of resource procurement, delivery, and ultimately, AF mission effectiveness. The need to predict future combat readiness resulting from sustainment and supply chain resources while facing a disruption is essential for holistically capturing the true impact of a robust supply chain on sortie generation capabilities. Current efforts, such as LDLW (Long Duration Logistics Wargame), intended to derive insights on the AF's ability to sustain an extended period of combat operations, derives sortie generation insights from simple logistic processes. Accurately capturing the impact of sustainment and supply chain concepts on AF network performance provides greater insight for decision makers when evaluating operational and strategic trade space impacts on the overall capabilities of the AF. This effort uses discrete-event simulation to model a repair-centric supply network decision trade space within a wargaming decision environment and formulates the associated network resilience tool requirements to support essential supply chain decision making. Specifically, this effort is intended to support the decision making and optimal resource allocation of supply chain capabilities to maximize network and base resilience to targeted adversarial attacks.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

57017 - Air Force's Analytical Wargaming of Logistics and Air Mobility: Reflections and Thoughts

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Dominick' Wright		

Abstract: Over the past several years, Air Force has made considerable progress infusing its wargaming of logistics and air mobility with analytical modeling. What began with the intention of more accurately constraining combat operations has evolved into being a significant boon for strategic development. Air Force Logistics' emphasis on realistically modeling airbases and infrastructure changed the gaming standard for basing assessment and eventually led to an entire game series devoted to strategic competition. Air Mobility's emphases on realistic force closure and aerial refueling have further informed theater posture and operational reach, respectively. Conditioning sortie production according to base suitability and resource availability has united operational and logistical planners in the determining of advance basing concepts that are operationally effective and logistically supportable. Rarer now, are cases where operators decide on schemes of maneuver in isolation, tossing to the logisticians trivialized yet complex support challenges.
Despite these achievements, Air Force Logistics and Air Mobility have much more to do in support of analytical wargaming. Inputs to analytical models tend to be complex and the process onerous, making the requirement of operating at game speed sometimes seem quixotic. Pre-loading the data is a reasonable mitigation but restricting game planning to model-determined rails is not. This presentation outlines a desired analytical wargaming end state, reviews what Air Force has achieved in progressing towards it, and discusses social, organizational, and technical means for closing identified gaps.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56846 - Using a "Pick-Up" Game to Assess New Technology Operational Requirements

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Terrance J. McKearney, FS		

Abstract: Military research and development (R&D) efforts need the engagement and input of actual operating forces to guide their engineering and prototyping efforts. However, involving the operating forces in the R&D process has always been a challenge: it is difficult to get engineers and scientists across the table from actual "operators" who have limited time. It is also difficult to draw serving operational personnel out of their immediate concerns for their reflections on applications and systems that might benefit them in the future. The author, supporting an Office of Naval Research (ONR) Innovative Naval Prototype (INP) project, developed the concept for using a wargame methodology tailored to a short two day session where operational personnel would be asked to respond to a scenario in a series of moves using a new technology. INP engineers and management participated in the event by briefing their concepts prior to "game play" and observing the operators' moves as the scenario developed. This presentation will describe the methodology used in this "pick-up game," the challenges in executing the event, and the data collection and analysis process that captured the input of the players for incorporation in technology design.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56857 - Wargaming when War is not the Answer: Multipurpose collective conflict resolution games

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr. Ruby Booth; Joshua Letchford		

Abstract: As analytical wargames gain popularity as a data generation process, application of the method to non-war contexts is both desirable and possibly inevitable. Such applications can provide additional proofs of salience to the broader scope of group behavioral dynamics and the methods validity. In the wargame, Assent, for NATO's Allied Command Transformation, we employed both military and non-military crisis scenarios to examine NATO consensus-making. Given Assent's design principles, it will be possible to examine modeling decision making dynamics among states within NATO without an external aggressor. This would enable players to practice consensus making while balancing national and collective needs and goals.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56824 - The GRAND Project: Consensus and Conflict Escalation in a NATO Context

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Kiran Lakkaraju, Ph.D; Wayne Buck; MR SIMON PURTON; Jason Reinhardt; Mika Armenta; Ben Bonin; Alisa Rogers; Dr. Andrew Reddie		

Abstract: NATO operates on the basis of consensus—in which all states have to agree (or at least not dissent) when, where, and how NATO should engage in a particular crisis. The opportunities for NATO delegations and staff to engage in this process is limited, however. This effort reflects an ongoing

project to design a wargaming framework, Assent, that both creates an environment for practicing consensus-making as well as substantively exploring crisis escalation in an alliance context. This presentation tells the story of designing this framework. Specifically, we examine NATO's institutional design, inventory the formal and informal processes that underpin NATO consensus-making, and outline NATO's crisis management toolkit. Finally, we turn to the early experimental design of the Assent wargaming framework and the data analysis plan that we intend to use to explore these issues.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56934 - Civil Affairs Force Modernization Assessment

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr. Paul Works		

Abstract: The Civil Affairs (CA) Force Management Directorate developed the forward-looking Civil Affairs: 2025 and Beyond White Paper (CAWP). This White Paper provided guidance for strategic planning, programming, force management, combat development, and testing of Army CA forces in order to meet worldwide strategic, operational, and tactical CA mission requirements in support of geographic combatant commands. As a result of this CAWP effort, the CA Proponent recognized that significant challenges existed across the current CA Force to performing their mission at all echelons across all components in support of Multi-Domain Operations. Starting February 2019, The Research and Analysis Center (TRAC) supported the CA Proponent in conducting a Force Modernization Assessment (FMA). The CA FMA proposed to understand CA Force challenges, examine those challenges within operational contexts, and identify potential mitigation solutions to the identified challenges in order to apply CAWP concepts. The CA FMA effort comprised two related elements: a traditional Capabilities-Based Assessment together with additional focus on the CA Force structure across all Army components.
This presentation describes the CA FMA effort, to include the wargame suite used during the Functional Solutions Analysis. Several recommendations from the CA FMA are currently being applied with the CA Proponent and additional recommendations are being socialized with Army Senior Leaders. The identified recommendations enable the CA Force to effectively organize, man, train, and equip in order to compete and win in a highly competitive and dynamic future environment as an integral part of the Army's future calibrated force structure.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

56889 - Techniques for Conducting Distributed Wargaming During COVID-19

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: MAJ Robert L Davis, P.E.		

Abstract: TRAC Capstone Wargames support Army modernization by integrating future concepts and capabilities within operational scenarios to characterize benefits and identify challenges. COVID-19 preventative measures necessitated adjustments to the execution of two AFC sponsored capstone wargames. TRAC had to find ways to elicit the participants' knowledge and enable participants to interact with each other without them being at the same location. TRAC conducted two classified operational-level wargames in a distributed manner on the SIPR network. This required changes to

traditional processes and tools to account for limitations to the study team's data collection and participant interaction during execution.

This presentation describes the impact of COVID-19 preventative measures and the necessary adjustments to wargame methods, models, and tools, including adjusted planning timelines, game processes, participant preparations, technical connectivity, and scenario refinement steps. TRAC's experiences demonstrate that distributed wargaming can provide opportunities for methods, models, and tools improvement in both in-person and distributed wargames within restricted environments.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

57037 - Playing on the Edge: Avoiding Ethical Pitfalls in Wargaming

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Dr. Ruby Booth		

Abstract: Experimental wargaming has incredible potential as a data generation process (DGP). We can use these games to simulate scenarios of interest at relatively low cost with minimal strategic consequences. However, this burgeoning opportunity must not blind us to the full implications of our work. Experimental wargaming has all the dangers of ordinary behavioral experimentation using human subjects, with additional ethical pitfalls unique to the wargaming context. In this talk, I will explain three such pitfalls, which I call: the Ender's Game conundrum, Aggro aggregation, and Ahistorical biases. We'll discuss the impacts of each on wargame design as well as possible mitigations when those exist. SNL is managed and operated by NTESS under DOE NNSA contract DE-NA0003525

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

57166 - Wargame Facilitation in a Virtual Environment

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: MAJ Harvey Clark Smith, III; Claire Fisher; Dr. Adam Patrick Shilling		

Abstract: Title: Wargame Facilitation in a Virtual Environment
Keywords: Wargaming, virtual, distributed, facilitation, moderation
Author Information: MAJ Harvey C. "Trey" Smith III, Center for Army Analysis, 6001 Goethals Road, Fort Belvoir, VA 22060, (703) 806-5681, harvey.c.smith2.mil@mail.mil
Distribution Statement A: Approved for public release.
Abstract: As many wargames shifted to virtual platforms in 2020, wargame facilitators have also adapted their styles and methods for facilitation. In virtual wargames, a few unique challenges and opportunities arise, in addition to different possibilities for overall discussion management. In terms of challenges, the facilitator's ability to "read the room" without seeing faces and body language is impacted, and initiating a free-flowing conversation requires managing the risks of participants talking over each other. On the other hand, chat functions easily capture sidebar discussions, and hand-raising mechanisms can allow participants to feel comfortable signaling their desire to talk. Facilitators need to make design and facilitation choices depending on the methodology, participant types, and topics. Free-flowing discussions with occasional prompting questions may work well for some wargames, but for others, a structured speaking order may elicit more engagement and insightful discussion.

This unclassified presentation will outline some of the challenges, opportunities, and experiences from facilitating multiple virtual wargames for the Center for Army Analysis. The intent is to have a discussion with other wargamers and facilitators about their experiences facilitating and participating in virtual wargames.

Classification: UNCLASSIFIED
Working Group:WG 30 Wargaming

WG 31 Operational Environments

56588 - Integrating Low Yield Nuclear Weapons into Wargaming

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Dan Kidd; Mr. Christopher Daniel Brinker, PhD		
Abstract: The US must be prepared to fight and win with conventional weapons on a battlefield where the opponent may use chemical, biological, radiological, or nuclear (CBRN) weapons to support conventional operations (theater use). Guidance from the Nuclear Posture Review and National Defense Strategy states that U.S. forces will ensure their ability to integrate nuclear and non-nuclear military planning and operations. To implement these concepts into the training, exercise and wargaming community, we must present this problem in a way that is palatable and in a language that is clearly understood to ensure that a nuclear insult becomes more of predicted and manageable change to the environment, and not the end of the scenario. DTRAs Wargaming and Analysis research and development program is developing a playbook that includes developing tactical nuclear objectives and scenarios; and the models, effects, and visualizations necessary to directly assist scenario developers. The intent is to develop a holistic guide and wargaming capabilities for integrating nuclear impacts into warfare specific objectives and scenarios, identify data/models/effects to be used in future games, and identify evaluation methods. This playbook will include templates for all domains and echelons from low strategic to high tactical to provide context, scale, structure and proposed visualizations to allow seamless integration into game development. Classification: UNCLASSIFIED Working Group:WG 31 Operational Environments		

56703 - Operations in a Nuclear Environment – What an Operations Officer needs to know

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Adrian Reenshuler; Dan Kidd		
Abstract: Recent Department of Defense guidance directs that U.S. forces must be prepared to integrate nuclear and non-nuclear military planning and operations. But how many know what integrated conventional and nuclear operations, and the post-nuclear strike environment looks like? What effect will a 5kt nuclear strike have on a brigade, battalion or platoon? Let's face it, most just don't know. This session will provide a non-technical understanding of nuclear weapon effects and what a post-strike battlefield nuclear operating environment looks like. Participants will leave knowing enough to start asking the right questions about how a nuclear operational environment will affect the battlefield and with the resources to find the answers.		

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

56982 - Demography and Security in Ukraine and Belarus

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:30 PM ET
Authors: Dr. Brian Nichiporuk		

Abstract: Ukraine and Belarus are two East European countries of increasing strategic importance to the US. Ukraine is a strategic US partner with a large territory, a large population, and abundant industrial and agricultural resources. It is the gateway to Southeastern Europe and is now being subjected to a Russian-organized separatist military campaign in its eastern regions. Belarus is governed by the authoritarian Lukashenko regime, but now has an organized pro-democracy opposition that wishes to bring Belarus closer to the West. If Belarus were to move away from Russia geopolitically, it would become more difficult for Russia to launch any military offensive against the NATO member Baltic States.

This presentation will examine how demographic factors are influencing the strategic environments in Ukraine and Belarus. It will unfold in three parts. First, it will review the key demographic trends in each country (fertility rates, ethnic composition etc.). Secondly, it will assess how demographic trends are affecting the generation of military power in each country, the development of military strategy in each country, and the sources of conflict in an around each country. Thirdly, the presentation will conclude with policy recommendations as to how US decision makers can best take advantage of regional demographic factors to advance US interests.

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

56367 - Agile, Scrum, and DevSecOps in a High-Intensity Deployed Environment

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Mr. Cameron Allen		

Abstract: With more data than ever flowing into government and military repositories, the Department of Defense (DoD) faces the evolving challenge of quickly providing its analysts access to the newest clean data. What processes can the DoD learn and adopt from the software development industry in order to be more flexible and agile in this endeavor? Furthermore, how can the DoD better integrate software development, information technology, and cyber security to pave the way for cloud-based data science tools and capabilities? This presentation shares the experiences of Army data scientists on a forward-deployed software team, and their successes implementing Agile, Scrum, and Development-Security-Operations (more commonly referred to as DevSecOps) methodologies into their high-intensity workflow.

