Working Group 4
Data Collection and Analysis
“An easily understood, workable falsehood is more useful than an unintelligible truth.”

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Introduction
Perla defines the seven elements of a wargame as “Objectives, Scenario, Data, Models, Rules, Players, and, for professional games, Analysis.” What Perla calls a ‘hobby game’ typically does not have any analysis element connected with the finished product. That said, we argue that a professional game is not simply a hobby game with ‘Analysis’ added in as an afterthought, but rather that a professional game must be designed around the means to collect the data required for the analysis.

For a professional game, the sponsor’s objectives and issues drive the game design. The analysis requirements are simply a translation of the sponsor’s objectives and issues into the information that must be collected to answer those objectives and issues. Thus the design of the other six elements needed for the game are driven by the analysis requirements. In short, for a professional game, the analysis requirements dictate the game’s design and conduct.

Study Team
One of the keys to a successful professional game is consider it to be a component of a larger study framework, which is intended to address the sponsor’s objectives, be they related to problem solving or decision making. This permits the analysts to pursue avenues to address the sponsor’s objective, even when they are not associated with any game. However, once the study is oriented to conduct gaming, the inclusion of analysts is critical to every phase, from the planning through the design, development, and conduct of the game. Too often, games are designed by non-analysts, and the analysts are “invited” to analyze a game that has been already designed and developed. Not building your analysis into the game design is a recipe for disaster, but is one that continues to be replicated throughout DoD. One recommendation is that the study team consist of a (game) design sub-team and an analysis sub-team, but both must be included in all game activities. Clearly, the game must be designed around the analysis requirements, so these two sub-teams must coordinate closely.

Types of Games
Games may be classified in several respects. In granularity they may range from strategic to tactical. They may address only decisions made by players within the game. Or they may address many aspects where the game is a driver for related activities, e.g., the human interactions of a command team or a command team’s use of new technology in their command and control support systems. The structure of a game may be intended to foster seminar interactions between participants (a seminar game). Or games may be to examine how some activity is or should be done or done better, e.g., logistics, information
operations, or targeting. They may examine a particular activity from different points of view or identify issues that can be included in subsequent analysis or in future exercises.

Games may be supported with computer-based models or simulations. Or they may be austere and rely on little more than maps and movable unit counters. The chosen forms of support should accommodate the chosen form of analysis, and, when applicable, extract related data, e.g., casualty counts from combat simulations.

With such variety, there is no one analysis approach that will be universally applicable. This section provides a “catalogue” of methods and tools from which analysts can choose those that may apply in a specific circumstance.

The recommended procedure is to focus first on the sponsor's objectives and the issues that surround them. War gaming may be chosen at this point as an analytical tool, or not. If it is chosen, then the analysis components should be addressed from the beginning of the study.

**Planning for Analysis**

Professional games require analysis, and an analysis plan defines the requirements for analysis. There is no on-size-fits-all prescriptive analysis plan, but an analysis plan should, include as a minimum, what the sponsor’s objectives and issues are that need to be addressed, what data needs to be collected in order to adequately address them, and when that data is expected be generated in the game.

“When” may sound unusual, but a game’s design is focused on collection the necessary data, so it is reasonable to expect that a certain item of data will be generated when players are forced to make specific decisions.

A specified data collection methodology includes the various tools and means that will be used to collect the required data. This methodology has as its focus the Data Collection and Management Plan. This is the roadmap that the analysis team lays out that specifies the data that must be collected in order to produce the required analysis.

Most analysis of games depends on solid planning so appropriate diagnostics can be applied after the conclusion of the games: “Something interesting happened back at that point... but why?” The better organized in advance the analysis sub-team is for applying subsequent diagnostics the better. Hence it is recommended that considerable effort be devoted to planning data collection and the follow-on analysis, so such diagnostics are relatively easy to implement. Progression through a game however can be very dynamic: after all, the idea is to have decisions of the player-participants influence the outcomes. Thus the analysis plan should not be (and cannot be) applied rigidly, but must be highly adaptable as events unfold.
From initiation of the study, the analysis team should document the constraints, limitations, and assumptions that apply, see [TRAC 2012]. These will affect the outcomes almost as much as player decisions, so a complete record should be maintained.

The analysts must anticipate the support they will need as the game is designed. Some of the obvious points are adjustments to the scenario and ensuring the schedule allows time for analysis tasks and the game design provides the opportunity for data to be collected. But there are many other aspects of support. For a larger game the analyst team may need a separate network for real-time collaborations, e.g., emailing, messaging, blogging, teleconferencing. If on-line surveys are part of the data collection, then all concerned need to have access to the larger network, and appropriate software may be needed to distribute, collect, and analyze appropriate forms.

