4.3 MODELING & SIMULATION (M&S)

PEO LS has a requirement for an integrated suite of M&S tools that can be used to support the development and modification of ground tactical vehicles throughout their acquisition life cycle.

M&S can and should play a critical role in the acquisition process. Among the many significant benefits that a simulation-based acquisition (SBA) approach can provide are:

- Identification of system requirements that are realistic and achievable
- Ability to optimize system requirements and perform requirements trades
- Reduction in cost and schedule
- Enable "virtual" vehicle designs to be functionally tested on computers
- Assess candidate vehicles against critical performance parameters
- Ability to evaluate potential new technologies and assess technology readiness levels (TRL)
- Significant reduction in the total life cycle cost (LCC) of the system

The ultimate value of a fully integrated M&S-based Systems Engineering (SE) capabilities toolset is that it can maximize the effectiveness of limited resources in bringing optimized, focused capabilities to the Warfighter.

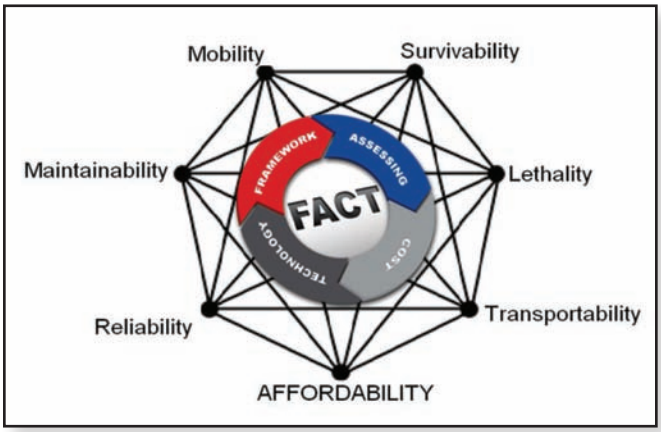
The Challenge: High fidelity M&S is required to significantly reduce program cost, schedule and performance risks across the PEO LS portfolio. The challenge for this focus area resides not only in developing these 'high fidelity' models but also in understanding the fidelity of current models.

The following initiatives describe some of the current efforts that potentially provide solutions to this challenge.

Potential Solutions:

PEO LS and MCSC Efforts

Framework Assessing Cost Technology (FACT): The FACT project is a System-of-Systems engineering toolkit that allows concurrent design trade modeling in a web based application. Modeling the trade-offs concurrently results in faster decision timelines and potentially limits the costly 'test and fix' approach often employed. FACT uses the common language (SysML) system and is 'model agnostic,' allowing the inclusion of multiple trade space models currently being utilized by the program managers.



HMMWV

One of the efforts within the FACT project is the development of a high fidelity HMMWV trade space model that will provide a foundation for a general design tool for light tactical vehicles. The objective of this effort is to provide a framework for integrating numerous models to assess the fidelity of current models and evaluate the available trade space.

ACV/AAV

Program Manager Advanced Amphibious Assault (PM AAA) received delivery of the FACT toolkit in February 2012 to conduct analysis on thresholds delineated in the Capability Development

Document (CDD) for the ACV program. The tool provides the Program Manager with an understanding of the possible trade-offs where further investment may result in enhanced capability.

Lightweight 155 Howitzer (LW-155)
The LW-155 FACT initiative, to begin in the second half of FY13, is endeavoring to break new ground in trade space modeling. This will be the first time the FACT M&S toolkit is used on a weapons system vice a tactical wheeled vehicle. In addition, it will be venturing beyond the conceptual design efforts already attempted and into the engineering and manufacturing phases of a fielded system. The objectives of the initiative are:

- Increase the strength (reliability) of the re-engineered components and the system as a whole
- Decrease Mean Time Between Repair
- Decrease the cost of repair parts
- Increase system availability
- Open competition for manufacturing repair parts to domestic sources of supply (potentially including government fabrication)

JLTV: The objective of this project is to develop a physics-based model that accurately predicts both soil/structure interaction and gross vehicle/crew response to underbody blasts. The underbody blast (UB) M&S efforts will: 1) provide the Joint Project Office (JPO) insight into force protection levels (initially from a structural standpoint and evolving to a crew response standpoint); 2) support engineering design analyses and modifications; and 3) provide supplemental information to support Key Performance Parameter analyses.

ONR Efforts

ONR has a broad mix of projects, many focused on ground vehicle programs, which add to development of a comprehensive suite of M&S tools for the Marine Corps:

Survivability Analysis of Alternatives Tool: Develop an M&S tool to conduct Analysis of Alternatives (AoA) that establish key survivability performance parameter thresholds for crew casualty and that help balance the weight allocated between underbody blast protection and other protection features in order to provide insight into where to invest for survivability.