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

56566 - Operationalizing Agile for Military Planners

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Ian Wolfe		
Abstract: Subject: Abstract submission for the MORS 89th Symposium		

Title: Operationalizing Agile for Military Planners
Submission for: WG 32 Special Operations and Irregular Warfare and WG 31 Operational
Environments, Military Operations Research Society (MORS)
Author: Ian Wolfe (iwolfe@mitre.org)
Classification: Unclassified

Presentation Abstract:
Agile as a concept was developed in 2001 as software developers rebelled against the constraints of traditional waterfall planning processes. The rapid pace and decreasing cost of innovation rapidly made the software market more complex, and traditional methods of software planning were no longer able to produce good and timely results. Military planning is at a similar point, where planners face complex and rapidly evolving challenges in the form of Irregular and Asymmetric Warfare. Despite this environment, the primary planning tool described by Joint Publication 5-0 – Joint Planning is linear and oriented around backward planning. This presentation examines why linear planning has been so successful historically, as well as why it is no longer up to the task with the aid of the Cynefin Framework developed by David Snowden. Finally, the author proposes an Agile Planning Framework that can be applied to operational problems in the field along a spectrum of complexity.

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

56928 - Providing Assured Position, Navigation, and Timing in a GPS Denied Environment

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. Timothy T Elkins; Mr. Jamie L. Stanley; Mr. Darryl S. Thompson		
Abstract: Assured Positioning, Navigation, and Timing (APNT) is a high-level reserve for systems that utilize Global Positioning Systems (GPS) for operational use. If GPS is degraded or inaccurate, APNT provides a backup to maintain operations and readiness. Accurate information about APNT, with an emphasis on distributing timing, is key to owning the battlefield and achieving tactical and operational success as communications, smart weapons, and security systems can become inoperable if timing is out of sync. This effort attempted to determine an alternative technique or system to provide APNT, with an emphasis on timing, to military, rotary aircraft. Classification: UNCLASSIFIED Working Group:WG 31 Operational Environments		

57008 - Risk Averse Autonomous Navigation from Human Demonstrations

Start Date: 6/25/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Christian Ellis; Dr. Lance Fiondella; Craig Lennon, Dr.; Dr. John G Rogers, III; Dr. Maggie Wigness		

Abstract: Traditional imitation learning provides a set of methods and algorithms to learn a reward function from expert demonstrations.
When building autonomous mobile robots, it may be easier to provide demonstrations capturing desired behavior rather than attempt to explicitly program it, providing flexibility to learn behaviors unanticipated by developers.
However, a minimal set of demonstrations is unlikely to capture the information required to achieve the desired behavior in all future environments.
Due to distributional shift among environments, the robot may encounter states rarely or never encountered during training, for which the appropriate reward value is uncertain, leading to negative side effects.
To operate safely in such dynamic environments, this paper proposes a Bayesian technique which quantifies uncertainty over the weights of a linear reward function given a dataset of human demonstrations.
This uncertainty is quantified and incorporated into a risk averse set of weights used to generate cost maps which act as input to a planner.
Experiments in a continuous 3-D unity environment with a simulated robot equipped with virtual sensors show that by using the proposed algorithm, the robot is able to avoid negative side effects requiring any new demonstrations.

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

56624 - Miniature Self Defense Munition

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Kaitlin Harris		
Abstract: The Miniature Self-Defense Munition (MSDM) is a threat agnostic kinetic countermeasure for aerial platform self-protection and base defense. It offers an affordable kinetic countermeasure against threats as a ground or aircraft launched line of defense. Its relatively small size allows for deep magazines and pod employment on aircraft or high capacity ground launch containers. The canister design offers a reduced logistics footprint, increasing deployment readiness while posing minimal impact to platform payload capacities. Classification: SECRET NOFORN Working Group:WG 31 Operational Environments		

56747 - Using Automated Virtual Environment Generation to Enable Parametric Simulations for Unmanned Ground Vehicles

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Dr. John Gabriel Monroe; Josh Fairley; Mr. Burhman Q. Gates, Jr; Stephanie Price		
Abstract: Modeling and simulation (M&S) tools play an important role in developing autonomous unmanned ground vehicles (UGVs). Using M&S, engineers can evaluate algorithm and sensor performance in a wide range of weather conditions, environment configurations, and mission scenarios with a fraction of the expense, risk, and time an equivalent set of physical tests entails. While accurate multi-body dynamics, powertrain modeling, and vehicle-terrain interaction (VTI) are important for a robust ground vehicle simulator, a detailed virtual environment, i.e., scene, is a critical component for UGV M&S. If the tool is to predict accurately an autonomous system's behavior in		

real-world conditions, the virtual environment that affects both the mobility and sensors of a UGV must be sufficiently realistic. For example, if a high-fidelity sensor model is to provide useful data to test the autonomy, the virtual sensor must have a high-fidelity environment to interrogate. Developing high-fidelity scenes for M&S tools is a complex task with many data requirements and sub- processes. ERDC has developed the Virtual Environment Generation Automation Scripts (VEGAS), which is a suite of tools that reduces the time and effort required to develop geotypical and geospecific scenes and to modify them parametrically once a base-line scene has been created. This presentation will introduce these capabilities and describe a use case that leveraged them to test autonomy robustness against varying vegetation density.

Classification: UNCLASSIFIED
Working Group:WG 31 Operational Environments

WG 32 Special Operations and Irregular Warfare

56617 - Evaluating Checkpoint Value in Afghanistan

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:30 PM ET
Authors: Mr Joseph L Stallings, Jr		

Abstract: (U) The Defense Threat Reduction Agency's (DTRA) Trends Analysis Branch conducts Operations Research and Systems Analysis to defeat Improvised Threats, to include Improvised Explosive Devises (IEDs), as weapons of strategic influence. Additionally, the Trends Branch conducts analysis support Command Assessments and Operational Decision-making.

(U) There are over 6000 checkpoints reported by the Afghan Security Force Commands. Checkpoints may be used to secure key terrain, limit enemy freedom of movement, protect civilian populations, or monitor traffic along key commercial or tactical routes, among other things. Despite perceived value for each, it is not feasible to man and maintain all reported checkpoints. As a result, the Resolute Support (RS) Command has been searching for a methodology to assess the value of checkpoints reported by the Afghanistan Security Forces in order to prioritize resourcing activities.

(U) The problem was approached as a Multi-Criteria Decision Analysis (MCDA). The dynamic decision environment and challenging utility assessment make this discussion noteworthy. The discussion will examine the selection of metrics that captured the utility of each checkpoint to the Afghan Security mission. Additionally, the discussion will address the development of a utility curve for each metric that could be used to determine a utility value for each checkpoint relative to each metric. Having established metrics and utility curves, it was possible to determine a "Contribution to Security" value for each checkpoint and rank order the checkpoints accordingly.

(U) Additional analysis was provided to assist in developing a discussion with Provincial leadership with respect to resourcing justifications. The logic behind the MCDA supported a starting point for discussions that would reveal new perceptions of utility and a basis for revisiting the MCDA process.

Classification: UNCLASSIFIED
Working Group:WG 32 Special Operations and Irregular Warfare

56822 - Drop the Hammer: Counter-Unconventional Warfare and a Future of SOF

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:30 PM ET
Authors: William Buppert		

Abstract: The Counter Terrorism mission in Special Forces (SF) and greater Special Operations Forces (SOF) has severely crippled the efficacy and strategic influence of SOF in the US and among coalition allies. Kicking down doors and shooting people in the face on balance strengthens insurgency operations and by extension excludes SOF concentration on unconventional and asymmetric solutions in Foreign Internal Defense hybrid missions and Unconventional Warfare. The new strategy may be Counter-Unconventional Warfare (C-UW).

COL Robert Jones (USA, Ret): "When we counter the UW campaigns of VEOs [Violent Extremists Organizations] like AQ and ISIS, we shift from being against a symptom we fear, to being for an end state far more can rally around. Ultimately, we are competing for strategic influence across the full spectrum of actors in the spaces where our interests manifest. C-UW recognizes that VEOs conduct UW campaigns and focuses on defeating their strategy, while at the same time out-competing them for influence with the insurgent populations they rely upon. C-UW narrowly focuses [Counter Terrorism] (CT) on UW operatives and foreign fighters."

This brief will discuss how the adoption of C-UW and the reframing and reduction of CT will match the capabilities of future SOF across the spectrum of conflict and optimize strategic influence. The presentation will also pose questions on the utility of active armed engagement and implications of anti-fragile frameworks in insurgent behavior.

Classification: UNCLASSIFIED
Working Group:WG 32 Special Operations and Irregular Warfare

56871 - Responding to the Threat of Image-Based C3 Disruption

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Dr. Douglas A. Samuelson; Dr. Spencer Graves		

Abstract: Mass media communications have shifted dramatically from linear, words-and-logic messages to images and memes. As Marshall McLuhan predicted, this shift transforms the nature and possibilities of governance and promotes tribalism. Recent US political campaigns provide striking examples of this phenomenon, including the ease of incitement to insurrection, but much broader applications are clearly possible. In particular, disinformation campaigns could disrupt C3, especially for small, loosely coordinated special operations units.

We discuss ways to identify and counter such disruptive activities. One area of experience that offers promise is Village Stability Operations, which focuses on building trusting communities that then become resilient against anti-government messages. Domestically, similar ideas are community-based policing and political community-building via extensive personal campaigning, also called "the ground game." Building trust is critical.

As in counter-terrorist operations overseas, slowly and carefully identifying the components of hostile networks and dismantling the information and financial structure are likely to work better than force-on-force "whack-a-mole" approaches. While there are highly appropriate legal restrictions on US military activities within the US, there is no reason why experienced VSO operatives could not train domestic law enforcement personnel.

Similarly, "whack-a-mole" actions against inflammatory media messages are unlikely to counter the polarization which some splinter groups promote and from which they prosper. Facilitating civil legal actions against malicious defamation, reestablishing a higher degree of Federal licensing and enforcement actions in mass media, and promoting a common trusted knowledge base seem more promising.

In military operationsore strongly establishing which sources of information to trust and how to recognize disinformation should be a high-priority operational security activity. Increasing joint training can help unit commanders discern which communications purportedly from or about other unit commanders should be treated with suspicion.

The central idea is to recognize that current threats are far more likely to be information-based rather than kinetic, and to acquire, train, prepare and respond accordingly.

Classification: UNCLASSIFIED
Working Group:WG 32 Special Operations and Irregular Warfare

57419 - Assessing the Benefits of an International Conflict Observatory

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Spencer Graves; Dr. Douglas A. Samuelson		

Abstract: We suggest that the ultimate outcome of almost any conflict that lasts longer than a few days may be largely determined by the actions of parties who were not initially involved. Conflicts expand primarily by attracting parties off the sidelines. We therefore consider what drives actors to leave the sidelines to join one side or the other in conflict, to increase or decrease their level of support for their chosen side, to desert or defect. How can we assess how current actions affect (a) the prospects for peace in the short term and (b) post-conflict developments?

Many if not all parties to conflict select their actions based on substantial misunderstandings of what motivates their adversaries. Consequently, parties are often upset with the evolution of the conflict and developments post-conflict. This suggests a need for an international conflict observatory that compiles and organizes evidence relating to these questions and makes them available, so more people and nations make better decisions regarding conflicts. Such compilations must also develop systems to distinguish to the maximum extent feasible the difference between honest information and deceit.

This presentation reviews existing organizations and individuals whose work relates to the dynamics of conflict, information, and decision-making. We aim to identify gaps and discuss possibilities for filling those gaps. These include the Stockholm International Peace Research Institute (SIPRI), the Peace Research Institute Oslo (PRIO), the Correlates of War project, and others. These issues include the question of whether a tendency to violence is associated with tyranny while nonviolence builds democracy.

In response, we propose the creation of an non-governmental international conflict observatory that will focus such research and foster collaboration on studies. This international conflict observatory may choose to encourage people concerned about conflicts to work with repositories like Wikipedia, that is, visible places where people with very different perspectives collaborate to develop something that most people can more or less live with. This contrasts sharply with the "echo chambers,"

seemingly increasingly prevalent, that promote separatism and conflict. Such an observatory can promote finding ways to use tools such as text mining, context analysis, and social network analysis to help identify conflicts and describe what motivates people on each side while also developing procedures that make it hard for malicious parties to disrupt this work and distort the results of these efforts.

An added benefit of such an observatory would be the development of international trust and collaboration relationships that would not be subject to disruption by abrupt changes in one or two nations' support. Such trust networks would be very helpful in issues such as limiting the proliferation of WMD and promoting effective responses to disease outbreaks and natural disasters.

Classification: UNCLASSIFIED
Working Group:WG 32 Special Operations and Irregular Warfare

55360 - Operationalizing Agile for Military Planners

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:30 PM ET
Authors: Ian Wolfe		

Abstract: Subject: Abstract submission for the MORS 89th Symposium

Title: Operationalizing Agile for Military Planners
Submission for: WG 32 Special Operations and Irregular Warfare and WG 31 Operational Environments, Military Operations Research Society (MORS)
Author: Ian Wolfe (iwolfe@mitre.org)
Classification: Unclassified
Presentation Abstract:
Agile as a concept was developed in 2001 as software developers rebelled against the constraints of traditional waterfall planning processes. The rapid pace and decreasing cost of innovation rapidly made the software market more complex, and traditional methods of software planning were no longer able to produce good and timely results. Military planning is at a similar point, where planners face complex and rapidly evolving challenges in the form of Irregular and Asymmetric Warfare. Despite this environment, the primary planning tool described by Joint Publication 5-0 – Joint Planning is linear and oriented around backward planning. This presentation examines why linear planning has been so successful historically, as well as why it is no longer up to the task with the aid of the Cynefin Framework developed by David Snowden. Finally, the author proposes an Agile Planning Framework that can be applied to operational problems in the field along a spectrum of complexity.