The actual data may be a combination of qualitative and quantitative components. The qualitative components may come from interviews, questionnaires, structured brainstorming, opinion surveys, or the ranking of options according to participant judgement. Quantitative components may include some form of scoring game results (e.g., in war games the casualty counts may be an important factor), and may be provided by the use of computer-based M&S.

**Preparing for Data Collection**
The analysis sub-team will consist of:

- Study director,
- Facilitator
- Scribe

Larger games will include a larger cast: adjudicators and assessors, subject matter experts and specialist panels, observers and data collectors, computer support, others

In the smallest professional games, there may be only two individuals: during game play, there should be a facilitator and a scribe at the least. (The study director may take on one of these two roles during gaming.)

The facilitator interacts with the player-participants and the scribe records activity. Trying to combine both functions may mean that neither is done well. Also the facilitator should not be the study director, unless the game is of very limited scope. In a game of any size, the study director is generally in demand for other tasks once the game is under way; whereas a full-time facilitator should not be distracted from the main task of guiding the player-participants through the scenario.
For games that are larger in scope, the analysis sub-team may be considerably enlarged. [More to follow on this.]

**Producing a Data Collection and Management Plan**
The Data Collection and Management Plan (DCMP) is the lynchpin of the professional game. Details on developing a DCMP can be found in [ABCA 2004]. The DCMP provides the means to translate the sponsor’s objectives and issues into the data that the game is designed to produce. A common convention that is used by analysts begins by taking the objectives and issues and decomposing them into “Essential Elements of Analysis” or EEAs. Again, there is no strict method for doing so. Each issue may produce an EEA, or an issue may be broken apart into several sub-issues before cogent EEAs can be identified. EEAs are typically stated as a question, such as “What were the key pieces of information that led player X to decide to employ nuclear weapons?” or “How lethal are the three blue tank alternatives?”

**Dynamic Scenarios**
Because games are dynamic events that rely on humans to make decisions and set the course of the game, creative methods and contingency plans may be necessary for collecting data that is vital to fulfilling key analytic requirements. Being able to “adjust on the fly” is a requirement for good game design in order to meet the sponsor’s objectives and issues. Just as a good commander has contingency plans at the ready, a good study director anticipates the need for contingencies as well.

[More to come: Injects, Branches and sequels, (they may be designed into whole vignettes that are prepared and introduced as needed), alternate data collection such as player interviews after the fact, player surveys, etc.]

**Composition, Positioning, and Training of Analysis Sub-Team members**
Analysis sub-teams typically are composed of analysts, observers, and data collectors. For smaller games, all three roles may be filled by analysts. There are larger-scale activities however, where members of the analysis team (typically data collectors and observers) will be augmentees who will join the study only as the game-playing phase is getting underway. In these cases, the augmentees may be unfamiliar with the game, with the analysis plan, with the data requirements from the DCMP, and with the tools that have been developed to assist in data collection and analysis. Thus, before game play begins, appropriate time and resources should be set aside for any training that may be required for those arriving to augment the analysis sub-team.

There are a number of critical positions that analysis team members fill during the game. Data collectors and observers may be positioned in each cell (Red, Blue, Green, White) to record decisions made and the information that led to those decisions. A game’s White Cell typically controls the game, and intercedes when the game play requires a decision or additional information that will allow the game to proceed. Recording those decisions and
their rationale often provides critical understanding of the game’s events. Having analyst team observers in the different player cells (Red, Blue, and Green) is critical, especially if the game is closed, and there are closed-door planning sessions. Leaders of each cell must be comfortable that their observer is non-partisan, and will not reveal confidences in the execution of the observer’s duties. In large games, observers that lurk in the break areas often come away with critical issues and information that cannot be gained elsewhere.

The analysis sub-team and any related observers or data collectors should conduct a rehearsal (or several rehearsals) before the game is played for real. This gives the analysis team a chance for a structured walk-through of how and when they will collect the necessary data. It allows them to develop or confirm a form of synchronization matrix to ensure that data collection is possible given that a game may have many “moving parts” and time and resources have to be appropriate to ensure that the right form of data collection can take place.

**Preparing Players and other Participants**

Players and other key participants should be provided with preparatory materials. As a minimum, players are typically provided a “read ahead” to familiarize them with the issues, objectives, scenarios, and player roles. For large games, a more detailed document, called a player handbook, may be produced. This should include both game-related material, e.g., the read-ahead items listed above, along with an administrative section that may cover travel arrangements, charging of various costs, availability of accommodations, phone numbers for contacts.