Modeling and Simulation of Advanced Armor Systems: Increasing fidelity in innovative armor predictive modeling and simulation tools. The ultimate aim is to provide designers and engineers with the ability to accurately model new designs and constructions.

Human Surrogate Development: Johns Hopkins University Applied Physics Laboratory is working to develop a human surrogate model of the brain to study the mechanisms that cause traumatic brain injuries and to discover innovative ways to mitigate the blast trauma.

Composite Armor Modeling and Optimization: Determine if sub-component (fiber, resin, and weave) contributions of today's Fiber Reinforced Plastic (FRP) composite armor can be adequately represented through numerical modeling; then validate against test data. The final product will accurately model new FRP armor compositions at reduced development costs.

Novel Ceramic Armor Configuration Modeling: Develop an accurate model to predict measurements of penetrator induced shock loads in ceramic armor.

Improved Survivability Modeling and Injury Prediction Correlation to Operational Requirements-Based Casualty Assessment (ORCA): Enhance ORCA blast module to more precisely predict injuries from IED and other blast events.

Armor Threat Level Survivability Model (ATL) Develop a tradespace model that will optimize warfighter load out, to include weight and movement constrictions of personal armor systems. The program will model bio-dynamics associated with acquire, aim, and shoot movements and investigate how it is affected by armor system worn in different threat environments.

TARDEC Efforts

Ground Vehicles M&S Playbook: TARDEC has been tasked by the Governance Board of the Joint Center for Ground Vehicles to develop an M&S Playbook to identify the M&S tools and best practices associated with each phase of the acquisition process. This data call is different because it is structured around the acquisition life-cycle as opposed to being a catalog or list of M&S tools. The objective is to understand and capture the best application of M&S for each specific phase of the acquisition process to emphasize the "how" (e.g., processes, inputs, decisions affected, etc.) rather than the "what" (i.e., the tools).

Safe Operations of Unmanned Systems for Reconnaissance in a Complex Environment: Provide perception, intelligence, control and tactical behavior technologies for autonomous collaborative unmanned systems for conducting safe operations in dynamic urban environments

OCP M&S: The OCP program is focused around technologies and platforms that are deliberately designed around the Soldier and Marine. M&S initiatives include:

- Exterior Protection: Develop protection designs, supplemented by advanced material and manufacturing solutions, that provide optimized protection for the occupant to the full spectrum of underbody threats (blast and penetrator).
- Interaction of Sub-Systems: Develop a detailed understanding of the interaction and fidelity of each sub-model of an end-to-end underbody event simulation.
- Threat Loading: A detailed understanding of the loading applied to a vehicle (and subsequently to the occupant) from all relevant UB threats.
- Structural/Material Response: Foundation for the development of a Material Specification for Formidable, Weldable Blast Resistant Materials by investigating material and structure processing-property relationships.

Threat Oriented Survivability Optimization Model (TOSOM) Improvements: TOSOM will provide optimized software with quantifiable metrics to assist in the streamlining of the concept definition phase for new programs. This streamlining will be accomplished through advanced and innovative capabilities to perform system level trades using a mathematical assessment of the benefits and burdens of both traditional and non-traditional survivability technologies in the development of Survivability options for vehicle platforms.

- Soldier Vehicle Blast Protection: This component of TOSOM was developed to provide a detailed analysis of the impact of underbody blasts on the military's ground vehicle fleet. The tool takes into account system-wide evaluation of the detonations' effects on ground vehicles, providing a comprehensive look over a range of variables.
- Survivability Analysis and Optimization: A component of TOSOM instrumental in performing rapid turnaround, first order analyses of survivability trade-offs in the design or modernization of military systems.

Hit Avoidance SIL: A tool to aid in the development and integration of Hit Avoidance Systems for ground-based combat vehicles.

SBIR Effort

Software for First Order Affects (FOA) of Blast & Ballistic Impact on Vehicles: This Phase 1 SBIR effort is developing a series of fast-running algorithms to improve the time to analyze first order screening of armor based solutions for tactical vehicles. Current finite element analysis can take days or weeks to develop a model and hours of work to adjust configurations. This solution can improve time to test various configurations, enhancing trade-off analysis processes.