Classification: UNCLASSIFIED
Working Group:WG 32 Special Operations and Irregular Warfare

56930 - Civil Affairs Force Modernization Assessment

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:30 AM ET
Authors: Mr. Paul Works		
Abstract: The Civil Affairs (CA) Force Management Directorate developed the forward-looking Civil Affairs: 2025 and Beyond White Paper (CAWP). This White Paper provided guidance for strategic planning, programming, force management, combat development, and testing of Army CA forces in order to meet worldwide strategic, operational, and tactical CA mission requirements in support of geographic combatant commands. As a result of this CAWP effort, the CA Proponent recognized that significant challenges existed across the current CA Force to performing their mission at all echelons across all components in support of Multi-Domain Operations. Starting February 2019, The Research and Analysis Center (TRAC) supported the CA Proponent in conducting a Force Modernization Assessment (FMA). The CA FMA proposed to understand CA Force challenges, examine those challenges within operational contexts, and identify potential mitigation solutions to the identified challenges in order to apply CAWP concepts. The CA FMA effort comprised two related elements: a traditional Capabilities-Based Assessment together with additional focus on the CA Force structure across all Army components. This presentation describes the CA FMA effort, to include the wargame suite used during the Functional Solutions Analysis. Several recommendations from the CA FMA are currently being applied with the CA Proponent and additional recommendations are being socialized with Army Senior Leaders. The identified recommendations enable the CA Force to effectively organize, man, train, and equip in order to compete and win in a highly competitive and dynamic future environment as an integral part of the Army's future calibrated force structure. Classification: UNCLASSIFIED Working Group:WG 32 Special Operations and Irregular Warfare		

WG 33 Social Science Methods and Applications

57000 - Human-Centric AI-Driven Decision Intelligence: Descriptive, Predictive, and Prescriptive Analytics

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr Maria Glenski		

Abstract: Human behavior is extremely difficult to measure, explain, and anticipate. However, large-scale dynamic multilingual multimodal open-source data, for example, from social media, provided researchers with the ability to extract knowledge and advance their understanding of human behavior and interactions with the goal of incorporating this knowledge into AI/ML models and simulations to enhance analysts' decision making and address national security challenges in the human domain.

In this talk we will showcase PNNL's descriptive, predictive and prescriptive AI-driven analytics that can be effectively used during COVID-19 pandemic to assist public decision makers to get insights in real-time, make informed decisions regarding the threat to mission, and plan accordingly. PNNL's AI-driven decision intelligence can assist the stakeholders with describe by using Deep Learning (DL) and Natural Language Processing (NLP) models; predict using DL models e.g., transformers, and graph convolutional neural networks (GCNs); and prescribe relying on causal structure learning.

Our descriptive analytics focuses on answering questions regarding "what has happened?". Extending from our earlier work, it analyzes millions of social media messages discussing non-pharmaceutical interventions (NPIs) enacted to mitigate the spread of COVID-19 in real-time (e.g., social distancing)

using NLP to infer audience reactions (in favor, against, or neither), perspectives (positive, negative or neutral), and psycho-demographics (gender, age, income and education level) over time across all 50 states in the US –https://watchowl.pnnl.gov/.

Our predictive analytics focuses on answering "what will happen?" questions, using a transformer-based deep learning model (inspired by our earlier work on forecasting influenza dynamics) to forecast the number of COVID-19 deaths and cases. Our preliminary experiments focus on state and county-level models that explicitly incorporate diverse heterogenous knowledge (e.g., NPIs enacted, compliance testing, mobility) combined with static location-specific data into predictive models.

Finally, our prescriptive analytics focuses on answering "how to make X to happen?", and relies on recent advances in causal structure learning to estimate the causal impacts of state-level interventions on COVID-19 dynamics. For example, our preliminary causal analysis shows that requiring self-quarantine after travel and banning small gatherings has a positive effect on improving case and death outcomes in the US.

Our comprehensive human-centric approach in response to COVID-19 crisis that combines AI-driven modeling, causal discovery and a suite of descriptive, predictive and prescriptive analytics will allow health decision makers to move from a reactive to a more proactive posture by automatically discovering timely, accurate, and actionable information – which will in turn enable early warning and rapid decision support.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

56666 - 1918 Influenza Pandemic: Overview, Actions, and Effects

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Ms. Diana M. Hanley		

Abstract: The 1918 Influenza (flu) Pandemic is known as the most severe and deadliest pandemic in the last century. Caused by an H1N1 virus, the pandemic killed an estimated 50 million people (675,000 Americans) and infected almost 500 million people worldwide (one-third of the planet's population).

As the world continues to face the recent 2019 Coronavirus (COVID-19) disease, the Analysis Development Group (ADG) at The Research and Analysis Center (TRAC) conducted in-depth research on the 1918 flu pandemic to provide information on how that pandemic can help the community to understand the effects of the SARS-CoV-2 virus.

This presentation includes an overview of the 1918 flu pandemic, the challenges it presented to society, and the control measures used to slow the disease's spread, emphasizing how theoretical modeling research helped identify these control measures' effects. The brief also provides insights into how society recovered from the illness and lessons learned to enhance decision-making for future pandemics.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

56595 - Development of Workforce Analysis Tool to Support COVID-19 Response Efforts

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. John R. Hummel, FS; Lawrence Paul Lewis; Dr. Braeton Smith; Joshua D. Bergerson		
Abstract: The COVID-19 pandemic has resulted in major disruptions in workforces around the world, millions of jobs lost and employees forced to work in isolation away from their offices and colleagues. There are also groups of workers whose jobs are considered essential, such as health care, public safety, grocery, and utility maintenance workers, that are required to work and interact with the general public, thus potentially exposing themselves, and their families, to COVID-19 infection. The Department of Energy Office of Science funded a major effort to develop decision support tools to analyze different COVID-19 response and mitigation concepts. Argonne developed a workforce analysis tool that included data from the Bureau of Labor Statistics on the workforces in every county of the United States, Puerto Rico, and the US Virgin Islands, as well as demographic data on these workforces from the U.S. Census Bureau American Community Survey. With this tool, analysts can determine the total number of workers and industries in their state or county. In addition, analysts can assess what portion of the workforce is considered essential, including the portion of those workers that have a higher vulnerability to infection because they are in frontline jobs. The tool also allows analysts to further evaluate the demographic attributes of these workforces that may increase their COVID-19 susceptibility and the potential negative outcomes if they contract COVID-19. In this presentation, we will describe the methodology used to develop the analysis tool, describe the data sources used, and present examples of the products that are generated. Classification: UNCLASSIFIED Working Group:WG 33 Social Science Methods and Applications		

57052 - Developing a large-scale synthetic population of persons for simulating COVID-19 transmission and response

Start Date: 6/23/2021	Start Time: 3:30 PM ET	End Time: 4:00 PM ET
Authors: Dr. Sara P. Rimer; Dr. Chaitanya Kaligotla; Dr. Charles M. Macal		
Abstract: To assist Cook County and the city of Chicago in their response to the COVID-19 pandemic, Argonne National Laboratory developed CityCOVID, an agent-based model that simulates the endogenous transmission of COVID-19 and measures the impact of public health interventions. We present details on the development of the large-scale (city to multi-county) synthetic population that serves as the basis for CityCOVID. This synthetic population is comprised of a set of "agents," who are individuals assigned their own set of (i) socio-demographic characteristics, (ii) behaviors (hourly activity schedules), and (iii) places they visit (according to their schedules), which collectively are statistically representative of a given geographic region. Additionally, these agents react to disease symptoms and non-pharmaceutical interventions. CityCOVID recreates the dynamics of disease spread through this population of agents. Each simulation scenario is based on a set of assumptions (informed by data and literature, and updated regularly) concerning non-pharmaceutical interventions and the corresponding agent behavior in response. We focus this presentation on the statistical methods and population-scale datasets used to build this synthetic population. Classification: UNCLASSIFIED Working Group:WG 33 Social Science Methods and Applications		

56681 - Corona Virus Disease 2019 (COVID-19) Support to 9th Hospital

Start Date: 6/23/2021	Start Time: 4:00 PM ET	End Time: 4:30 PM ET
Authors: Danielle Monique Aldrich		

Abstract: The COVID-19 pandemic continues to strain the medical system beyond the normal standards and levels that the healthcare system in the United States is prepared to handle. In the early days of the COVID-19 pandemic, the epicenter was in New York City (NYC), NY. In late March 2020, the 9th Hospital, a Joint task force made up of medical personnel from all services, was deployed to operate an alternate care site (ACS) at Jacob Javits Convention Center in Manhattan, NY. The Javits Center was originally designed to temporarily reduce the burden of non-COVID-19 illnesses on area hospitals but quickly transitioned to taking on only COVID-19 positive patients. Soon after deployment, the 9th Hospital reached out to The Research and Analysis Center (TRAC) for analytical assistance to help optimize its response to the COVID-19 outbreak.

TRAC's study team utilized a discrete event simulation model to create a baseline that represented the activities and experiences that the 9th Hospital's staff experienced during their time in NYC. Variations of the baseline were used to conduct predictive analytics and pave a path forward to mitigate some of the challenges faced by the study sponsors and help shape future deployment efforts.

The study found that there are multiple ways of increasing efficiency throughout the deployed hospital while also decreasing the total number of patients requiring treatment at any one time. The team also highlighted changes that reduced staff burnout and potential re-infection rates.

This presentation will cover the methods, models, and tools used by the TRAC study team to inform 9th Hospital concerns, key results, and how these results can be utilized to inform medical responses the Army can implement at ACS in infectious disaster situations.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

56710 - The accountability paradox confirmed: Positive and negative effects of accountability on improvement in US federal agencies

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Mr. Steven Lagan		

Abstract: Public organizations are expected to use performance information to improve their programs and to give account to the public. However, a large and growing body of research suggests that using performance information for accountability decreases the likelihood that public managers will use performance information to improve their programs -- a so-called 'accountability paradox.' The US Government Accountability Office conducts periodic surveys of US federal managers, examining their performance measurement and management practices, yet almost no research has examined the effects of accountability on managerial use of performance information. This study seeks to fill that gap by examining recent GAO survey data and drawing conclusions regarding the types of account-giving activities that promote or discourage federal managers' use of performance information in decision-making.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

56715 - Selecting performance measures for a defense process improvement program via consensus-based action research

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Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Mr. Steven Lagan		

Abstract: Public organizations are expected to measure their performance and use this information for external accountability and internal managerial purposes. Prior research indicates that using the same performance information for both external and internal purposes may trigger a variety of unintended negative consequences, including decreased use for internal purposes. This study presents the results of an action research project in which a defense process improvement program used consensus methodologies to select program performance measures that were useful for external purposes and, separately, for internal purposes; for dual-purpose measures, the group deliberated to determine the most appropriate use(s) for each measure. Measures were built around a logic model framework, using three action cycles. This innovative measurement selection process may be employed by other public sector organizations, in any industry or agency, to help decrease risks and increase benefits associated with implementing a comprehensive performance measurement system.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

57130 - Improving Government Effectiveness, Efficiency, & Affordability: Accounting for the Human Domain in the Market of Public Goods

Start Date: 6/24/2021	Start Time: 12:00 PM ET	End Time: 12:30 PM ET
Authors: Dr. Lisa Oakley-Bogdewic; Ms. Emaan Osman		

Abstract: Abstract: This brief leverages landmark literature in the social, political, and biological sciences to present the importance of accounting for the Human element in the complex decision-making space that is "the Government." Specifically, we will discuss why results in the market of public goods are generally not affordable, efficient, and effective, and what can be done to improve decision-making, operations, and outcomes. Key terms: Affordability, Effectiveness & Efficiency, Principal Agent Problem; Arrow's Impossibility Theorem; Tragedy of the Commons; Theory of Second Best; The Theory of Bureaucracy.
Authors: Dr. Lisa Oakley-Bogdewic and Emaan M. Osman

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

56603 - Assessing the Benefits of an International Conflict Observatory

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Spencer Graves; Dr. Douglas A. Samuelson		

Abstract: We suggest that the ultimate outcome of almost any conflict that lasts longer than a few days may be largely determined by the actions of parties who were not initially involved. Conflicts expand primarily by attracting parties off the sidelines. We therefore consider what drives actors to leave the sidelines to join one side or the other in conflict, to increase or decrease their level of support for their chosen side, to desert or defect. How can we assess how current actions affect (a) the prospects for peace in the short term and (b) post-conflict developments?

Many if not all parties to conflict select their actions based on substantial misunderstandings of what motivates their adversaries. Consequently, parties are often upset with the evolution of the conflict

and developments post-conflict. This suggests a need for an international conflict observatory that compiles and organizes evidence relating to these questions and makes them available, so more people and nations make better decisions regarding conflicts. Such compilations must also develop systems to distinguish to the maximum extent feasible the difference between honest information and deceit.

This presentation reviews existing organizations and individuals whose work relates to the dynamics of conflict, information, and decision-making. We aim to identify gaps and discuss possibilities for filling those gaps. These include the Stockholm International Peace Research Institute (SIPRI), the Peace Research Institute Oslo (PRIO), the Correlates of War project, and others. These issues include the question of whether a tendency to violence is associated with tyranny while nonviolence builds democracy.

In response, we propose the creation of an non-governmental international conflict observatory that will focus such research and foster collaboration on studies. This international conflict observatory may choose to encourage people concerned about conflicts to work with repositories like Wikipedia, that is, visible places where people with very different perspectives collaborate to develop something that most people can more or less live with. This contrasts sharply with the "echo chambers," seemingly increasingly prevalent, that promote separatism and conflict. Such an observatory can promote finding ways to use tools such as text mining, context analysis, and social network analysis to help identify conflicts and describe what motivates people on each side while also developing procedures that make it hard for malicious parties to disrupt this work and distort the results of these efforts.

An added benefit of such an observatory would be the development of international trust and collaboration relationships that would not be subject to disruption by abrupt changes in one or two nations' support. Such trust networks would be very helpful in issues such as limiting the proliferation of WMD and promoting effective responses to disease outbreaks and natural disasters.

