Usability Study of the Department of Defense Joint Analysis System

Doug Bardin, Estelle Hong, Daniel O'Loughlin and Zachary Maodus

Abstract— **The Department of Defense (DoD) uses modeling and simulation as a primary tool to plan future operations and facilitate decision making. Simulations help decision makers analyze a scenario and make decisions based on the simulated outcomes. The purpose of this project is to apply the Systems Design Process (SDP), developed and utilized extensively at the United States Military Academy, in the form of a usability study of one of DoD's newest campaign level simulations. The Joint Analysis System (JAS), formerly known as the Joint Warfare Simulation (JWARS), is the first campaign analysis tool to incorporate all three services of the military. The most obvious benefit of JAS over the separate service models is the explicit modeling of the interdependencies that exist between the services. It also incorporates a theater level logistics model not found in any other service model.**

Even with its added benefits, the separate service analytic communities have been slow to adopt JAS as the simulation of choice for campaign level analysis. One fear is that JAS run scenarios may show a service, organization or major weapon system as being less integral to a campaign's success than previously believed. Since scenarios are typically forecasting likely campaigns 15-20 years in the future, this could lead to major changes in service funding. There are also issues pertaining to the overhead involved with learning a new simulation and a resistance to change from the model they are already familiar with using.

In an effort to increase the user base, the focus of this project was to develop a tutorial that shows the basic functionality of JAS utilizing an unclassified campaign level scenario. A usability study was performed at the undergraduate level to analyze ease of use and understanding of the simulation based on information learned in the tutorial. The objective is to pass this tutorial along to the other service academies and DoD analytic agencies.

I. Introduction

With the increased dependence on technology, civilian organizations and corporations around the world have learned to use computers to help facilitate daily and long term decisions as appropriate to their needs. This statement still holds true for government agencies and departments. More specifically, the Department of Defense (DoD) uses the latest technology to assist decision makers at every level. With warfare being the DoD's primary function in government, simulations have become the preferred method of facilitating decision making at the highest level. Simulations allow organizations to save time and money without having to experience any negative consequence that may adversely affect the organization as a whole. Military simulations in particular allow decision makers to see probable outcomes of their decisions without having to put any lives at risk or waste resources. These campaign models exist to support the different branches of the military. Some of the campaign models used by the DoD to support joint campaign analysis are the Tactical Warfare Integrated Environment (TACWAR), Thunder, the Joint Integrated Contingency Model (JICM), Extended Air Defense Simulation (EADSIM), and General Campaign Analysis Model (GCAM). Each model gives a separate but distinct perspective on all different aspects of war: land warfare, air warfare, maritime warfare, and tactical ballistic missile defense (TBMD). TACWAR is a simulation from the 1960s that focuses mainly on land warfare but still has some air assets within the model. Thunder is a primarily air fighting simulation used by the United States Air Force. JCIM is a simulation from the 1990s that has special focus on land and air warfare. The U.S. Army uses this simulation for its campaign analysis. EADSIM is a tactical ballistic missile simulator used by the Office of the Secretary of Defense (OSD). GCAM is a primarily maritime analysis tool used by the U.S. Navy. Figure 1 shows how JAS encompasses the separate service models.

These campaign analysis tools each offer their own point of view for a wartime campaign plan. However, they are still separate simulations which fail to recognize the necessary interdependencies between the armed services of the DoD. Due to the reliability of the services upon one another, the Office of the Secretary of Defense (OSD) felt it necessary to create a campaign analysis tool that encompasses all aspects of joint warfare. The Joint Warfare Simulation (JWARS), later renamed the Joint Analysis System (JAS), models all aspects of joint warfare. This ten year, 100 million dollar effort provides a platform for the Department of Defense to use for future operations. Currently JAS is being used by a limited number of analytic agencies. The separate service analytic agencies are slow to accept the new program since they are comfortable with the models they currently use and
also feel JAS may not represent their true capabilities.