In most games with senior leaders acting as players, a “spin-up” session that brings players up to speed on the game preparation material should be scheduled for the first day of the game, as senior leaders often do not have the time to read materials provided ahead of time.

**Dress Rehearsal**

At least one “full dress rehearsal” should be conducted. This will constitute a last rehearsal for the analysis team as well as for players or surrogates for them. The idea of this rehearsal is not to deal in any detail with the mechanics of how the game works (the game design sub-team may have detailed rehearsals for this). This event is conducted to examine the “human factors” of the game and its facilities, e.g., can everyone see everything they need to, will comments from one participant be heard by all, will food and drink be conveniently located, break areas adequately marked, outside communication access, etc.
Collecting Data

We talk about data collection here in terms of how it provides the information required for the analysis to be completed, however this should not be confused with the element “Data” from Perla’s seven elements. Perla’s “Data,” or more accurately “Data Base” refers to the information players may use to help them make a decision. In some instances, data needed for analysis may also be used to update or add to the Data Base by providing the players feedback, but it is important to realize the distinction.

In most cases, analysis data must be collected as the game unfolds. However there is also a component of data that may be required within the game to determine certain outcomes. If computer-based M&S are used to support the game, analysts have traditionally been responsible for the preparation and running of the M&S as well as analysis and/or interpretation of the M&S output.

It may also be necessary to collect data during the course of a professional game partly to be used for analysis, but also to provide feedback to players during the course of a game. Some gaming facilities may provide this in the form of video replay of player interactions, or where computer simulations are used in support, the computer may provide a replay with a moving map and symbols. Since gaming often focuses on human decisions, it seems only natural to provide the players with feedback that gives them a better understanding of their impact on game results.

[More on: Gist of game activity. Other means – interviews, player feedback, opinion surveys and ranking of options. Analysis network.]

Conducting Analysis
[More to come on: Filtering for quality. Validating observations. Emerging insights. The lessons process that many military services have OILs – observations, insights, lessons.]

Reporting Analysis Results
[More on: Quick look report. AAR with player-participants. Table of Contents for a final report.]

A candidate table of contents for a study’s final report is:

- Chapter 1: Introduction
  - Purpose
  - References
  - Objectives
  - Scope
  - Intent
  - Report Structure
- Chapter 2: Literature Review
Literature Resources
Player Material (summary, if appropriate, with additional maps, scenario
details, system specifications in annexes)
Data Sources (including data within associated models and simulations, with
appropriate detail provided in annexes)

Chapter 3: Study Framework
Characteristics
Architecture
Organization Design
Key Systems
Schedule of Events
Training

Chapter 4: Analysis Framework
Constraints
Limitations
Assumptions
Methodology
Summary of issues as used in DCMP
Analysis Products

Chapter 5: Analysis Results
Linkage Between Metrics
Focus Areas
Integrated Insights
Summary

Annexes: (as required)

Completing the Project
Lessons are not learned until there has been a change in behaviour. Analysis is not
complete until the report has been published. ... and then the analysis team may still have a
role in briefing the higher-ups.

Annex A – Best Practice
- Start the analysis at the beginning, even before folks have decided they want a
  professional game. (Determine objectives first, then establish what will need
analysis, then choose the appropriate tools – then, if gaming was one of the chosen tools, use this handbook.)

- Plan analysis and data collection methods to suit the potential opportunities. (Avoid analysis approaches that are clearly not suited to the objectives.)
- Retain flexibility.
- More to come.

Annex B – Tools

Analysis Plan. This is a detailed account of the analytic basis for the game. It defines the problem and alternatives to be analyzed. It should include the roles of leaders of the analysis team and the sharing of responsibilities within the study team; details of the methods and tools that will be applied; plans for the necessary resources to support the analysis plan; milestone charts for completion of various phases in the study; the constraints, limitations, and assumptions have come to light at the time of its publication; and coordination arrangements with other participants, e.g., player-participants, game designers, scenario writers, support personnel for computers, security, administration, logistics. It identifies issues, sub-issues, and subsequent essential elements of analysis (EEA) and measures of merit (MOM) that will be applied during the game. The Data Collection and Management Plan will provide a more detailed description of the components of the analysis plan. See [ABCA 2004]

Data Collection and Management Plan. The most apparent part of the data collection and management plan is a spreadsheet where the rows represent a hierarchical decomposition of issues and the columns represent several derived elements, e.g., essential elements of analysis (EEA) or measures of merit (MOM) for a specific EEA or sub-issue. The DCMP expands upon the analysis plan and should give details of how and when specific elements of data may be collected. It may include detailed links to the events in the scenario and when they are likely to occur, so observers will be on hand at the right moment. Again the ABCA Analyst Handbook provides details with an example. See [ABCA 2004]