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

55209 - DIGITAL DISPARITY AMONG THE U.S. ARMY AND ALLIED DEVELOPING COUNTRY ARMIES IN RELATION TO LOCATION ON THE LITERAL-VISUAL CROSS-CULTURAL CONTINUUM

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. Jim Schnell		

Abstract: This report describes the digital disparity among the U.S. Army and allied developing country armies in relation to location on the literal-visual cross-cultural continuum. Digital technologies are recognized as spawning intercultural challenges that exist regarding the disparity in digital backgrounds among U.S. and developing country coalition forces. This impacts the planning and conduct of military operations. Related challenges exist within the U.S. Army education & training system and operationally for developing countries as observed via uneven adaptation of digital technologies in developing countries, such as Afghanistan.

The author addresses increased emphasis on visual imagery over literal messages as it relates to U.S. Army cultural initiatives in varied contexts. As the U.S. moves to being a more visually oriented society, via web based and new communication technologies, literal forms of communication that generally have more emphasis on critical thinking are being displaced by the visual domain that

stresses more imaginary associations. Thus, the visual dominates at the expense of the literal and the imagination presides over critical thinking. This is worth noting because most Army cultural education is conveyed via visually oriented technologies.

key words: digital technology, cross-cultural relations, military coalitions , visual communication and military education

Classification: UNCLASSIFIED
Working Group:WG 33 Social Science Methods and Applications

WG 34 Data Science and Analytics

57055 - Community Analysis for Transportation Network Sustainability

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Nick Napier		

Abstract: United States Transportation Command (USTRANSCOM) manages and ships over a million wholesale
sustainment requisitions every year* and these movements are only a small piece of USTRANSCOM's overall functional responsibilities to project and sustain military power. The Command is accountable for the management of a shipping network covering all Combatant Commands (COCOMs) across multiple transportation modes: air, surface, and freight. USTRANSOM is applying an innovative, new method utilizing network modeling and graph databases to manage highly connected data.
With the use of the network modeling method, many forms of analysis can be carried out to assess the
node and edge importance's. As the size of the network model increases, an individual node's values can
be skewed by distal unconnected nodes. Partitioning methods known as community detection have recently gained momentum in the early 2000s to look at subgraph communities within the network. Communities, clusters of related nodes, organically form within a network. The members of any given
community will have closer relationships with each other than the nodes outside of their group. The characteristics of a community vary from the full network, allowing for the identification of critical information that may have been overlooked in the complete network. This information provides the opportunity to identify behavior of similar groups such as flow percolation, estimate resiliency, find nested relationships, and provide important subgroupings of data for further analysis.
The application of community algorithms to the transportation network provides decision-makers with
the ability to identify critical locations and routes to make better, faster decisions for the warfighter.

*The subset of data used for this assessment contained 1,078 delivery locations using air, sea, and rail data.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56609 - Community Analysis for Transportation Network Sustainability

Start Date: 6/22/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Mr. James Zylinski; Kristy Hollingshead		

Abstract: One of the key breakthroughs of deep learning on challenging natural language processing (NLP) problems has been the use of word embeddings as a learned representation for text, where words that have similar meanings have a similar representation. There are several well-known, time-tested techniques for exploiting word embeddings that enable a user to explore the "semantic space" of a given word of interest. Cosine similarity measurements permit a user to identify the terms that are most-similar to another given term, while word analogy method adds and subtracts vectors to reveal token analogs (Mikolov et al., 2013). Other useful techniques have been developed over the years: word embeddings can now be used to detect diachronic semantic shifts, such as the change in the meaning of the word gay from care-free to homosexual over time (Kutuzov et al., 2018), or to provide responses to questions by returning a span of text from a corpus that contains the answer to a user's query (Devlin et al., 2019). However, none of these methods provide a user with a technique to link two semantically-dissimilar words. If, for example, an analyst wished to reveal and explore the relationship between hot and cold, they could iteratively retrieve the top-n most-similar terms to hot, decide subjectively which they think appears more "cold-like", return its most-similar tokens, and repeat the process until arriving at the term cold. Such a manual process would be time consuming and potentially confusing towards the center of the semantic bridge where a forest of neutral terms must be navigated. This would become even more challenging in the situation where someone is seeking to identify a relationship between conceptually divergent terms, such as hypersonic aircraft and ultra-high temperature ceramics, especially if the individual is not a subject-matter expert in those fields. This presentation describes a technique for filling this analytic gap, which we term Semantic Path-Finding. This semantic path-finding method can be used to rapidly and automatically identify relationships between two potentially very dis-similar words, thus providing a user with an intuitive yet deep understanding of the subject matter. We have used this technique to find a semantic path from simple terms such as safety and danger (producing the sequence safety-protection-risks-threat-danger), or even numerical terms like 1 and 5 (returning 1-2-3-4-5) and thus providing strong sanity checks, to more complex ideas such as socialism and communism, and semantically-disparate associations such as that between ceramics and hypersonics. Semantic path-finding has numerous mission-relevant uses, from expediting subject-matter familiarity to enabling the exploration of the interplay between disparate forms of technology.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56487 - Infectious Probability: A Novel Metric for COVID-19 Risk Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Ian Paul Kloo		

Abstract: The early days of the COVID-19 pandemic were marked by big decisions and tremendous uncertainty. As a member of the USMA COVID-19 analytic team, I started working on metrics and visualization methods to help leaders throughout the DoD enterprise make decisions in this difficult environment. This presentation will discuss the analytic approaches that we tried and describe how they led to a useful and novel metric called infectious probability. Additionally, I will discuss the tooling and overall data science methodology that drives the resulting decision tool: BigMap (https://iankloo.github.io/bigmap/).

This presentation serves as a case study in the application of a full-cycle data science methodology (problem definition, analytic development, web scraping, visualization, and app development/deployment) to a real-world problem.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56466 - Using Neural Network Modeling to Classify Customer Sentiment with a Semi-Supervised Learning Approach

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Matthew Burzenski		

Abstract: This project presents an application of Natural Language Processing (NLP) and Machine Learning (ML) techniques to classify user sentiment based on free-text survey responses. Two customer feedback datasets provided the basis for our model: dataset 1 was a broadly scoped survey and includes customer sentiment labels; dataset 2 was a narrowly scoped survey without sentiment labels. We used regular expressions to computationally label 15% of the observations from dataset 2 after performing n-gram analysis on a small subset of manually labeled responses. Our model aims to leverage known sentiment labels of dataset 1 to generate sentiment labels of free-text responses in dataset 2. In addition, our analysis focuses on detecting and correctly classifying negative sentiment responses. After following typical NLP preprocessing steps, such as spell check and tokenization, we concatenate the two datasets and use one-hot encoding to add an additional feature indicating the original data source. Our final model consists of a balanced neural network trained on word embeddings from the combined dataset and achieves an overall accuracy of greater than 90%. For comparison, a similar model trained solely on word embeddings from dataset 1 and tested on dataset 2 scores an overall accuracy of 87.1%. While the overall accuracy differential is not substantial, the new model attains a significantly higher precision when detecting false positives, which is crucial given our emphasis on detecting negative responses within dataset 2.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56583 - Satellite Dish Detection as a Semi-Supervised Small-Object Localization Problem

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Daniel Grahn		

Abstract: Understanding the satellite communication abilities of a country provides a unique look into their civil and military capabilities. However, manually searching vast swathes of land for satellite dishes which may be just a few pixels in diameter and then determining their look angle is time-intensive and costly. Such processes are fruitful ground for learned object detection. Three major problems present itself in this task. First, there are no pre-labelled training dataset and bounding-box labels are expensive to generate. Second, satellite dishes are small objects within the images. Finally, generating a ground-truth dataset of look-angles is complicated and impractical. We overcame these challenges by making use of active and semi-supervised learning using a custom loss function and GradCAM to effectively localize dishes; a custom, minimal CNN to avoid small-object detection issues caused by excessive convolutions; and traditional CV to produce bounding boxes and look angles. This workflow demonstrates a series of techniques which could be applied to different tasks within the remote sensing and computer vision domain.

| Classification: UNCLASSIFIED |
| Working Group:WG 34 Data Science and Analytics |

56538 - Using RShiny to Create Analytic Dashboards for the Defense Language Institute

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: MAJ Colby Smithmeyer		

Abstract: The Defense Language Institute Foreign Language Center (DLIFLC) seeks to leverage their data to understand what student, faculty, and curriculum factors affect student outcomes on the Defense Language Proficiency Test (DLPT). To assist DLIFLC in this effort, The Research and Analysis Center (TRAC) provided support in data modeling and visualization. It then leveraged RShiny to develop analytic applications to display the outputs of these models, making them accessible to non-technical users and allowing Senior Leaders access to real time data and the ability to make timely data driven decisions.

TRAC collaborated with Naval Postgraduate School faculty and students from the Graduate School of Operational and Information Sciences to develop statistical models using various machine learning algorithms to develop the models and create the prototype applications. It then worked DLIFLC cyber security and information technology personnel to create an RShiny server on the DLIFLC network to allow the applications real-time access to DLIFLC student data.

This briefing provides an overview of the problem, methodology, relevant outcomes, and future applications of this analysis.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56855 - From Model to Impact: Leveraging OLS to Inform and Mitigate Gender Pay Disparity

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Jose R Carreno; Amanda George; Kelly Sobon		

Abstract: Naval Information Warfare Center (NIWC) Pacific, an Echelon III command in the Department of the Navy, conducts frequent workforce analysis to ensure its hiring and retention efforts reflect the knowledge, skills, and diversity of talent necessary to deliver C4ISR, cyber, and space warfighting capabilities. As part of the focus on diversity, NIWC Pacific's Equal Employment Opportunity (EEO) Office recently undertook an in-depth look at the representation of female employees in the overall workforce, utilizing an advanced barrier analysis framework.

In traditional barrier analysis, a trigger is identified, and then the data is compared to a common baseline or benchmark to determine if an anomaly exists in the representation of an identifiable group (gender, ethnicity, or other characteristic) of employees. NIWC Pacific built on the traditional model of barrier analysis by using statistical regression modeling to identify predictive factors in the workforce characteristics with respect to pay.

This presentation will detail the analysis model used to determine the significance of gender in salary determinations at NIWC Pacific, and how one department used this model to derive actionable insights. While data sensitivity issues preclude sharing specific findings, this case study highlights an

analytical methodology that identified specific areas in need of attention, broke down assumptions, and helped avoid a "one-size fits all" remedy. Finally, presenters will share both the strengths and limitations of the approach, and share—at a general level—the impact of these findings on the department.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56860 - Analytics: Hedging vs. Prediction

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr. Tovey Chaim Bachman		

Abstract: Analytics: Hedging vs Prediction
Businesses and Government are increasingly relying on predictive analytics to support decision-making--Artificial Intelligence (AI) and Machine Learning (ML) being two of the most sought- after forms. Such predictive methods train algorithms on one set of data, validate on a second set, and if successful, apply the algorithms to make predictions on new data. But significant disruptions have occurred over the last year or two, such as COVID-19, trade disputes, and political instability. Sudden changes in the operating environment, whether due to a virus, or changes in the geopolitical situation, can render existing data and assumptions irrelevant—invalidating data used to train algorithms, or revealing weakness in the algorithms themselves.
Such disruptions in the operating environment have led to a debate about the effectiveness of predictive analytics in a turbulent environment. Some say that organizations must become even more reliant on predictive analytics, to support an agile response to changing conditions. Others say that analytics are ineffective in the face of disruptive phenomena, and that decision-makers should fall back on human judgment. Both points of view have problems. It is unclear that algorithms' assumptions and logic can be adapted rapidly enough, and that new training data emerges in a timely fashion. On the other, hand human judgment has limited ability to handle complexity and suffers from inherent biases.
What determines the most effective type of analytics for decision-making is the underappreciated time element—the time between a decision and when its impact is felt. If that time to impact is short (e.g. days), agility may succeed, if timely data is available and the algorithm can handle it appropriately. If the time to impact is long (months to years), the operating environment may have changed radically by the impact point, rendering the results of the decision ineffective, or even disastrous.
When the time to impact is long enough that the operating environment can significantly and abruptly change, what is needed is a form of prescriptive rather than predictive analytics, based on a hedging strategy. Hedging algorithms, using simulations and high-powered computing platforms, now within reach of many organizations, can test the effects of a potential decision for robustness against thousands of possible future operating scenarios. We describe a successful application for the Defense Logistics Agency, and discuss other potential applications, such as planning for the work force of the future, or managing a portfolio of research projects.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57016 - WEB APPS AND CLOUD: PROGRAMMING MODERN DATA SOLUTIONS

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: MAJ Marc Eskew; Robert Smith		

Abstract: There is an emerging opportunity for the analytic community to revolutionize how data is created and utilized with a combination of cloud technologies, programming, and web applications. The capability is available today to allow a moderately experienced R programmer to create products that go beyond simple dashboards or reports. Army Futures Command (AFC) is using Shiny web applications, NoSQL databases, and Agile development processes to create and utilize enterprise accessible data in the cloud. Problems that would either be solved with the creation of either a new spreadsheet or a long and expensive contracting process can now be solved by an individual or small team with a flexible web app developed in weeks instead of years.

The signature effort proving this capability is a full stack developed application for the Army Cross Functional Teams (CFTs) to develop records for emerging efforts. CFTs access a Shiny application developed specifically to capture the data with a modern UI/UX. The application uses a mongoDB backend instead of a traditional SQL database many enterprise applications use. The advantages of this are simple use of the API through the R 'mongolite' package, the document structure is more intuitive for individual CFT efforts, and the flexibility of the documents allows for easy changes to the schema as requirements change or develop. As a product of the AFC Data and Decision Science Directorate (DDSD), Agile methodologies can be employed to rapidly produce a minimum viable product and iterate improvements to the software. This application is now providing data informing senior leader decision making and powering the AFC Modernization COP.