All authors are with the Department of Systems Engineering at the United States Military Academy, Mahan Hall, Bldg. 752, West Point, NY 10996 845-938-2788; fax: 845-939-5919; e-mail: Douglas.Bardin@usma.edu.

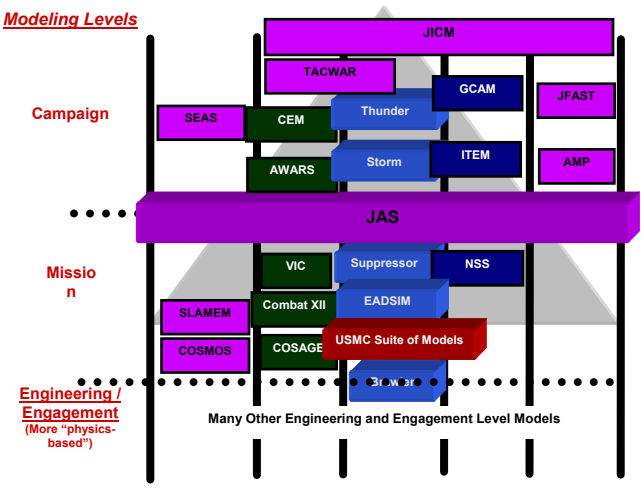

Figure 1

II. JAS BACKGROUND

The Joint Analysis System was conceived in 1995 under the Joint Analytic Model Improvement Program (JAMIP), headed by the Deputy Secretary of Defense. Representatives from each branch of service formed an organization to develop the new program. The new JWARS office fell under the Office of the Secretary of Defense (OSD) Program Analysis and Evaluation (PA&E), where the program was initially bred and developed. Still today the JWARS office (now the JAS office) operates under the OSD PA&E Simulation Analysis Center (SAC) and continues in its development.

JAS is a theater-level *strategic analysis* tool to support and assist DoD decision-making through campaign-level simulation. Strategic analysis is "an analysis of force sufficiency and effectiveness conducted by the DoD Components to support the development and evaluation of the defense strategy."[1] The studies conducted at the OSD PA&E/SAC are conducted to provide defense analytical baselines for potential future operations; others are conducted for planned operations to determine the effects of the environment, task organization, logistics flow and communications on the overall outcome of the campaign across all armed services. While service-specific models have provided input to previous analytical baselines, JAS incorporates them into a single simulation that better represents the interdependencies of the services on an operational level. This high-level simulation was developed to replace existing service models for joint campaign-level operations.

The Joint Analysis Simulation simulates integrated intelligence, surveillance, service weapon systems, and joint task forces. It simulates operation plans to help determine timelines for future operations; helps establish the best combination of mixed forces; assists in understanding how weapons are best used in meeting and planning an operational goal; assesses combat effectiveness; allows for a sensitivity analysis on the system; and expands upon the concepts and doctrines of war [2].

The Joint Analysis System integrates functionality on the operational level that currently exists in each of the individual simulations used by the different services. JAS functionality includes: air/space, land, maritime, transportation, and logistics. UAVs, satellites, or ballistic missiles are some assets that are portrayed in the air/space functionality. The air operations functionality also includes pre-assigned strike missions, apportionment, and identifying the objectives by time within each region. Airborne, Air Assault, or Amphibious Operations are depicted under the land warfare functionality.

There are many details that coincide with an operation within JAS in order to create a more accurate battlefield simulation. For example, a land order would include tasks to subordinate units and some details for executing the plan. These orders consist of information ranging from the maneuver sequence to the fire support request. In addition, the mission, objective, participants, and the time needed to execute the tasks are included. The transportation and logistics functionality addresses air, land, and sea operations; concerning placement of troops, movement of troops and supplies, and the processing of supply requests. JAS also includes a robust Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) modeling capability making the simulation extremely complex, yet powerful. JAS is built using battlespace entities (BSE) to represent units, installations, or major systems operating in the battlespace. Unique only to JAS, BSE's model operationally functional actors and possess specific behaviors and capabilities. There are seven domain managers dealing with the different functions that are offered including:

- movement
- interactions
- environment
- adjudication
- event management
- data collection
- simulation management

A movement manager controls movement of the BSE's within the battlespace, while the interaction manager lets the BSE's know when they "might" interact with each other. The environment manager depicts the physical situation that the BSE's, as well as the other components, will operate in. The adjudication manager calculates the attrition while the event manager tracks the queue of events, schedules new events, handles canceled events, and advances the simulation by each event. Finally, the data collection manager consists of instruments that collect specific sets of data from the BSE's during the simulation and sends it to the simulation database while the simulation manager organizes and manages the storage of data. The domain managers, though functional, are continuously being improved to execute the simulation as efficiently and effectively as possible.

JAS is currently managed by the JAS Program Office which is under the JFCOM J9, also known as the Joint Force Command. In the past year, OSD PS&E/SAC conducted a JAS analysis of two potential future situations. These situations, known as MCO-1 (multi-combat operation 1) and MCO-2 (multi-combat operation 2), were also analyzed using the individual service simulations. The JAS analysis provided results that were consistent with the individual service campaign analysis tools. This comparison of simulations demonstrated that JAS is capable of accurately depicting combat operations in each of the branches of service as well as the combined arms fight. JAS is used continually to model potential situations and conduct sensitivity analyses for different courses of action.

III. Project Objectives

The main objective of this project is to help the JAS office identify user issues and help determine why acceptance of this new simulation has been so slow (Figure 2). Additionally, the team was asked to broaden the JAS user population and potentially create a future user-base that will be more confident in using JAS for campaign-level analysis.

The first step toward broadening the user base of JAS is to introduce it to future military leadership. Such leadership is found at the various service academies as well as the junior officer corps. The focus of this project is on the service academies and potential users within computer simulations classes.

A tutorial was created for use in a classroom environment that introduces new users to just some of the functionality of the simulation. Rather than wading through the many pages of the User's Manual, the JAS tutorial addresses common operations like changing the task organization of a military unit or changing its weapon mix in a pre-modeled scenario. It also shows how Microsoft Access or Excel can be used for the post processing of data after a scenario is run.

IV. Methodology

The Systems Decision Process, or SDP, is a holistic systematic methodology for problem solving the uses value-focused thinking. Developed in the Department of Systems Engineering at the United States Military Academy, the SDP is a four phase process that includes: 1) Problem Definition, 2) Solution Design, 3) Decision Making, and 4) Solution Implementation [3]. It is an iterative process that incorporates sub-tasks within each phase with the main focus being on recommending and implementing the solution that provides the greatest value to the stakeholders and the decision-maker.

The problem definition portion of the SDP is essential because it specifically defines the project objective or problem. The sub-tasks of the Problem Definition phase are stakeholder analysis, functional analysis, and value modeling. Stakeholder analysis is used to identify the people and organizations relevant to the problem at hand and to

