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Team 3: Total Life Cycle Management: Automated Model Development

Eberth, Robert

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TEAM 3 MEMBERS

Marine Corps Systems Command, Team Lead
Major Stephen Mount

Other Marine Corps Representatives
Robert Eberth (PEO Land Systems)
Mark Danison (MCSC)
Captain Jonathon Derosier (HQMC, I&L)

Naval Postgraduate School, US
Keebom Kang
Captain Shawn Phillips

Simulation and Data Management Professionals
Jake Enholm (Claxton Logistics)
Andy Foote (Alion Science)
Larry Paige (Claxton Logistics)
Mike Tomlin (Clockwork Solutions)
Tom Turner (Concurrent Technologies)
Dan Widdis (Concurrent Technologies)

INTRODUCTION

Total Life Cycle Management (TLCM) is the process which enables program managers to make life-cycle decisions across all phases of the acquisitions process. Life-cycle sustainment, operational performance issues and requirements are system dependant. Relevant issues arise from early in the process during the Material Solutions Analysis Phase, all the way through Operations and Support. Adaptive and modular modeling and simulation tools have been developed to address these complex issues throughout the life-cycle the Marine Corps weapons systems.

Previous work from Naval Postgraduate School students has focused on the Total Life Cycle Management – Assessment Tool, from Clockwork Solutions. This technology has been successfully used in numerous studies in support of program managers and logistics decision makers throughout the Marine Corps. Marine Corps Systems Command and Headquarter Marine Corps, Installations and Logistics have also pursued a more scalable approach to life-cycle modeling and simulation using EXTENDSIM 7.0.

During the International Data Farming workshop both simulation environments were explored using readily available, organic, Marine Corps availability and maintenance data. Data extraction and model build times were drastically reduced with the use of an interface developed by Captain Shawn Phillips. The ability to link Marine Corps data repositories and life-cycle simulations will give decision makers the ability to produce relevant, timely and cost-effective solutions to system operational effectiveness issues.

PROVIDING RELEVANT SOLUTIONS

In addition to providing analytic rigor to standard system reliability, availability and maintainability assessments, modeling and simulation can provide the program manager insight into a myriad of TLCM process areas.

- System Performance Requirements: What level of future system performance is required in order to meet/exceed the desired capability? What availability is required or attainable in order to meet/exceed the desired capability?
- Depot Maintenance Planning: Which Principal End Items (PEIs) would best benefit from overhaul? Which sub-systems are driving low reliability or availability numbers?
- Product Upgrade: What is the most cost-effective solution to upgrade the capability of a system? Is continued investment in sub-system reliability or availability improvement worth the capital investment, or should extra spares be purchased?
- Product Support Plans: What are the potential tradeoffs when considering different product support plans? How do overarching process improvements affect material availability and mission readiness?

These and many other TLCM questions are potentially addressed using TLCM-AT and EXTENDSIM 7.0, but the process of data manipulation and model building is often time consuming and cumbersome. While accurate results continue to be paramount, timeliness of analysis was the focus at IDFW 18.

BRIDGING THE GAP

The Bridging Operational Logistics Tool (BOLT), designed and implemented by Captain Shawn Phillips, enables the model builder to rapidly extract data from an Excel source file, change the model input parameters and implement design of experiments (DOE) for TLCM simulations. In order to assist in the verification of the two modeling environments the following factors were determined to be of interest and were varied using DOE:

- Maintenance Times
- Operational Tempo (expressed in total miles and average miles/hour driven in a year.)
- Vehicle Population
- Percentage of parts found to be un-repairable upon inspection.
- Shipping Time
- Scale of failure distribution

The levels of these factors were set using data sources and technical manuals. Without the aide of BOLT, these variations to the models could have possibly taken days or weeks to implement. During IDFW 18, team 3 was able to set up the parameters, analyze the input data, agree upon the validity of assumptions, run the simulation, and verify the accuracy of the results, in a single afternoon.

In order to determine the accuracy of the results and the importance of the factors of interest the team used the following methodology:

1. Use a time period in which data is known
2. Determine historical parts usage for the entire period
3. Input the parameters into the simulation for the first half of the period and then predict the parts usage for the second half.
4. Use root mean square error to measure the difference between simulation predictions and actual parts usage.
5. Determine factors of interest using statistical software.

RESULTS AND ANALYSIS

The analysts using TLCM-AT and EXTENDSIM 7.0 both implemented the same methodology and experienced similar results. Mean time between failure, vehicle population and operational tempo proved to be the most significant factors overall. Several interactions between maintenance and shipping times were also noticed, but at a lower level. The analyst's ability to use BOLT and DOE to explore the entire decision space, when parameters are unknown, replaces the need to solely rely on subject matter expertise. The increased knowledge that is derived from using DOE empowers the program manager to focus data collection efforts on the factors of most importance in order to improve a models output and predictive capability.

Operational usage of ground combat systems is an especially difficult metric to capture. In order to more fully explore BOLT and the two modeling platforms, a real-world operational scenario was explored in which a ground commander would have had some prior knowledge of a pending deployment. Using the IDFW developed methodology, the team was able to accurately predict the observed increase in system part usage with a corresponding projected increase in operational tempo and vehicle population. Solely based on simulation results, the operational commander would have only been short 17 total parts over the period of the deployment. This is especially important when planning austere contingency operations where parts and logistics assets are limited.

CONCLUSIONS

IDFW 18 provided a unique venue for a team of Government and industry simulation and data management professionals to combine their expertise in the pursuance of a common goal. With the implementation of BOLT, the TLCM insight that modeling and simulation provides is now more accessible to Program Managers and decision makers. Days and weeks of complex data manipulation and model development have been successfully reduced to several hours of an experienced analysts time.

The two simulation platforms exercised were similar in their results and modeling methodology, but their actual implementation will vary significantly. The Marine Corps plans to use them both as complementary capabilities to provide both rapid and more detailed analysis. The path forward should include a detailed and documented validation of both simulations, by the utilizing agencies, in accordance with the approved DoD instruction.

For detailed explanation of TLCM modeling and simulation efforts in the Marine Corps and actual results from IDFW 18, please contact Major Stephen Mount, stephen.mount@usmc.mil or 703-432-3868.