The development of programmers organic to the DoD and adoption of cloud technologies are opening up new possibilities to innovate. This use-case is still being developed and refined, but it demonstrates that the combination of creative tech talent, availability of open source programming tools, and cloud resources can modernize business processes without prohibitive costs.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56914 - A Novel Methodology and System to Increase Accuracies and Confidence for Supervised Machine Learning Models in Production with Sparse Datasets

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Abhishek Paul; Christopher Lock; Joshua Mutugi		

Abstract: This new decade of digital transformation will revolutionize how organizations operate. Machine learning (ML), specifically supervised ML, has been identified as a powerful tool to automate classification tasks where a plethora of historical data resides. A key aspect of supervised ML is the need for large and clean datasets where the target variable is known. For many organizations, this is a difficult requirement to meet. Many times, only sparse datasets are available which alters the ML's ability to predict accurately. The purpose of this study is to propose and demonstrate a novel methodology to increase accuracies and confidence for supervised ML models in production with sparse datasets; a notional aircraft maintenance dataset is applied. The effort produces a new method to account for sparse classes in an end-to-end automated ML system. The method provides a production system to continuously improve a sparse training dataset while increasing model accuracies and confidence. This approach can be tailored for use on supervised ML applications with sparse datasets.

| Classification: UNCLASSIFIED |
| Working Group:WG 34 Data Science and Analytics |

56786 - Data and AI help contracting officers free up funds for high-priority projects (ULO)

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Joseph Troy Morgan; Jacob Scanlon		

Abstract: In March 2020, Army Vantage and the Army Contracting Command (ACC) began working together to address a seemingly simple set of questions: How much funding is currently on a contract, and when does that funding expire? Without easy situational awareness of the amount of excess funds on a contract, contracting officers (KOs) and financial managers often were unable to identify excess funds until they had expired and were no longer available to use for other Army priorities.

Army Vantage, ACC, and DataRobot planned and developed a way to address this challenge, integrating multiple data sources into one cohesive data layer. Together, the partnership designed an ULO identifier tool to sit atop the data foundation. The ULO identifier tool, which employs DataRobot's artificial intelligence to predict which Army contracts are most likely to have excess funds, rapidly surfaces how much money is outstanding on them and, crucially, when that money expires. This allows KOs across the Army to much more efficiently sort through and identify contracts they may wish to deobligate. A screenshot of this tool is available at www.army.mil, "Army Vantage helps contracting officers free up funds for high-priority projects". This tool allows KOs across ACC to much more efficiently sort through and identify contracts to analyze.

According to ACC officials, the results from the tool's use have been outstanding financially. Furthermore, the ULO tool has resulted in more efficient use of human capital, maximizing the impact of contracting officers' limited time.   According to ACC officials, the results from the tool's use have been outstanding. From March 1 to September 30, 2020 specifically, usable deobligations were more than $2.7 billion, versus ~$1.5-$2 billion in past years. The Army can now redeploy those deobligated funds for more effective purposes. Perhaps even more important, as a reflection of DataRobot's mission focus to build DoD AI capacity, the project now serves as an exemplar development and deployment roadmap for future DoD AI projects to follow.

| Classification: UNCLASSIFIED |
| Working Group:WG 34 Data Science and Analytics |

56763 - Cloud Native Data Analytics: Speed, Capability, Scale

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Chad Cravens		

Abstract: Cloud-native is the next frontier for highly scalable data management and analytics. Due to the rapid advancement of this emerging field, there is often confusion of what it means to be "cloud-native" and how these emerging technologies can be leveraged to accelerate decision making. Open source technologies, such as Kubernetes, serve as the foundation for much of the cloud-native concepts such as distributed storage, software-defined networks, multi-tenancy, zero trust security models, and distributed service meshes. These technologies work in concert to deliver a seamless experience to analysts and decision-makers and provide virtually unlimited compute, storage, and analytics capabilities at speeds not seen before. However, this often requires highly skilled engineers

to work in a rapidly evolving ecosystem to develop and maintain the various components, which can be very expensive and time-consuming to successfully stand up and manage.

The Cloud Native Compute Foundation (CNCF) is an emerging open source ecosystem of hundreds of technologies with an estimated market cap of $15T and funding of over $15B (https://landscape.cncf.io/). Open Source Systems (OSSYS) specializes in this open source ecosystem and its emerging technologies. OSSYS will present Analytics HQ, a fully automated, cloud-native analytics environment with the mission of enabling an analytics value stream that automatically integrates dozens of leading analytics tools from this ecosystem to drive decision-making capabilities at greater scale, faster speeds, and enhanced security. We will present what factors represent true "cloud-native" compute capabilities and the associated challenges of standing up these various tools.

We will demonstrate how Analytics HQ can, in minutes, standup a cloud-native ecosystem leveraging concepts such as Infrastructure as Code (IaC), automated secrets management, distributed storage, and automated ETL processes that work in concert to ultimately provide a web-based environment that gives analysts the tools they need to store, query and present data that would otherwise take months, or even years, to develop. We will present our approach with automation such as containerization to enable secure secrets management, how Analytics HQ interfaces directly with Kubernetes, and the security that is managed behind the scenes to provide these necessary features. We will present why abstracting these infrastructure details to ultimately enable analysts is so important.

By automating the deployment and management of a true cloud-native environment, Analytics HQ can drive unprecedented capability, speed, and scale that ultimately enables better analytics and decision-making within agencies. Analytics HQ can truly disrupt the analytics space by invalidating legacy assumptions about what it takes to stand up and manage various analytics tools and systems such as clustered databases, big data systems, and artificial intelligence/machine learning models.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56927 - Iterative Analytics in Support of a Data-Driven Culture: A USCG Waterways Commerce Cutter Case Study

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Jamie Frost; Mr. Joseph W Kidwell; Meghan Steinhaus		

Abstract: Many companies and firms across various industries find themselves on a journey of becoming a more data-driven organization. Although the term 'journey' insinuates a specific destination, a data-driven organization is better described by its culture around data for decision making, as opposed to a singular technical infrastructure or workforce. Two of the most important aspects of any analytics project are adequate data and receptive decision makers. Missing either of these ingredients stymies the success of a data analytics project and, ultimately, progress towards a data-driven organization. Adding to the challenge is the fact that these two key ingredients are interdependent; it is hard to have one without the other. This leaves analysts in a difficult position: the available data might not be sufficient for the desired analytics project effort; yet analysts feel institutional pressure to provide results in order to demonstrate the value of data-driven insights to decision makers. Using a Coast Guard case study of an analytics project to support the recapitalization of the CG's inland cutter fleets, this presentation highlights the value of an iterative approach to

problem solving where decision maker participation is vital in developing model assumptions when the desired data is not fully available. When the available data is lacking, and/or the decision makers are not fully vested, an iterative approach to the analytics effort provides an opportunity to strengthen decision maker buy-in and cultivate an organizational culture that values and supports data analytics.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56553 - In-Stride Analysis of Tactical Network Data During Project Convergence

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Matthew D Smith		

Abstract: During operational experiments, tactical networks can generate large volumes of data in the form of packet capture data, system logs, instrumentation measurements, and even manual data entries. As tactical networks have evolved from low-throughput radio systems to high-capacity IP-enabled networks, this data can easily exceed 1 TB per day, making it difficult to process and extract insights in near-real time to track exercise event and inform upcoming exercise planning decisions. This talk presents a unified assessment framework applying data analysis methods to conduct in-stride analysis of experimentation data for the Army's Project Convergence. We apply data reduction, machine learning, and data visualization techniques to process and analyze large volumes of network data to extract meaningful insights in near real time. We demonstrate how this analysis can deliver key operational insights during experiment execution, including assessment of tactical network health and performance, the optimal placement or realignment of sensor nodes within the network topology, and highlighting performance and uncovering issues or concerns within the system of systems under evaluation.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57025 - Conformal Prediction Approach to Multi-Response Prediction Regions

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Capt. Chancellor A Johnstone		

Abstract: Conformal prediction is a method for capturing uncertainty within regression and classification tasks through the use of conformity scores. Prediction intervals generated using conformal prediction have marginal finite-sample validity, even with no closed-form distributional assumptions. While conformal prediction has been used extensively in applications with univariate responses, little work (until recently) has been done to extend its use to the multi-response setting. We focus on the regression task and introduce a conformal prediction approach to deliver simultaneous prediction regions for multiple, potentially dependent, responses. Utilizing Mahalonobis distance as a multivariate conformity score, we explore finite-sample performance as it relates to prediction region coverage and efficiency. We also provide a method for split-conformal inference as well as a potential way-forward for better conditional validity. We would like to discuss potential applications of simultaneous conformal prediction as it relates to uncertainty quantification, robust optimization, or other methodologies.

| Classification: UNCLASSIFIED |
| Working Group:WG 34 Data Science and Analytics |

56370 - Predictive Aircraft Maintenance: Detecting Imminent Part Failure with Advanced Ensemble Learning Methods

Start Date: 6/24/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Joshua Couse		

Abstract: Predictive maintenance has the potential to revolutionize Air Force operations. With a fleet of thousands of old and new aircraft, the Air Force spends nearly $50 billion dollars annually on operating costs and maintenance. Meanwhile mission capable (MC) rates decline as aging aircraft push well beyond their intended service dates. Deteriorating MC rates have become a rising concern among DoD leadership as the U.S. must innovate and modernize our force to meet today's challenges. Mission ready warfighters are key to the Air Force's ability to meet any adversary, anytime, anywhere. In collaboration with MIT Lincoln Laboratory, our team looked to advance predictive maintenance capabilities through a study on the C-5 Galaxy. By developing data-cleaning and feature generations pipelines, we transformed over three million records of maintenance events into a machine learning ready dataset. Through the application of survival analysis via Cox regression and advanced ensemble learning algorithms we were able to develop a classification model that preemptively detects over 2,500 failures of the C-5's main landing gear. Our model demonstrates the potential to deliver an additional 500 flights hours to the warfighter per year of operations, providing key capabilities to meet the growing challenges of tomorrow.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57387 - Data Analytics Development from Military Operational Data

Start Date: 6/24/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: James Downey; Zachary Ellis; COL Paul F Evangelista; Ethan Nguyen; Charlotte Spencer		

Abstract: Each year, the National Training Center (NTC) located at Fort Irwin, California, hosts multiple Brigade-level rotational units to conduct training exercises. NTC's Instrumentation Systems (NTC-IS) digitally capture and store
characteristics of movement and maneuver, use of fires, and other tactical operations in a vast database. The Army's Engineer Research and Development Center (ERDC) recently partnered with Training and Doctrine Command (TRADOC) to make
some of the data available for introductory analysis within a relational database. While this data has the potential to expose capability gaps, uncover the truth behind doctrinal assumptions, and create a sophisticated feedback platform for Army leaders at all levels, it is largely unexplored and underutilized. The purpose of this project is to demonstrate the value of this data by developing a prototype information system that supports post-rotation analytics, playback capabilities, and repeatable workflows that measure and expose ground-truth operational and logistical behavior and performance during a rotation. The Army modeling and analysis community stands to benefit from systematically curating and archiving the database in order to enable future analysis of the NTC-IS data.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56646 - Distributed Data Collection Events

Start Date: 6/24/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Lisa Colelli		

Abstract: As part of the Army Futures Command's (AFC) Top-down Future Development Process, The Research and Analysis Center (TRAC) is responsible for conducting an annual Capstone Wargame to analyze the key concepts and modernization capability priorities. The 2020 Capstone event included two coordinated events.

TRAC conducted the European Command and Indo-Pacific Command capstone wargames to assess the suitability of recommended Force Packages and Calibrated Force Postures to inform Army Modernization efforts. These wargames are historically conducted onsite, enabling fluid collaboration among players. However, due to the novel coronavirus outbreak of 2019, TRAC conducted these 2020 wargames in a distributed environment, bridging the lack of in-person attendance with remote virtual sites. For these distributed wargames to be successful, the TRAC team developed a data collection management plan (DCMP) suitable for using a suite of tools hosted in a cloud-computing environment. This enabled event participants and study analysts to share information, collect data, and observe real-time trends remotely. The DCMP and primary, alternate, contingency, emergency (PACE) plans required a unique type of coordination among the study team, players, and information technology to overcome technological, communication, and data collection challenges that occurred throughout the game. These challenges included common and consistent network access to Secret Internet Protocol Router Network and Global Video Services collaboration and resource availability, among others. The team was able to use a suite of data analysis tools for study analysts to visualize and understand trends in the responses of the observed real-time events of the wargame to facilitate cross-functional area discussions that aided in identifying key insights.

This presentation will show the approach used to tackle the problem, the obstacles faced, and how they were dealt with by applying a distributed approach to data collection. Additional insights on data management methods, capturing results, and the analysis approach during this distributed event will also be presented.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56879 - A System Design Approach to Development of Analytic Applications

Start Date: 6/24/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Dr. John Richards; Dr. Jon Alt; Mr. James Richards; Willie Brown; Mr. Blaine W Fulton; Titus Rice; Christopher Morey		

Abstract: The United States Strategic Command (USSTRATCOM) J4 analytics team utilizes data pulled from the Defense Readiness Reporting System (DRRS) to inform decision makers on the readiness of the force. Previous research produced a proof of concept application to generate analytic insights from DRRS data queries for key decision makers, but this work lacked integration with analytical workflow, validation of selected analytic techniques, and left a desire to explore more advanced analytic methods. This research utilized "systems thinking" and the CRoss Industry Standard Process for Data Mining (CRISP-DM) methodology to build custom-built analytic products that utilize unstructured data to enable data-driven decision making. The project generally followed the Cross

Industry Standard Process for Data Mining (CRISP-DM) methodology in order to: 1) develop an understanding of the decisions within the J4 that require analytic underpinnings; 2) understand the existing tools and methods used to inform these decisions; 3) identify improvements to existing tools; and 4) develop new analytic software tools to support emerging use-cases. This presentation provides an overview of the implementation of "systems thinking" and the CRISP-DM framework, challenges of integrating research and development across various platforms and network classifications, as well as lessons learned in working with a stakeholder in implementing data analytics.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56658 - Meta-Heuristic Optimization Methods for Quaternion-Valued Neural Networks

Start Date: 6/25/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Jeremiah Bill; Mr. Trevor Bihl; Dr Lance Champagne; Lt Col Bruce A Cox, PhD; Captain Phillip R. Jenkins, USAF, Ph.D.		

