SYSTEMS ENGINEERING RESEARCH CENTER

Model Centric Engineering - Insights and Challenges: Primary Takeaways from a Government-Industry Forum

Dinesh Verma

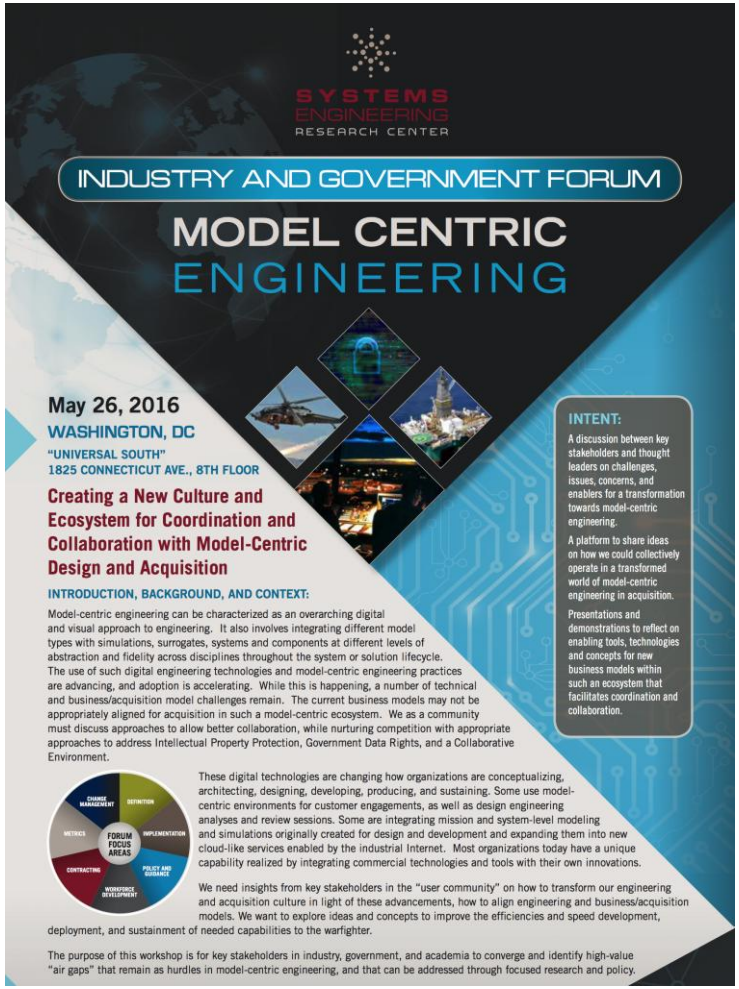
Megan Clifford

MCE Forum – WHY?

- Model-centric engineering (MCE) is an overarching digital and visual approach to engineering.
- Use of digital engineering technologies and model-centric engineering practices are advancing, and their adoption is accelerating.
- Concurrently, a number of technical and business/acquisition model challenges remain. As an example, the existing business models may not be reconsidered and re-aligned for acquisition in a model-centric ecosystem.

MCE Forum – WHAT?

- The MCE Forum allowed a balanced perspective between industry, government and academia.
- Key stakeholders in industry, government, and academia converged and identified high-value shortfalls that remain in model-centric engineering that can be addressed through focused research.
- 75 attendees at the Forum: 15 from Academia; 25 from the Government; and 35 from Industry.



MCE Forum – Agenda (Interaction and Discussion Intensive)

SYSTEMS ENGINEERING RESEARCH CENTER

Industry and Government Forum on Model Centric Engineering
FHI360 Conference Center
1825 Connecticut Avenue NW
Washington, DC 20009-5721