Command, Command Team, and Decision Making. Many military OR studies deal with command and control. Outside of the military domain, command and control might be understood as operations management – making decisions for the firm in real time. Military OR studies have ranged from evaluating procedures to testing prototype equipment. Many of these studies have used a war game to provide a cocoon around a team comprising a commander and staff to walk them through command and control activities while measuring some aspect of performance [NATO 1999]. A specific part of command and control is the effectiveness of the
people engaged in the process. Command is often viewed as a highly personal matter, linked to leadership abilities and command style. As such, the idiosyncratic nature of command makes it difficult to analyze. However, the activity in the staff surrounding a commander can be viewed as more procedural, albeit with the human factors of the participants affecting the team’s performance. A mature tool for determining the effectiveness of command team effectiveness is provided by NATO. [NATO 2005, 2012a]

Situational Awareness. Situational Awareness (SA) is "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and the projection of their status in the near future" (Endsley's definition (1995)). In the military domain, this definition overlaps with a command team in the sense that one aspect of a team’s performance is generally how well that team can understand their operational environment. But it can be applied to individuals, e.g., how well an air traffic controller can monitor the aircraft in his or her airspace and predict the future geometry of them. Apart from the decision-making aspects within a command team (largely covered by CTEF) there are methods like Situation Awareness Rating Technique (SART) and Situation Awareness Global Assessment Technique [Endsley, et al. 1998].

Decision-making Support Systems. The military environment places considerable stress on command and control support systems, usually based on a network of computers. The equivalent in the civilian realm would be management information systems, particularly those intended for application in emergency or disaster situations.

Task Evaluation. NASA-TLX is a method to assess workload. NASA-TLX permits participants to make subjective assessments of workload of one or more operator working with various human-machine systems. NASA-TLX is a multi-scale assessment procedure that derives an overall workload score based on a weighted average of ratings on six subscales. See [NASA undated].

Player-Participant Feedback. See http://www.opanalytcs.ca/progames/Feedback.html

Questionnaires. See http://www.opanalytcs.ca/progames/Feedback.html

Extractions from Combat Simulations and Similar Packages. See http://www.opanalytics.ca/progames/Numbers.html

Software for Analysis Team Consultation. Web-based content management systems (like Drupal, see [Tomlinson and VanDyk 2010]) allow convenient design and
maintenance of functions that are familiar to users of blogs and wikis. If a site on a network is provided to members of the analysis team it can be used to collaborate on analysis and data collection issues as a game unfolds.

Presentation of Results. See [Dewar 2012] and [Few 2010] for advice on presenting data to diverse audiences. Both references provide advice on providing data analysis in pictorial form to users in web-based environment.

Annex C – Logistics and Administration

More to come. May get moved to back of the whole MORS handbook.

References


NASA Task Load Index. Undated. See: http://humansystems.arc.nasa.gov/groups/TLX/


TRAC. *Constraints, Limitations, and Assumptions Code of Best Practice*. TRAC-TD-05-011 (rev. 1) TRADOC Analysis Center, Fort Leavenworth, KS. June 2012 (PowerPoint file.)
Games are focused on human player interactions and decisions, and analytic games must be able to collect and analyze qualitative data. In some instances, there are quantitative data, possibly a large volume, also being produced and collected that should be incorporated as part of the analysis. The working group will assess the need for data collection, analysis methods and tools by game design type, and attempt to match existing methods and tools with identified game design types.
• Chair: Jeff Appleget
• Co-Chair(s): Fred Cameron

• **Approach(s):** Play a quick version of “Zebra” seminar wargame to illustrate data collection challenges and techniques
• **Guidelines:** informs potential participants of pre-reading, expected proficiency, homework, etc.

• **Impact:** participants are working toward a product(s) that helps what?

• **Objectives:**
  – What WG products support them?
  – Where in your internal agenda will they be addressed?

• **Essential References:**
Working Group 4
Agenda

• Tuesday:
  – Meet and greet
  – Introduce sponsor engagement strategies as a precursor to creation of a DCMP (you don't get the problem right, the best DCMP can't help you).
  – Review what a DCMP is and best practices for creating a DCMP.
  – Introduce the concept of measurement space (to illustrate that a DCMP provides the impetus for game design).