Abstract: In recent years, real-valued neural networks have demonstrated promising, and often striking, results across a broad range of domains. This has driven a surge of applications utilizing very high-dimensional datasets. While many techniques exist to alleviate issues of high-dimensionality, they all induce a cost in terms of network size or computational runtime. This work examines the use of quaternions, a form of hypercomplex numbers, in neural networks. The constructed networks demonstrate the ability of quaternions to encode high-dimensional data in an efficient neural net-work structure, showing that hypercomplex neural networks reduce the number of total trainable parameters compared to their real-valued equivalents. Finally, this work introduces a novel training algorithm using a meta-heuristic approach that by- passes the need for analytic quaternion loss or activation functions. This algorithm allows for a broader range of activation functions over current quaternion networks and presents a proof-of-concept for future work.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57027 - Identifying changepoints in time-series data using wavelet analysis

Start Date: 6/25/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Kelly Pearson-Potts; Margaret Mueller		

Abstract: United States Transportation Command (USTRANSCOM) is the provider of full-spectrum global mobility solutions for the Department of Defense in times of peace and war. Every week, USTRANSCOM conducts thousands of air missions and ground shipments around the world. During these operations, vast amounts of data is captured so it can be used to forecast and streamline future operations.

One of the challenges of working with this data is that operational environments change over time. A forecasting model built on data from peacetime will not be likely to make accurate predictions in times of war. To develop accurate predictions, these paradigm-shifts, or change points, need to be detected in the data. Humans can do an excellent job of looking at a chart and identifying change points. This task is more difficult for computers. One of the key challenges is identifying seasonality, which occurs when data experiences regular and predictable recurring changes. An example in the commercial world would be increased sales at toy stores in December or florists in February. The

difficulty in getting a computer to identify change points stems from time-series imperfections such as weather delays, quantity fluctuation, sick personnel, etc. The commonness of these variations means that an ideal change-point detection method needs to be an inexact process which leaves some room for minor variations.

USTRANSCOM's Enterprise Data Sciences (EDS) team has implemented wavelet analysis to overcome these challenges. Wavelet analysis is commonly used in the field of Oceanography to identify waves. The EDS team has adapted this process to USTRANSCOM's multitude of time series, pinpointing where and when changes occurred. Incorporating wavelet analysis in existing data assessment methods has improved the availability of information and increased customer capabilities. As a result, the data, methods, and models are equipped to be current and reliable for future predictions.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

55251 - THE APPLICABILITY OF MACHINE LEARNING METHODS ON INFRARED VIDEO DATA

Start Date: 6/25/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: Victoria Gerardi		

Abstract: Situational awareness is a necessity for the warfighter. Using radars, cameras, and sensors is a common surveillance method for the US Army. One type of sensor is known as an Electro-Optical/Infrared (EOIR) Sensors, which use both visible and infrared sensors, allowing them to be useful in both light and dark (day/night) scenarios. These systems can be used to detect Unmanned Aircraft Systems (UAS) that are present in the sky. Recognizing these objects in the sky requires diligence from the human that is monitoring the system.
This technical report was completed with the intent of investigating the feasibility of using machine learning algorithms on this type of sensor data to identify UAS in the sensor output. The sensor output was fed into a feed forward convolutional neural network which classified images as either containing a UAS or not. The convolutional model proved to be effective first attempt at working with this data.
This report also provides a future direction to expand upon the work done for this report. Recommendations include fine tuning this model, as well as using other machine learning methods on this data set such as object detection and the "You only look once" (YOLO) algorithm. From this report, future iterations of this project can build off of this work, applying machine learning to similar data and building the Army's machine learning and artificial intelligence capabilities. The data used for this project was provided by the Precision Targeting and Integration group in the Combat Capabilities Development Command – Armaments Center.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56946 - Data Driven Anomaly Detection in Unmanned Air Vehicles

Start Date: 6/25/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Weston Daigle		

Abstract: Current standard practice for operational UAV maintenance is reactive; parts are repaired after they have already failed. This reactive approach often leads to ineffective missions, cancelled flights, and unexpected downtime. The DoD spends more than 10% of their annual budget on

maintenance. Hence, the ability to predict failures before they occur would improve performance while reducing costs. Recognizing the drawbacks of the current maintenance paradigm, the DoD Joint AI Center established a Predictive Maintenance National Mission Initiative to develop the ability to anticipate probable future maintenance actions. To advance toward proactive maintenance practices, we propose a data-driven system designed to identify anomalous flight data that can be used as an indication of impending failures and required maintenance. Using Northrop Grumman's High Altitude Long Endurance platforms as the pilot example, we benchmark the performance of many machine learning methods and demonstrate the viability of our approach on historical data for the braking system controller. We introduce a novel, effective deep learning-based autoencoder that outperforms classical methods. We demonstrate promising results with detecting anomalies indicated by known problem alerts and raw text flight notes, where we achieve greater than 80% detection rate with under 30% false positive rate. Furthermore, we show success with transfer learning, where we train on one platform's data and evaluate on another.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57004 - AI-driven Analytics for Cognitive Security: Real-Time Assessment and Intervention into the Information Environment

Start Date: 6/25/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Dr Maria Glenski		

Abstract: In recent years, more and more incidents have happened worldwide as a result of disinformation and misinformation spread online, particularly on social media platforms, and there has been an unprecedented resulting impact on society. PNNL has developed a suite of AI-driven analytics that have demonstrated success in detecting and characterizing operations in information environments including foreign disinformation campaigns across multiple social media platforms, such as Twitter, Reddit, YouTube, VKontakte, GitHub, Weibo, and Telegram. Recently, PNNL's technology was successfully used to assess the cognitive domain – analyzing content and characterizing audiences – during the COVID-19 crisis (live demo available at https://watchowl.pnnl.gov/).
In this talk we will present PNNL's cutting-edge approaches to detect, characterize, and defend against influence operations based on novel in-house developed deep learning and natural language processing models and analytics to automatically:
- Analyze Information: Detect information narratives and infer latent information properties from language and user behavior, e.g., moral foundations, subjective and biased terms, and other social and psycho-linguistic properties of discourse e.g., connotations.
- Understand Audiences: Infer audience emotions, psycho-demographic traits, cultural backgrounds, perspectives across multiple languages, fine-grained reactions, suspicious accounts.
- Characterize Information Environment: Provide real-time multidimensional assessment of information diffusion across multiple social platforms combined with actionable insights from analyzing information and understanding audiences. Our in-depth analysis focuses on measuring core properties of information diffusion – speed of spread, audience, reach, and lifetime, understanding information recurrence patterns, detecting coordinated activities, and analyzing social network structure.
- Discovering Causes and Effects to Enable Precision Communications: Rely on causal structure discovery approaches, and interactive analytics to mine natural experiments from large-scale observational data to explain why some messages spread and some do not, and why some messages

evoke certain emotions, perceptions, or particular response from the audience. Our novel causal discovery approaches to explain human behavior and engagements with information will enable proactive precision communications – automatically generate a message to achieve desired spread and to appeal to targeted audiences, their perceptions and emotions.

PNNL's technology is a unique end-to-end solution that does not have any competition on the market, to the best of our knowledge. It enables real-time joint assessment of the cognitive and information domains of information operations, which is necessary to provide a comprehensive understanding of foreign influence and disinformation campaigns in the information environment.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

56378 - Contextualizing Army Readiness using Army Vantage: Methods for Developing Timely Visual Decision Support Products

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: Martin C Harris

Abstract: Headquarters, Department of the Army, G-3/5/7 recently asked the Center for Army Analysis (CAA) to investigate how much unit readiness the Army will need to meet global requirements during the implementation of the new unit lifecycle model called the Regionally Aligned Readiness and Modernization Model (ReARMM). This presentation will report on our use of the Army Vantage data management platform to determine the number of units required to meet operational demands.

The Army is in the business of building unit readiness to meet global requirements. However, during the recent years of protracted conflict, the Army potentially overinvested in readiness. Using ReARMM as the template for managing readiness targets, we investigated how many brigade combat teams the Army needs to meet demands across C-levels, a four tier rating scale that assesses a unit's readiness to accomplish its core functions and provide its designed capabilities. Additionally, we highlight how we were able to better understand the risk space involved to determine proper levels of readiness. Lastly, we will share how we used the tools and data available on the Army Vantage platform to quickly iterate on visual decision support products.

Classification: SECRET NOFORN
Working Group:WG 34 Data Science and Analytics

56907 - Predicting Future Program Health Assessments

Start Date: 6/25/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET

Authors: Dr Brad Guthrie; Dr. Greg H. Gehret

Abstract: Air Force acquisition programs currently are assessed a health score in five different areas (cost, schedule, performance, funding, overall); these assessments are reported in the MAR (Monthly Acquisition Report). A classification-based prediction model (using XGBoost in Python) was constructed to predict future MAR assessments up to 24 months in the future utilizing >200 attributes related to program health. Further, techniques such as sentiment analysis, topic modeling, and web-scraping were used to derive several of these program attributes. The model provides several capabilities to decision makers, including: (i) a probabilistic forecast of future MAR assessments for individual programs, (ii) factor analysis to understand how each program attribute contributes to each

prediction and (iii) what-if analysis to determine the effect of improving factors for individual programs on forecasted MAR assessments.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57128 - A Data Analytic Environment to Enable Senior Leader Decision Support - United States Central Command Use Cases

Start Date: 6/25/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Anita Rice Adams; Jim Soehlke; Carlius Mapp; Austin Pearson		

Abstract: The vision from the December 2020 DoD Data Strategy is "DoD is a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency". One of the three initial focus areas in the strategy is Senior Leader Decision Support, which aims to "accelerate the Department's transition to using live, interactive data in place of static slides to inform strategic outcomes". This paper describes efforts in support of United States Central Command (USCENTCOM) to realize the goals of the DoD Data Strategy and the Senior Leader Decision Support focus area.

Daily, USCENTCOM collects, integrates, visualizes, and analyzes tremendous amounts of data in support of ongoing operations and to maintain AOR-wide battlespace awareness. The data comes to the Command from partner nations; other Combatant Commands; Component Commands; Services; military, government, and law enforcement agencies; as well as news, social media, and other publicly available information sources. Most of this data arrives as unstructured data such as email text, MS Office products such as PowerPoint and Word, and chat. Structured data - such as locations of entities, and inventories of munitions, supplies, and personnel - are embedded in the unstructured feeds and are manually extracted to produce static dashboards in Power Point. This process is effective but is slow, does not easily scale, and does not provide the repository of machine-readable data required for advanced analytics including machine learning. USCENTCOM's goal is automated data integration and analysis to support faster and better operational decision making.

The MITRE Corporation, in collaboration with the USCENTCOM J3 and J6, developed a conceptual architecture for a data analytic environment (DAE) to support USCENTCOM's goal. The DAE describes the end-to-end pipeline from the authoritative data source, the acquisition, integration and storage of the data, access to the data by analytic tools, and enterprise data management across the lifecycle of the data to ensure its provenance and quality. The team prototyped the DAE and analytic dashboards for two use cases: Commander's Daily Briefing, and the COVID Crisis Action Team Daily report. This paper describes the DAE conceptual architecture, the use case prototypes, and lessons learned.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

57213 - The intersection of data visualization and desirability in set-based design, tradespace analysis and multi-objective optimization

Start Date: 6/25/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr Douglas M Ray		

Abstract: Decision analysis methods play an integral part in systems engineering trade studies. Tradespace analyses make use of utility functions which transform objective measures into value or

utility scores. These are analogous to desirability functions employed for the purpose of multiple response optimization in an industrial engineering and product development context. Existing desirability functions do not adequately address unique needs of the system engineering trade study. In addition, reliance on optimization algorithms to solve trade study problems can present some challenges such as difficulties in interpretation, and result in point-predictions within the decision space or tradespace which provide little visibility with respect to the broader near-optimal solution spaces within the tradespace. This challenge is analogous to the limitations of point-based design approaches versus set-based design methodologies.

The purpose of this paper is to (1) propose a new composite desirability approach which can be generalized to a variety of trade study problems, including those with many decision attributes (input dimensions) and multiple objectives with different priorities, and (2) demonstrate the value of data visualization methods in augmenting set-based design, decision analysis, and optimization problems. The methodology is adapted to two DoD system design case-studies. A strategy is employed which addresses common challenges encountered in complex decision spaces, such as high dimensionality, nonlinearities, and competing objectives. The emphasis is to simplify the decision space and aid in interpretation of results by interdisciplinary audiences and project stakeholders to compel informed decision making. The results illustrate the effectiveness of the proposed approaches at identifying distinct and globally feasible design configurations relative to KPP's. A validation study serves to illustrate the effectiveness of the proposed approach.

Classification: UNCLASSIFIED
Working Group:WG 34 Data Science and Analytics

WG 35 AI and Autonomous Systems

55240 - AI and Autonomy II Workshop

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET
Authors: Mr. Donald H. Timian		

Abstract: Title: MORS AI and Autonomy Special Meeting; 25-28 October 2020

Authors: Mr. Don Timian and Dr. Nate Bastian

The Military Operations Research Society (MORS) is hosting its second Artificial Intelligence (AI) and Autonomy Special Meeting at the Johns Hopkins University Applied Physics Laboratory in Laurel, Maryland, October 25-28, 2021. Purpose of this presentation is to increase "word of mouth" about the Special Meeting.

To foster broad participation from a full spectrum of AI and autonomy leaders, practitioners, analysts, scientists, engineers, and researchers interested in AI and autonomy, this Special Meeting will be held at the Unclassified level.