Agenda

Thursday, May 26, 2016

Registration, Breakfast and Welcome	
8:00a–8:45a	Registration and Continental Breakfast
8:30a–8:45a	**Welcome & Announcements** **Ms. Philomena Zimmerman**, *Deputy Director, Modeling, Simulation, Analysis, and Open Systems (ASD – R&E: Systems Engineering);* **Dr. Dinesh Verma**, *SERC Executive Director*
Sponsor Perspective	
8:45a–9:00a	**Forum Shaping Remarks** ***Ms. Kristen Baldwin***, *Acting DASD (SE)*
Government & Industry Perspective	
9:00a–9:30a	**The Need for a Transformation - A Government Perspective** **Mr. Dave Cohen**, *Director, Mission Engineering & Analysis Dept, NAVAIR*
9:30a-10:00a	**The Need for a Transformation - An Industry Perspective** ***Aaron Copeland***, *Director, Systems Engineering, Mission Systems Sector, Northrop Grumman*
10:00a-10:30a	Transition Break
Morning Panel	
10:30a – 12:00p	**Panel: How the Government & Industry Can Collaborate More Effectively** *Moderated by:* ***Mr. Robert A. Gold***, *Director, Engineering Enterprise, OUSD(AT&L)/ASD(R&E)/Systems Engineering* *Panelists:* ***Ms. Carla Coleman***, *Huntington Ingalls, Inc. - Newport News Shipbuilding (HII-NNS);* ***Mr. Dave Cohen***, *NAVAIR;* ***Don Kinard***, *Lockheed Martin;* ***Paul J. Russo***, *US Navy;* ***Mark Signorelli***, *BAE Combat Vehicles;* ***Col. Kelly Tucker***, *US Air Force*
12:00p – 1:00p	Lunch

Breakout Sessions		
1:00p – 2:45p	**Breakout Session 1:** **Discussion on a Collaboration Operational Model between Industry and Government** ***Dr. Donna Rhodes***, *Director, Systems Engineering Advancement Research Initiative (SEAri), MIT; Principal Investigator, SERC*	**Breakout Session 2:** **Discussion on Capabilities of New Operational Paradigm** ***Dr. Jon Wade***, *Director, Systems and Software Division and Distinguished Research Professor, School of Systems and Enterprises, Stevens; Chief Technology Officer, SERC*
2:45p – 3:00p	Transition Break	
3:00p – 3:45p	**Current State of Research and Development in Support of Engineered Resilient Systems (ERS)** ***Mr. David Richards***, *Technical Director, ERS, ERDC*	
3:45p – 4:00p	Transition Break	
Afternoon Panel		
4:00p – 5:00p	**Panel: Tools and Infrastructure in support of Model Centric Engineering - a Tool Vendor Perspective** *Moderated by:* ***Mr. David Long***, *CEO, ViTech and Former President, INCOSE* *Panelists:* ***Dr. Dave Richards***, *US Army ERDC;* ***Mr. Barclay Brown***, *IBM;* ***Mr. Venkat Parameshwaran***, *Altair;* ***Dr. Scott Ragon***, *Phoenix Integration;* ***Mr. Don Tolle***, *CIMdata, Inc.*	
Wrap Up		
5:00p – 5:30p	**Open Microphone and Additional Actions**	
5:30 – 6:00p	**Social and Networking Session**	

Three Contextual Talks – Practice, Acquisition, and Research

- *The Need for a Transformation – A Government Perspective*, **Mr. Dave Cohen**, Director, Mission Engineering & Analysis Dept., NAVAIR
  - *Instead of focusing on Individual Systems, thinking must focus on Integrated Warfighter Capability*
  - *Focus on a small number of sacred requirements, and then develop concepts and architectures, leading to detailed requirements*
  - *Kill chain analysis at the mission level to allow exposure to key capability gaps at the mission level*
- *The Need for a Transformation - An Industry Perspective*, **Mr. *Aaron Copeland***, Director, Systems Engineering, Mission Systems Sector, Northrop Grumman
  - *Challenges include lack of standard operational architectures, common standards (small set), and an ability to trade between abstraction and fidelity in selected domains*
- *Current State of Research and Development in Support of Engineered Resilient Systems (ERS),* ***Mr. David Richards***, Technical Director, ERS, ERDC
  - *Focus on integrated visualizations and computational models from operational concepts to physics-based models to buy down risk; Focus on system resiliency/adaptive to wide range of possible scenarios*

Panel: How Government and Industry Can Collaborate More Effectively

- The Lead System Integrator (contractor or government component) needs to able to leverage MCE data to allow effective mission and system analysis for rapid deployment of system of systems capabilities.
  - The intent is not for the acquisition organizations to impose digital engineering technologies on contractors and but rather evolve to it in a collaborative manner while maintaining healthy competition.