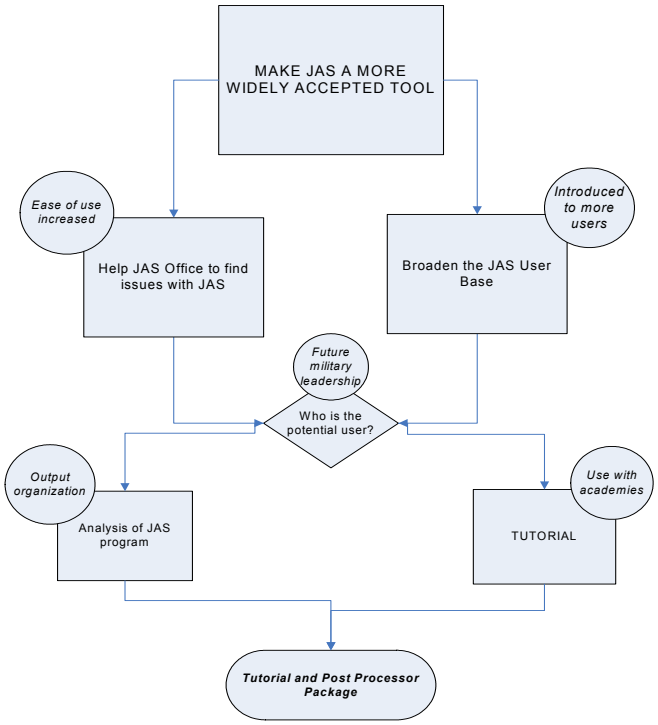

Figure 2.

determine their wants, needs, and desires with respect to the problem. The stakeholders in this project include the DoD analytic agencies, the JAS program office and OSD PA&E/SAC. Stakeholders help the group to focus on specific aspects where further advancements in the program would be most effective. Functional analysis is a systematic process to identify the system functions and interfaces required to achieve the system objectives. The JAS program is extremely complex, so the majority of the functional analysis involves working through the program and gaining an understanding of how the system works. A trip to the JAS office in Washington, DC allowed the group members to interact with JAS programmers who shared their expert knowledge of the program and taught the group how to operate the system. Finally, Value Modeling involves the objectives that are obtained from the stakeholder and functional analysis, which are used in order to evaluate possible solutions.

The Solution Design phase of the SDP develops a collection of possible solutions that is continually checked and refined. From this set of candidate solutions, a final recommendation is made. Solution design is broken down into idea generation, alternative generation, and solution enhancement. Idea generation actually begins in the problem definition phase. It addresses possible solutions to the problem defined in the previous phase. Through alternative generation, a candidate set of solutions is formed. By continually revisiting the stakeholder values and the original problem statement, the set of alternatives is refined and altered to optimize value to the decision-maker. This meant determining which of the many capabilities and

functionalities of JAS to include in the tutorial and how to structure it.

Next, the Decision Making phase is applied to select the best candidate solution. It was decided that the JAS tutorial would be broken down into two main functions: operating JAS and exporting and analyzing data. Operating JAS consists of playing a scenario on the playback tool as well as manipulating the inputs of the scenario in various ways. The data analysis includes simply exporting outputs from the scenarios that were previously run and using Microsoft Access to post-process and analyze the results. The post processor is an active database that helps the user to filter outputs. Initially reports were used to give users the data sets that were found to be important during the stakeholder analysis. While reviewing the reports created, however, it was evident that there were simply too many iterations of outputs to put into simple reports. In one scenario, the messaging traffic report resulted in over 21,000 pages o data. The decision was made to create forms that would allow the user to choose from the two most important fields of data to find those data sets that are most important to him or her. The tutorial was developed and tested using West Point cadets with various experience levels and backgrounds. In a classroom environment, the test group found it easy to work through JAS tutorial, exercise some of its functionality and manipulate inputs and outputs. When working through the post processor to find and analyze data, the cadets found very little or no trouble getting quickly to the information they were asked to locate. Comments and suggestions were collected resulting in some wording and graphics changes to the document.

The final, and arguably most difficult, step in the SDP is the Solution Implementation phase. Though this project does not implement the use of the tutorial at any DoD analytic agencies or service academies, the tool will be made available to the client for distribution.

V. Analysis

After creating the tutorial and post processor for classroom use, undergraduates from the US Military Academy were asked to work through the document. Three Cadets from three different companies were selected to take part in a trial of the product. Most of the cadets were freshman or sophomores who came straight to West Point after graduating high school and did not know a great deal about simulation or the military in general. The cadets came on two different days, approximately one month apart, to work on the two separate sections of tutorial. The first section, tested in February, involved running playbacks of scenarios in JAS and changing inputs to the simulation. The second session, completed late March, tested their ability to export outputs from JAS and use the post-processor to analyze the outputs.