Meeting Objective:

o Within the next five years the Department of Defense (DoD) will start to deliver AI-enabled capabilities and autonomous systems (e.g., the Army's Expedient Leader-Follower or ExLF).

o Much like in the 1980's when the Army's "Big 5" were fielded – for AI-enabled capabilities and autonomous systems – operations research (OR) analysts will be asked to conduct cost analysis, force structure analysis, and analyze changes in Tactics, Techniques, and Procedures.
o Thus, OR analysts must be familiar with capabilities and limitations of AI and autonomy technologies.

In addition to the meeting objective, the presentation will include a brief description of the five planned tutorials (on October the 25th), both Keynote Speakers (26 October), and the five Sessions (26-28 October):

#1 Defense and Security Applications
#2 Ethics and Explainability
#3 Test and Evaluation Capabilities
#4 Ongoing International and Industrial Applications
#5 Looking Five Years into the Future

Minus Questions: Approx. 10 Minutes Need for Presentation

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

57059 - How Much AI/ML do I need to Learn?

Start Date: 6/22/2021	Start Time: 12:30 PM ET	End Time: 1:30 PM ET
Authors: Mr. Jerry L. Schlabach		

Abstract: Artificial Intelligence (AI) and Machine Learning (ML) are powerful new technologies that will disrupt and transform future combat operations. AI/ML and Operations Research (OR) are independent fields of academic study with limited historical overlap, which has led to a significant knowledge gap within the OR community regarding the newer technologies. However, in order to perform Analysis of Alternatives (AoA) studies and Military Utility Assessments (MUAs) of future AI/ML-enhanced systems, OR Analysts will require a basic understanding of capabilities and limitations. This presentation will outline a spectrum of 'AI/ML understanding required for OR Analysis' with respect to typical OR tasks. One implication is that a modest grounding in AI/ML fundamentals, well short of an advanced degree, is sufficient for a large percentage of future AI/ML-focused OR studies. This presentation will suggest some basic elements required for such a modest grounding. The author is a retired Army Military Intelligence Officer with an MS in Computer Science (AI) and twenty-five years of experience in AI-centric Army Acquisition. He is also a co-chair of MORS Working Group #35, "AI and Autonomy."

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56685 - Artificial Intelligence for Combat Simulations

Start Date: 6/22/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Charles Timm		

Abstract: Military course of action development relies heavily on subject matter expert input and table top wargaming to develop and evaluate plans. The Research and Analysis Center, working with

students and faculty at the Naval Postgraduate School, are developing a framework for training reinforcement learning agents to develop courses of action in different training scenarios. However, many simulations were not developed with idea extracting state space information, injecting new actions, or with the idea of using artificial intelligence agents for either training or implementation. This presentation will outline the simulation and hardware requirements for this type of analysis. It will then discuss a proof-of-principle application using convolutional neural network function approximation in OpenAI gym environment to train an agent in the first, most basic, principles of war such as closing with the enemy and massing of fires. This framework can be applied to different combat simulations in order to produce agents useful as adversaries during training, or to enable faster comparative analysis of competing capability sets. As a first step towards application, agents trained in this framework are tested in the Versatile Assessment and Simulation Tool (VAST) to demonstrate future use in both simulations and wargames. Because wargames and simulations typically only explore a small portion of the potential simulation trajectory, automated course of action development and non-fragile agent behavior, though deep reinforcement learning, would allow greater exploration of decision space.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56727 - Remembering the Operator in Partially-Automated System Analysis

Start Date: 6/22/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Matthew A C Guckenberger; Dr. Alicia Sudol; Professor Dimitri Mavris		

Abstract: With the increasing integration of automation technologies, the role of the operator is changing from sole actor to a shared supervisor/actor role. This change requires new modeling techniques in operational studies to provide the analytics for assessing system performance. Studies on unmanned ground vehicle operators and recent crashes being partially blamed on automation technologies demonstrate the need to measure and assess operator awareness and workload. Overcoming these challenges requires an assessment early in the design cycle for operator awareness and workload. This modeling methodology integrates concepts from cognitive engineering into operations analysis to better capture and analyze the effectiveness of increasingly automated systems. An agent-based model is created using Operational Event Sequence Diagrams and concepts from situation awareness research to guide agent formulation. The agent rule set is then mapped to the NASA Task Load Index scales to provide a dynamic output throughout the simulation. A traffic model is built in AFSIM to compare the mental workload associated with city versus highway driving. The dynamic workload measurement is the first step in a framework which will enable automation technologies to be traded during the conceptual design phase. The diligent mapping of actions between the automation and operator, along with these new awareness and workload metrics, is required if operation's models are expected to provide decision makers with the analytics necessary for assessing heavily automated systems.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56447 - A Framework for Considering Trust of Artificial Intelligence Algorithms

Start Date: 6/22/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Dr. Philip Slingerland; Lauren Perry		

Abstract: Increasing adoption of AI throughout the defense, government, and commercial sectors has brought significant attention to the topic of trust. Driven by the recent successes of AI algorithms in a range of applications, users and organizations rely on AI to provide new, faster, and more adaptive capabilities. However, along with those successes have come notable failures, such as bias, vulnerability to adversarial attack, and inability to perform as expected in new environments. With these issues in mind, a framework is recommended that aims to encourage the development of AI-based applications that can be trusted to operate as intended and function safely both with and without human interaction. This framework offers guidance for each phase of AI development (design, development, and deployment) through a detailed discussion of potential pitfalls, potential metrics for measuring trusted attributes and mitigations strategies.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

55325 - Improving AI/ML Department of Defense Ethical Testing

Start Date: 6/22/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Mr. Walt DeGrange		

Abstract: The testing of ethical principles for Machine Learning (ML) and Artificial Intelligence (AI) models that may learn with the addition of new data sources outside the traditional DoD Test and Evaluation (T&E) cycle requires a new process. This presentation proposes a T&E rubric to improve the Department of Defense ML/AI model test effectiveness for acquisition program managers and each program's Chief Developmental Tester. We evaluate 144 research papers in a DoD testing context categorized by three broad ML classes based on data type (e.g., supervised learning, unsupervised learning, and reinforcement learning); makes recommendations on what properties to test for (e.g., correctness, relevance, robustness, efficiency, fairness, interpretability), provides an idealized workflow of how to conduct testing and presents an idealized way to look at where to conduct ML component testing (e.g., data processes, frameworks, and coded algorithms). Applicable T&E methodologies, use, and policy changes are also recommended. The proposed T&E rubric is intended to support Defense Department acquisition policy in DoD 5000.02 and uses the Defense Innovation Board AI Principles: Recommendations on the Ethical Use of Artificial Intelligence by the Department of Defense February 2020 AI Ethics Principles for DoD. This research was funded by the STAT Center of Excellence (COE).

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

55284 - Risk Averse Autonomous Navigation from Human Demonstrations

Start Date: 6/23/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Christian Ellis; Dr. Lance Fiondella; Craig Lennon, Dr.; Dr. John G Rogers, III; Dr. Maggie Wigness		

Abstract: Traditional imitation learning provides a set of methods and algorithms to learn a reward function from expert demonstrations.
When building autonomous mobile robots, it may be easier to provide demonstrations capturing desired behavior rather than attempt to explicitly program it, providing flexibility to learn behaviors unanticipated by developers.

However, a minimal set of demonstrations is unlikely to capture the information required to achieve the desired behavior in all future environments.
Due to distributional shift among environments, the robot may encounter states rarely or never encountered during training, for which the appropriate reward value is uncertain, leading to negative side effects.
To operate safely in such dynamic environments, this paper proposes a Bayesian technique which quantifies uncertainty over the weights of a linear reward function given a dataset of human demonstrations.
This uncertainty is quantified and incorporated into a risk averse set of weights used to generate cost maps which act as input to a planner.
Experiments in a continuous 3-D unity environment with a simulated robot equipped with virtual sensors show that by using the proposed algorithm, the robot is able to avoid negative side effects requiring any new demonstrations.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56971 - Mobility-based Dynamic Re-routing of Military Ground Vehicle Maneuvers

Start Date: 6/23/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Dr. Jeff Durst		

Abstract: The U.S. Military defines ground vehicle maneuvers as "a movement to place … land forces in a position of advantage" and ground vehicle mobility as "a vehicle's capability to move over a specified terrain, which is influenced by other environmental conditions." Untold amounts of time go into meticulously planning land force maneuvers, specifically in predicting mobility and creating vehicle routes. The mission planners have to first determine if the vehicles can move over the specified terrain. They then can plan routes around this information. To do so, data about the terrain and environment are used to inform decisions; unfortunately, these data are often of low resolution and quality. The actual forces on the ground going into the maneuver are working off a "best guess" to execute their mission. However, the ground forces can find themselves in dangerous or even unnavigable conditions. By the time the operation begins, data such as weather conditions or terrain type can change dramatically. When these changes happen, ground vehicle operators are put into a dangerous position that threatens not only their lives but the success of the entire maneuver.

The heart of the problem is that operators lack the ability to intelligently re-route during operations. Operators cannot find the safest way out of danger and don't have the tools on hand to re-route. Operators need a tool that 1. Detects dangerous mobility conditions, 2. Understands the vehicle's mobility, and 3. Can provide operators with alternate routes. The presented research will propose a solution to the latter two needs.

First, a new type of route planning algorithm will be presented. Traditional path and route planners are based on computer science "best practices." They often focus on the shortest route from Point A to Point B, or the route that has the fewest turns, etc. This type of route planning is sub-optimal for military ground vehicle maneuvers. First, the shortest path might not be the fastest path due to terrain conditions. Second, the technically "optimal" path might have the vehicle traversing hostile areas. Ground vehicle operators need an on-board route planning algorithm capable of understanding their vehicle's mobility. The re-routing must focus on keeping operators safe, not on traditional metrics such as speed or distance traveled.

Second, the ability to make this route planner aware of the vehicle's mobility will be presented. When the operators encounter changes in the environment and terrain, the ideal route planning algorithm should not only find new paths but also determine mobility along these paths. By using real-time on-board mobility simulations, the route planner can find the best possible route; one that keeps the operators out of danger from difficult terrain and hostile threats. These simulations will allow the routing algorithm to find not the "optimal" route, but the safest route that will ensure the success of the total ground force maneuver.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56746 - Using Automated Virtual Environment Generation to Enable Parametric Simulations for Unmanned Ground Vehicles

Start Date: 6/23/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET

Authors: Dr. John Gabriel Monroe; Josh Fairley; Mr. Burhman Q. Gates, Jr; Stephanie Price

Abstract: Modeling and simulation (M&S) tools play an important role in developing autonomous unmanned ground vehicles (UGVs). Using M&S, engineers can evaluate algorithm and sensor performance in a wide range of weather conditions, environment configurations, and mission scenarios with a fraction of the expense, risk, and time an equivalent set of physical tests entails. While accurate multi-body dynamics, powertrain modeling, and vehicle-terrain interaction (VTI) are important for a robust ground vehicle simulator, a detailed virtual environment, i.e., scene, is a critical component for UGV M&S. If the tool is to predict accurately an autonomous system's behavior in real-world conditions, the virtual environment that affects both the mobility and sensors of a UGV must be sufficiently realistic. For example, if a high-fidelity sensor model is to provide useful data to test the autonomy, the virtual sensor must have a high-fidelity environment to interrogate. Developing high-fidelity scenes for M&S tools is a complex task with many data requirements and sub- processes. ERDC has developed the Virtual Environment Generation Automation Scripts (VEGAS), which is a suite of tools that reduces the time and effort required to develop geotypical and geospecific scenes and to modify them parametrically once a base-line scene has been created. This presentation will introduce these capabilities and describe a use case that leveraged them to test autonomy robustness against varying vegetation density.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56915 - A Novel Analytical Approach to Monitor Supervised Machine Learning Models with Natural Language Processing in Production

Start Date: 6/23/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET

Authors: Abhishek Paul; Christopher Lock; Joshua Mutugi

Abstract: Over the past several years, there have been many advancements with machine learning (ML) and identifying the impact this new technology can have across industries. Through this process, supervised ML and natural language processing (NLP) have proven to be effective for automating tasks in research environments with problems such as multi-class text classification. As organizations move to productionizing ML models, they will have to identify methods to monitor and ensure quality of the ML model in production. A major underlying assumption with supervised ML models is that

they work well in environments that are similar to the environment in which the model was trained and tested. If the environment changes while the machine learning model is in production, this could cause erroneous predictions from the model. To mitigate this risk, new tools will need to be created to monitor production environments. The purpose of this study is to propose and demonstrate a novel analytical approach to monitoring a supervised ML model with NLP in production; a notional aircraft maintenance dataset is applied. The effort produces a new metric that measures the textual environment in production to provide a signal that alerts of a potential environmental change for the model. This analytical monitoring approach can be tailored for use on supervised ML applications with NLP.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56917 - A Novel Methodology and System to Increase Accuracies and Confidence for Supervised Machine Learning Models in Production with Sparse Datasets

Start Date: 6/23/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET
Authors: Abhishek Paul; Christopher Lock; Joshua Mutugi		

Abstract: This new decade of digital transformation will revolutionize how organizations operate. Machine learning (ML), specifically supervised ML, has been identified as a powerful tool to automate classification tasks where a plethora of historical data resides. A key aspect of supervised ML is the need for large and clean datasets where the target variable is known. For many organizations, this is a difficult requirement to meet. Many times, only sparse datasets are available which alters the ML's ability to predict accurately. The purpose of this study is to propose and demonstrate a novel methodology to increase accuracies and confidence for supervised ML models in production with sparse datasets; a notional aircraft maintenance dataset is applied. The effort produces a new method to account for sparse classes in an end-to-end automated ML system. The method provides a production system to continuously improve a sparse training dataset while increasing model accuracies and confidence. This approach can be tailored for use on supervised ML applications with sparse datasets.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56749 - Characterizing the Local Curvature of Convolutional Neural Network Basins with Gaussian Paths and Quality Engineering

Start Date: 6/23/2021	Start Time: 1:30 PM ET	End Time: 2:00 PM ET
Authors: Benjamin Morris		

Abstract: Due to the complexity of deep neural network loss surfaces, training a deep neural network through optimization routines can sometimes yield very poor solutions and hard-to-generalize results. Characteristics of the loss surface are inherently impacted by the architectural choices that a model-builder must make while designing a neural network instance. Identifying architectural components that yield favorable conditions for optimization is an active area of research, with theoretical results often making several simplifying, layer-specific assumptions, and empirical results often focusing primarily on known state-of-the-art architectures or much smaller architectures with grid-search methods employed for later analysis. One characteristic often assumed to exist for neural network loss surfaces is Beta-Smoothness, a means of bounding local curvature. We seek to address the

problem of holistically identifying network architectural components that most impact Beta-Smoothness through empirical evidence found by applying a quality engineering approach, Design of Experiments (DOE).