- Complexities of modern evolving systems means we must be able to perform syntheses and analyses, and share digital artifacts and information across diverse domains and disciplines, as well as diverse systems.
  - Challenges include, but are not exclusive to, appropriately acquiring and using government data rights, intellectual property marking and protection, and contracting using digital engineering artifacts and evidence as deliverables.
  - Another challenge is the MCE framework for collaboration spanning the lifecycle – addressing the security for different levels of classification and aggregation, the appropriate levels of visibility and transparency, and making use of increased technical cohesion.

Panel: How Government and Industry Can Collaborate More Effectively

- All parties are currently operating with an audit mindset, creating enormous amounts of requirements and in long lead times before a systems or solution even goes to test.
- The modeling environment can drive down the number of requirements while facilitating the product to be in test rapidly, allowing for test driven development.
  - Focus early through a small set of key/sacred requirements to embed the notion of validation, and test driven development can allow us to capture the potential of model centric engineering.
  - Knowledge capture in models (reference architectures, design and architecture patterns, design and architecture rules) within the context of an accepted ontology can bring increased efficiency.
  - While the number of requirements in a complex program often exceeds human comprehension, the interchange between industry and government on the comprehension of the requirements can be improved through MCE. This would be infinitely better than a document containing numerous pages.
- As the digital thread feeds manufacturing, if a digital twin were present, it would provide the basis of operations and sustainment, and evolution.

SYSTEMS ENGINEERING RESEARCH CENTER

First Breakout Session:

Collaboration Operational Model (Industry and Government)

Capabilities

- Shared common understanding of model-based deliverables
- Standard interfaces facilitate and allow data sharing
- Open design space – using value based approaches
- Culture: Every day is design review; data is more open vertically; Robust trade-space analysis; Effective Knowledge Management

Opportunities

- Leadership commitment to total lifecycle cost approach
- Establish tool standards, ontologies, data standards, and open architectures
- Well defined CONOPS and Mission analysis connecting to user value
- Culture: collaborative decision making; key stakeholder commitment to MCE

Barriers

- Culture, trust, and unstable funding
- Status quo with skills gaps in workforce and current approach to acquisition deliverables
- Too much reliance on current methods, processes, data, and tools
- Lack of funding for early engagement of downstream disciplines early – test, manufacturing, sustainment.

Breakthroughs

- Early adaptor/successes and case studies
- An environment to enable appropriate data rights to the right folks, with proper context, for decision making and trade-space exploration
- An open system/framework to support tool agnostic use for users
- Develop means to foster an appetite for alternative deliverables

SYSTEMS ENGINEERING RESEARCH CENTER

Second Breakout Session:

Discussion on Capabilities for a New Operational Paradigm

Capabilities

- Likely a single logical model throughout the life cycle, either integrated or federated – Single Source of Truth
- A standardized validation and verification approach and process for models being used
- Document centric reviews replaced by evidence based models
- Models integrated across domains and disciplines – and abstraction levels

Opportunities

- Identified tools and methods to build, manage, and use set of models within an environment

Barriers

- Cultural issues with reliance of a document centric CDRL based approach
- Ability to list assumptions across all key stakeholders
- Ability of the MCE to support innovative conceptualization
- A program management framework appropriate to MCE

Breakthroughs

- Role of Advanced Software Methods – leveraged to support integrated modeling?
- Is it possible to construct a model translator?
- Can we provide full life cycle visibility with visualization capabilities?
- Can we use tutorials of what has been done already to ramp up new participants?