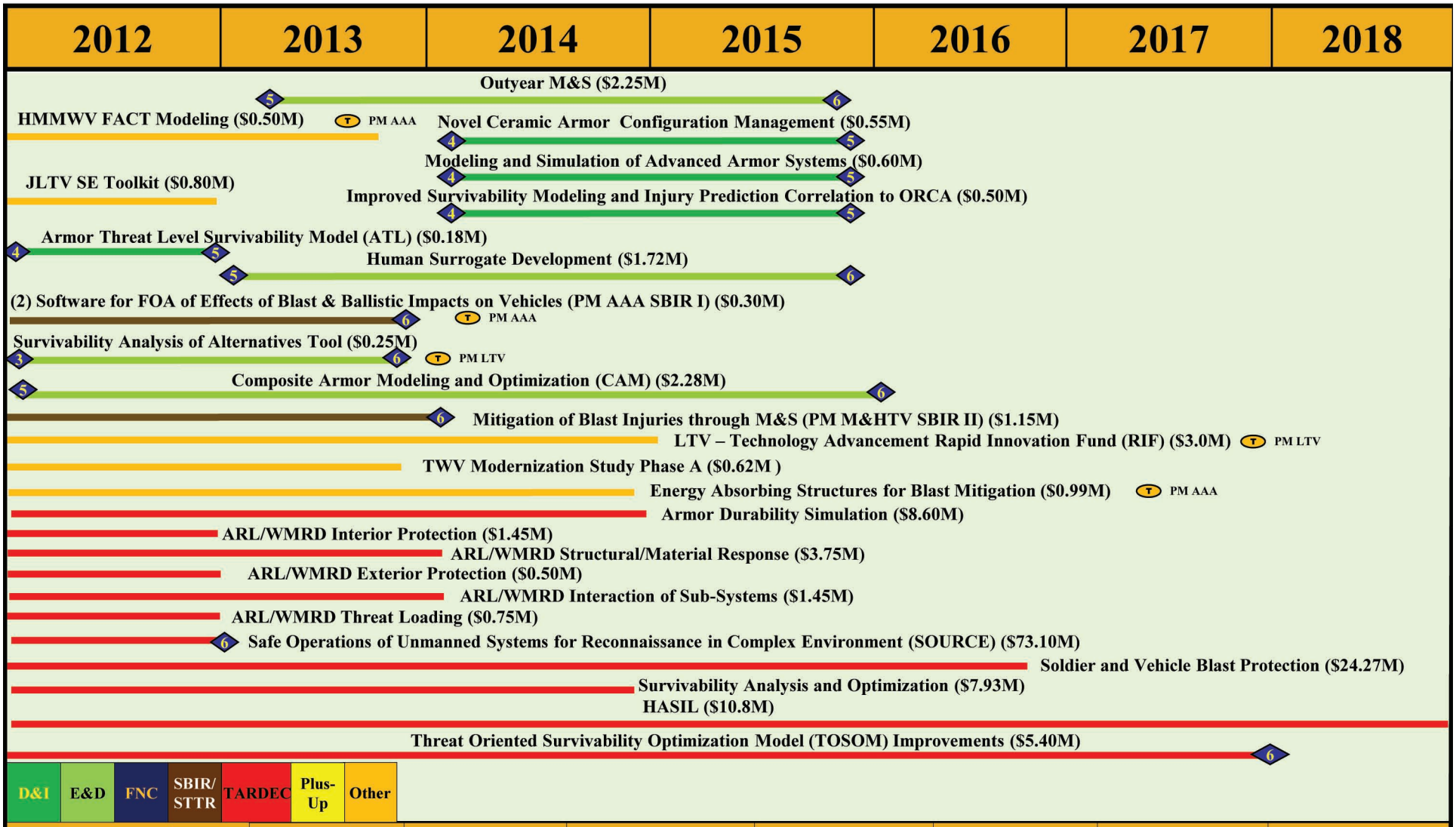
Other Efforts

Adaptive Vehicle Make: The DARPA AVM is a portfolio of programs attempting to address revolutionary approaches to the design, verification, and manufacturing of complex defense systems and vehicles. The three primary programs are META, iFAB and FANG Ground Vehicle (GV) programs. Components of the program leverage crowd-sourcing and will be open source, with the ultimate intent to develop a next generation combat vehicle program from introductory modeling through manufacturing and production.

The META program portion of AVM is endeavoring to transform the timeline required in the existing systems engineering approach to developing, integrating, and testing new defense systems. The project centers around computer model based techniques, massively expanding their capabilities, and designing a program that will encompass a complete cradle-to-grave analysis for a new ground vehicle system design.

The M&S Focus Area Charts on the following pages highlight critical efforts monitored and supported by the PEO LS S&T Director.

Modeling and Simulation



Funding Profiles ($M)	FY 12	FY13	FY 14	FY15	FY 16	FY 17	FY 18
S&T (6.2 / 6.3)	33.59	18.52	18.46	9.83	5.28	1.70	5.00