• Wednesday: Understand the importance of and challenges with data collection in gaming
  – Zefra Play
  – Discussion of data collection methods and tools

• Thursday
  – Understand the different data collection methods and tools available, by game design type (maybe), e.g seminar, system, hybrid, etc.
  – Identifying analysis techniques and tools that are used or could be used
Tuesday Session: Understand The importance of and challenges with data collection in gaming

- Discussion topics: How sponsor objective and issues drives the DCMP.
- Discussion topics: How the DCMP drives game design and game type(s). [measurement space introduction and tie in]
- Presentations
- Milestones
- Handout material

- Goals:
  - Identification of data collection methods and tool requirements by game design types
  - Assessment of data collection methods and tools available to support game design types

[Prep for Zefra play on Wed]
Wed AM: Understand The importance of and challenges with data collection in gaming

- Discussion topics: Play Zefra with Data collectors, analysts, white cell designees

- Goals:
  - Experience the challenge of data collection
  - Understand how game management affects data collection
  - Critique data collection techniques
  - Review supplemental data collection techniques (such as surveys, interviews, etc)
• Discussion topics: Data collection methods, techniques and tools
• Presentations
• Milestones
• Handout material

• Goals:
  Identification of data collection methods and tool requirements by game design types*
  Assessment of data collection methods and tools available to support game design types
  Identification of existing gaps in data collection methods and tools available WRT game design types
Thursday AM Session: identifying analysis techniques and tools that are used or could be used

- Discussion topics: challenges with data collection and perhaps challenges with game analysis. Also, start identifying different analysis techniques and tools available.
- Presentations
- Milestones
- Handout material

- Goal: Identification of technical methods for analyzing mixed (quantitative and qualitative) data
Thursday, Morning Session
Consolidate Findings

- Discussion topics:
- Presentations
- Milestones
- Handout material
Working Group 4
Topics Intersecting Other Groups

• Data Collection
  - Game design and development—must design the game around the data needed to answer sponsor’s objective and issues
  - Objective Development—sponsor’s objective and issues are key to the development of the data that needs to be collected (EEAs, MOMs, MOEs, MOPs, etc)
  - What will you discuss that’s useful to other WGs—linkages and importance of incorporating DCMP into
game design
  - Where is the topic on your timeline?

• Analysis
  - What other WG’s will discuss this topic—Objective Development
  - What do you need from other WGs
  - What will you discuss that’s useful to other WGs
  - Where is the topic on your timeline(?)
The group will produce these distinct products:

- Identification of data collection methods and tool requirements by game design types*

- Assessment of data collection methods and tools available to support game design types

- Identification of existing gaps in data collection methods and tools available WRT game design types

- Identification of technical methods for analyzing mixed (quantitative and qualitative) data
Data Collection

- Examining the development of the DCMP
  - Objective -> Issues > Sub-issues > EEAs > MOM > MOE > MOP
  - Over time or phases in a game

- How to ensure data collection by using Injests, Branches, and Sequels

- The concept of measurement space to ensure the game has the proper breadth to get to the issues you need to collect data on (proper game design)

- Data collection methods
  - Data collectors
  - Optional paper forms
  - Interviews
  - Computer entry
  - Video/audio
  - AAR(?)

26 September 2007
Analysis

- Some triage of results (Insight, observation, finding)
- Quick report before players depart
- AAR to confirm (or deny) findings
- SOTA
- The NATO technology methods
Objectives of Analysis in War Gaming

- Who won?
- Why (and where) did they do better than expected?
- Why (and where) did they do poorer than expected?
Analysis to Answer the Questions

• Who won? *Analysts need:*
  – Established winning conditions
  – Measurements that determine if winning conditions were met

• Why (and where) was result better than expected? *Analysts need:*
  – Identification of successes
  – Diagnostics to backtrack successes to causes

• Why (and where) was result poorer than expected? *Analysts need:*
  – Identification of failures
  – Diagnostics to backtrack failures to causes
The Old Way and the New Way

Can we determine cause and effect?

- Games with simple structure

- Games with complicated structure

The “New Way” may actually be the really old way of the British Empire, and the Roman En
Models, Complexity, and Error

- Specification Error
- Measurement Error
- Model Error

Minimize Model Error
Models, Complexity, and Error

- Specification Error

- Measurement Error

- Model Error

Minimize Model Error
Issues from SWG Week at NPS

- Role of the Facilitator (characteristics, role, procedures, ...)
- Development of Scenarios (with associated vignettes and injects)
- Data in a SWG is more like facilitated brain-storming, e.g., it’s all about the discussion (and not just the numbers, e.g., loss-exchange ratios)
- Hybrid gaming: combination of SWG and computer-supported gaming
- Sequential gaming: first a SWG, then move to more computer-based approaches
- Tiered approach, as in Perla on NWC Global