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

57114 - Test & Evaluation of ML Models Using Charybdis

Start Date: 6/23/2021	Start Time: 2:00 PM ET	End Time: 2:30 PM ET
Authors: Eric Nelson		
Abstract: Machine Learning models have been incredibly impactful over the past decade; however, testing those models and comparing their performance has remained challenging and complex. In this presentation, MORSE will demonstrate novel methods for measuring the performance of computer vision object detection models, including running those models against still imagery and against moving videos. The presentation will start with an introduction to the pros and cons of various metrics, including traditional metrics like precision, recall, average precision, mean average precision, F1, and F-beta. The talk will then discuss more complex topics such as tracking metrics, handling multiple object classes, visualizing multi-dimensional metrics, and linking metrics to operational impact. Anecdotes will be shared discussing different types of metrics that are appropriate for different types of stakeholders, how system testing fits in, best practices for model integration, best practices for data splitting, and cloud vs on-prem compute lessons learned. The presentation will conclude by discussing what software libraries are available to calculate these metrics, including the MORSE-developed library Charybdis. Classification: UNCLASSIFIED Working Group:WG 35 AI and Autonomous Systems		

56563 - Collaborative Communications through Non-Traditional Modes

Start Date: 6/23/2021	Start Time: 2:30 PM ET	End Time: 3:00 PM ET
Authors: Michael Woudenberg; Joshua Deiches; Troy Shideler		
Abstract: Collaborative communications of manned and unmanned teams predominantly focuses on transmitting information via the radio frequency (RF) spectrum. This singular focus results in network overload, bandwidth limitations and susceptibility to communications denial that result in system fragility. This presentation will investigate the limitation of RF centric communications and explore non-traditional modes of communication, leveraging advanced technologies while fusing with Joint All Domain Operations (JADO) and DARPA's Mosaic construct. Classification: UNCLASSIFIED Working Group:WG 35 AI and Autonomous Systems		

56470 - Machine-learning Anti-Jam Interference Cancellation: "MAJIC"

Start Date: 6/23/2021	Start Time: 3:00 PM ET	End Time: 3:30 PM ET
Authors: Phil Hess; Donna Branchevsky; Nathan Whitehair; Anson Lam; Adam Belhouchat; Alex Eapen; Terry Ferrett, III		

Abstract: Although there are several digital signal processing (DSP) approaches to mitigate jamming in GNSS systems, most anti-jam (AJ) techniques are tailored to exploit properties of specific threat waveform type(s). Some techniques attempt to isolate the threat in a digital domain (time, frequency, wavelet, etc.) that make the waveform more separable, however what works for one jammer type may not work for another. This approach may require the victim AJ logic to detect the jammer waveform type(s) and choose the best anti-jam algorithm from a library of AJ techniques. The problem of removal becomes even harder in the presence of multiple simultaneous jammers, as the properties of the combined jammer waveforms may not allow sufficient removal. A multiple-element antenna approach may address some of these issues, however this may not be viable for GNSS systems with size, weight, and power (SWaP) constraints. This motivated us to investigate the potential of machine learning for developing a "black box" system capable of removing as many jammers as possible from the output of a single-element GNSS antenna.

To that end, a convolutional neural network (CNN) architecture was trained to remove multiple combinations of jammer waveforms. The trained CNN was loaded into a custom GNU Radio block which performed inference using TensorFlow. The block was used with a software-defined radio (SDR) front end, inserted between the jammed GPS feed and the antenna port of a commercial off-the-shelf (COTS) receiver. The COTS GPS receiver was able to navigate in a multitude of jamming environments with "MAJIC" AJ protection at high jammer to signal (J/S) ratios.

To date we have built two versions of the MAJIC SDR system: a high-SWaP system which can process Mcode capable bandwidths, and a low-SWaP, portable, embedded platform which can process bandwidths sufficient for civilian GPS jamming mitigation. We show that even the low-SWaP version of MAJIC can mitigate a wide variety of jammer waveform combinations.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56639 - Trust in Autonomous Systems

Start Date: 6/24/2021	Start Time: 10:30 AM ET	End Time: 11:00 AM ET
Authors: Michael Woudenberg; Joshua Deiches; Dr. George Mark Waltensperger		
Abstract: One cannot attend a meeting centered around AI and autonomous systems of late without the question arising, "How much trust do we need in these systems?" And, probably more importantly, "How will we know they can be trusted?" Trust is intrinsically a human notion. It does not occur in the physical sciences unless a human is involved. That is, trust is fundamentally a social-psychological construct. It is not absolute. Trust is situational, circumstantial, changes over time with a changing environment and task. To complicate matters, given the same circumstances, the level of trust may deviate from person-to-person depending on those circumstances mentioned above. This paper will begin with a background discussion of trust and the challenges with conceptualizing it, measuring it and applying its tenets to autonomous systems. As we understand the philosophy of trust, the next step is to decompose it into accurate representations for systems designers to leverage with analytic tools. Key to designing autonomous systems, with trust in mind, is understanding what the customer is asking the system to do, in what environment they are asking it to perform, and finally, and probably most importantly, what users will actually allow it to do. This presentation introduces Autonomous Environmental and Trust Frameworks, the assumptions underlying each, and how they present the OR analyst with a means to understand complexity and trust regarding autonomy.		

Autonomous systems development creates wicked problem spaces. When working in those spaces, discrete and meaningful assessments of trust are often unattainable and often not believable. We propose a method to avoid that trap through a series of linear transformations and scalar multipliers that leverage the Trust and Environmental frameworks with a tool called "Fides." Fides translates a subject matter expert's judgment into broad, geometrical boundaries that represent how certain choices in operational requirements constrain the design space in some ways, but also expand that trade space in other ways. New and meaningful methods will be discussed to exploit those trade opportunities for trust.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

57237 - An Assessment of Techniques to Detect TOR Network Flows

Start Date: 6/24/2021	Start Time: 11:00 AM ET	End Time: 11:30 AM ET
Authors: Jeffrey Dean		
Abstract: The Onion Router (Tor) network can provide a means for attackers to avoid attribution and obfuscate malicious network traffic. Because of this, detecting Tor connections is of great interest to network defenders. We investigate a number of detection algorithms, testing them on both PCAP and Zeek log data (where applicable) and comparing both data sets in terms of detection effectiveness and computational efficiency. Network traffic to/from a medium sized campus network is used as our data source. Classification: UNCLASSIFIED Working Group:WG 35 AI and Autonomous Systems		

57238 - Data Science-Driven Cyber Threat Hunts at DSC-PIT: Tactics, Techniques, and Procedures.

Start Date: 6/24/2021	Start Time: 11:30 AM ET	End Time: 12:00 PM ET
Authors: MAJ Kurt Klingensmith; Tina Agarwal; Chad Davis; Sam Duran; Josiah Pickett		
Abstract: Leveraging a variety of big network data from Gabriel Nimbus, NETCOM's Data Science Center-Pittsburgh (DSC-PIT) conducts routine cyber threat hunts for worldwide network and cyber mission forces. These proactive efforts identify malicious, suspicious, or network performance-degrading activities that go undetected via existing tools and network configurations. To execute threat hunts, DSC-PIT employs and continuously refines a thorough methodology that follows industry best practices by exploiting machine learning, automation, and open-source commercial Application Programming Interfaces (API). Through these methods, DSC-PIT identifies threats within the DoD Information Network and informs customers of findings through novel threat hunt storyboards. DSC-PIT's efforts provide actionable insights on network behavior for customers across the network and cyber mission workforce, while employing and developing new tools, models, and methods for identifying threats to network performance. This presentation provides an overview of threat hunts, methodologies, analytical techniques, tools, and future applications of the analysis.		

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56765 - Active Set Prediction via Recurrent Neural Networks for Power Grid Optimization

Start Date: 6/24/2021	Start Time: 12:30 PM ET	End Time: 1:00 PM ET

Authors: Ethan King; Arnab Bhattacharya; Dr. Samrat Chatterjee; Craig Bakker; Feng Pan; Matthew Oster; Casey Perkins

Abstract: Operational decision-making problems in the power grid, such as the Economic Dispatch (ED) and Unit Commitment (UC), aim to maximize economic efficiency while satisfying demand and required safety margins. However, uncertainty and variability in renewable generation and demand, requires the optimal dispatch set-points to be updated frequently in response to observed realizations and near real-time forecast updates. To address the challenge of computing frequent real-time updates to the optimal solution, we propose the use of a machine learning approach that learns the mapping between uncertainty realizations and the set of active constraints of the optimization model. A key novelty of our approach is the use of long short-term memory (LSTM) neural networks to learn the active set in problems with non-linear system dynamics and temporal constraints. As opposed to directly learning the optimal solutions (called end-to-end learning), our approach can provide significantly better solution quality and provide better feasibility guarantees. The learnt neural-network model can be then used to predict solutions in real-time. We will demonstrate the efficacy of our approach for the Economic Dispatch problem with generator dynamics, which is tested on a 9-bus test system. Our approach will be compared to traditional optimization and existing end-to-end learning approaches.

Classification: UNCLASSIFIED
Working Group:WG 35 AI and Autonomous Systems

56688 - Reinforcement Learning for Risk-Based Robust Cyber-Physical System Control

Start Date: 6/24/2021	Start Time: 1:00 PM ET	End Time: 1:30 PM ET

Authors: Yan Du; Dr. Samrat Chatterjee; Arnab Bhattacharya

Abstract: U.S. critical infrastructure such as energy, transportation, and water represent cyber-physical
systems (CPS) with integrated information flow and physical operations that are
vulnerable to natural and targeted failures. Safe, secure, and reliable operation and control of
such systems is critical to ensure societal well-being and economic prosperity. Automated
control is key for real-time operations and may be mathematically cast as a sequential decision-making
problem under uncertainty. Emergence of data-driven techniques, such as
reinforcement learning (RL), have led to promising advances for addressing sequential decision-making
problems for risk-based robust control. This talk will describe multiple types of RL
methods (e.g., model-free, model-based, hybrid model-free and model-based, and hierarchical)
applicable for risk-based robust CPS control. Problem features and solution stability
considerations tied to these methods will also be discussed. Finally, a motivating notional
example with a heating, ventilation, and air conditioning (HVAC) control system will be
described and risk-based RL approach results will be presented.

| Classification: UNCLASSIFIED |
| Working Group:WG 35 AI and Autonomous Systems |

57028 - DeCypher: Human Machine Interaction For Graph-Based Cyber Situational Understanding

| Start Date: 6/24/2021 | Start Time: 1:30 PM ET | End Time: 2:00 PM ET |

| Authors: Christine DiFonzo; Dr. Steven Noel |

Abstract: This presentation will demonstrate DeCypher, an intelligent query translation system that transforms natural language questions to graph database queries. DeCypher alleviates user cognitive load and bridges usability gaps, enabling rapid understanding of complex operational security scenarios. Real-time cyber situational understanding via a natural language interface eliminates the need to write complex queries, improves human machine interaction, and greatly reduces the time for responding to cyberattacks.

DeCypher is integrated with the MITRE CyGraph platform for graph-based analytics and visualization. MITRE's CyGraph platform has demonstrated advanced capabilities for graph-based cyber situational understanding, e.g., in tactical military operations. Still, achieving more sophisticated analytic results generally requires formulating more complex queries. Users are required to know the underlying database schema as well as the syntactic and semantic rules of the query language. Networks change rapidly, and time sensitive incidents can be missed when focus is diverted to query generation, instead of threat detection, mitigation, and response. An initial prototype of DeCypher is currently developed to help address these challenges. DeCypher accepts phrases from an operator expressed in natural language, translates them to formal graph query, and submits the resulting queries to the CyGraph server. Depending on the query, the responses are either visualized in the CyGraph user interface or translated back into natural language through DeCypher.

DeCypher focuses on improving Cyber SU in dynamically evolving operational environments for mission-focused cyber resilience. A central theme of this work is that cyber situational understanding is greatly enhanced and streamlined through more natural human-computer interaction. Focus is kept on mission objectives and cyber resilience, rather than the underlying query language syntax and database schema. With DeCypher, analysts can focus less on needing to develop complex queries and more on getting the situational understanding and answers they need.

DeCypher uses contextual natural language processing and machine learning to translate ad hoc queries expressed through natural language into corresponding formal graph query language. This includes experimentally validating various models for user query intent classification, such as Naïve Bayes and deep learning transformers to recognize the query intent of the user. Additionally, the application of convolutional neural network models for named entity recognition is used for tagging elements of input natural language according to formal entity types. Semantic and syntactical similarity models are also used to compare tagged entities to elements of a graph data model and maintain a domain-agnostic approach. DeCypher capabilities are expected to improve through continual feedback and learning so that DeCypher can rapidly adapt to new situations.

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