After working through the tutorial, many cadets felt overwhelmed by the many different capabilities of the simulation. When asked about whether or not they felt comfortable working with JAS before using the tutorial the unanimous response was “no,” however after working for less than an hour with the tutorial all of the cadets felt comfortable working with JAS on a low level. While the cadets demonstrated throughout the tutorial session that they were able to easily navigate the post processor, the question and answer period pointed out both strengths and weaknesses of the product.

While the tutorial directed the cadets in making specified changes to the scenario, they were still confused by the many capabilities in JAS that were not addressed by the tutorial. This was primarily due to their low experience level in using military simulations. Though there were minor glitches in the usability study that seem to be present in all simulation experiments, much feedback was captured and improvements were made to the tutorial that improved the original tutorial.

One of the main points captured in the study was, in order for users to truly understand and appreciate the power of this analysis program, a significant amount of time must be spent on learning the functionality and capabilities of the system. This tutorial helped first time users feel comfortable with some basic functionality of JAS and is expected to do the same for more seasoned users of military models and simulations.

VI. Conclusion

By applying the Systems Decision Process to the OSD PA&E’s desire to increase the user-base and acceptance of JAS among the campaign analysis community, we are able to successfully develop a tutorial that meets the needs of new and first time users. The process assisted the team in developing the tutorial and an operational post-processor which allows new users to learn about and use JAS without being overwhelmed by its extensive capabilities.

The JAS program is an extremely complex and powerful tool that will benefit all of the military services greatly in the future. Once the user base is broadened, the full effects of the program will be felt. Integration of all services is important to successful military operations. As the military continues to upgrade technology and acquire new resources, JAS helps the decision-maker to realize the impact of such products in the military. Now, using the newly created tutorial and post processor, a larger user-base will be able to reap the extraordinary benefits of the Joint Analysis System.

VII. Recommendations

From the beginning of the year, the capstone team formulated ideas while researching and performing case studies to help the JAS office in understanding how to broaden the JAS user-base. It is our recommendation that the Office of Secretary of Defense (OSD) push forward simulation training to the lowest level as quickly as possible. The United States military spends billions of dollars acquiring and incorporating technology that will play a major role during both combat and peacetime operations. It is essential to make sure the right equipment is acquired, tested and put into operation. JAS is an effective tool in helping do this.

In order to create a larger user base that will feel more confident in applying JAS to real world situations, the JAS office needed to create and integrate a more simplistic teaching tool into basic leadership training for the military. As a result, the capstone team developed a tutorial that would help those who are new to the simulation as well as those who are currently using it, to translate the magnitude of outputs that JAS produces. This tutorial was tested with nine cadets who had varying experience with any type of simulation. As the JAS office integrates the tutorial system into the teaching process for military leadership, the user base will certainly grow. More people will be able to understand how JAS works and what it is used for, and it will be used on varying levels of analysis using the post processor to filter outputs.

It is important that OSD introduces simulations; specifically JAS to all of the different military academies. This will allow future leadership in the military to be familiar with a common analysis system. This theater-level strategic analysis tool is already a proven asset. Not only should OSD push the different service academies to incorporate this into the curriculum; they should also look to see if basic leadership training units can have instruction on this simulation tool. If more people are familiar with the simulation, there will be less resistance to change from the models they have become familiar with using.

ACKNOWLEDGMENT

It would have been impossible for the capstone group to even fathom doing an analysis of such a powerfully complex program without the expert assistance of the OSD PA&E. A one-day learning session at the office in Washington, DC made it possible for the team to work through and analyze the program. Numerous phone conversations continued between the office and West Point, whenever the team ran into significant issues. Not only did the JAS technicians help the team greatly, but LTC John Crino, who was the team's liaison at the JAS office, has made a number of trips back and forth between DC and New York in order to help the team to keep on track and to clear up any questions that might need to be confronted. We thank the OSD PA&E JAS office for their continuous assistance throughout this project. Only with their help was the project and analysis possible.

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