SYSTEMS ENGINEERING RESEARCH CENTER

Key Questions – Captured Insights – Participant Interchange

- **Need for a well defined "game plan" to guide technical leaders looking to transition towards greater model centricity**
  - **What are the pre-requisites? What is the best approach given the unique context of each organization? How to assess organizational readiness? What are the generational issues?**
- **What is the technical makeup of the canonical design team in a model centric context?**
- **There needs to be a move from implicit designs to explicit designs – we cannot change what we don't completely understand – without unintended consequences.**
- **To understand and address cultural changes, there needs to be a pragmatic narrative on the why, what, and how in support of MCE – developed and delivered with impact.**
- **What is the organizational ROI related to MCE?**
- **There is a need to develop guidance on how to put MCE on a contract with sample language describing deliverables, GFI, evaluation criteria, etc.**

Four Recurrent Themes/Benefits related to MCE

- Improved Acquisition
- Improved Efficiency and Effectiveness
- Improved Communications: Better Trade-Space Exploration, Reduced Risk
- Improved Designs and Resulting Systems and Solutions

1. Improved Acquisition

Accepting digital models as deliverables during the acquisition process (as opposed to digitized documents) could improve the government's understanding of a project's status and risks as well as reduce the workload associated with generating and reviewing documents for both government and contractors. The government could use their own analysis tools to computationally validate a contractor's deliverables in a way that is not possible with documents.

2. Improved Efficiency and Effectiveness

A digital "twin" of the system in question can be used to expedite production activities and maintenance activities as well as perform "what-if" analyses and test the effects of operational changes. All of these could result in reduced time and effort in the performance of existing tasks.

3. Improved Communication; Better Trade-Space Exploration; Reduced Risk

While digital models are already used extensively in system development, each stage of the development as well as each specialty/domain has its own suite of modeling and analysis tools and these are often incompatible. (e.g., it might not be easy to extract useful information from a hardware model and import it into a cost model) As a result, translation among the various tools is time consuming and error prone. Greater model transformation across domains and disciplines could potentially improve communication among specialists as well reduce work and errors.

4. Improved Designs and Resulting Systems and Solutions

Today it is often difficult to understand the impact of a requirement or a design decision until late in the development process when test articles are built or detailed, system specific simulations are completed and validated. Consequently, adverse consequences from an early requirement or design decision may not be recognized until late in the development process when the costs and time to correct are substantial. Multi-scale simulation using “off the shelf” or modified models could be used to perform detailed and extensive trade studies to identify these adverse consequences before a commitment is made to requirements and/or design decisions.

Download the Final Report on the MCE Forum

- http://www.sercuarc.org/wp-content/uploads/2014/05/MCE-Forum-Final-Report.pdf

SAVE THE DATES:
NOVEMBER 16-17 2016

MARK YOUR CALENDAR AND JOIN US

4th ANNUAL SERC DOCTORAL STUDENTS FORUM

WEDNESDAY
NOV 16 2016
12:00 – 5:00 PM

The SERC Doctoral Students Forum provides an opportunity for selected doctoral students conducting systems research at one of the SERC universities to present their research in an open forum. This half-day event provides an opportunity for the attendees to have insights into on-going research, and to influence its direction, while also meeting a number of doctoral students from the SERC universities. A networking reception with heavy hors d'oeuvres will immediately follow the event. Attendance is open to government, FFRDCs, national laboratories, industry, and academic institutions. Industry participants will have a nominal registration fee.

8th ANNUAL SERC SPONSOR RESEARCH REVIEW

THURSDAY
NOV 17 2016
8:00 AM – 5:00 PM

This one-day research conference highlights over twenty ongoing SERC research projects. Several of these research projects are ready for pilot use and transition to practice. Researchers from the SERC universities will discuss their research, highlight results, and describe opportunities for government agencies to sponsor and participate in their projects. Those from government agencies, FFRDCs, national laboratories, industry, and academic institutions are welcome to join SERC researchers and students for a stimulating exchange of ideas. Industry participants will have a nominal registration fee.

For more information:
Mitchell Kerman / mkerman@stevens.edu
Megan M. Clifford / mcliffor@stevens.edu

LOCATION:
20 F Street NW
Conference Center
Washington, DC 20001

SYSTEMS ENGINEERING RESEARCH CENTER

SERC TALKS

UPCOMING TOPICS:

What Lives at the Intersection of MOSA and Set-Based Design?
Gary Witus, Wayne State
October 5 | 1:00 pm ET

Why is Human-Model Interactivity Important to the Future of Model-Centric Systems Engineering?
Donna Rhodes & Adam Ross, MIT
December 7 | 1:00 pm ET