INCOSE MBSE Workshop at INCOSE IW 2014: "Infusing MBSE Across Domains"

CIMdata Commentary

Key takeaways:

- *Outside of the software engineering domain (where the model-based principles were initially developed and applied starting in the 1980s), cross-domain MBSE is still in the very early stage of industry adoption, similar in nature to mechanical CAD and CAE technology in the early to mid 1980s*
- *Early adopters of MBSE are starting to implement this approach within selected programs and domains with positive metrics of success; albeit not without the normal challenges of major process change and related organizational training*
- *System modeling languages such as UML/OMG SysML and Modelica are rapidly maturing to meet the needs of the systems engineering community*
- *Standards for MBSE data exchange, interoperability, and data visualization (e.g., OSLC, OSLC4MBSE, FMI and DoDAF) are rapidly emerging and maturing*

INCOSE MBSE Workshop Highlights

Over 400 INCOSE[1] members attended the recent International Workshop 2014 and MBSE Workshop events held in the Los Angeles, CA area from January 25-28. An intense two-day weekend workshop was focused exclusively on Model-Based Systems Engineering (MBSE). MBSE is one of the key strategic initiatives of the INCOSE SE Vision 2020[2].

The charter of the INCOSE MBSE Initiative is to promote, advance, and institutionalize the practice of MBSE through broad industry and academic involvement. These activities focus on research; standards; processes, practices, and methods; tools and technology; and outreach, training, and education. To accomplish these objectives, the MBSE Working Group consists of a number of Challenge Teams, Activity Teams, and related Working Groups/Collaborations.

During the course of the two-day MBSE Workshop, speakers from industry, government, and academia presented on their experiences with implementing MBSE in application domains covering space systems, aircraft, defense systems, rail and infrastructure, vehicle and automotive, engine and powertrain, and consumer products. Participants from research and academia as well as MBSE and PLM solution providers presented during breakout sessions on their activities in MBSE Model Management, MBSE Modeling and Simulation Interoperability, and System Modeling and Simulation (a relatively new NAFEMS and INCOSE joint activity).

Of particular note are some of the lessons learned by industry leaders such as JPL, Ford, Boeing, Procter & Gamble, and the Department of Defense as they have embarked on

[1] The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded to develop and disseminate the interdisciplinary principles and practices that enable the successful realization of today's complex systems. Since INCOSE's formation in 1990, this global organization based in San Diego, CA. has grown to over 9,420 members consisting of 67 local chapters located in 58 countries.

[2] MBSE Definition (INCOSE SE Vision 2020, September 2007)
"Model-based systems engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

implementing the model-based digital approach and technology into their traditional document-based systems engineering organizations. Despite the significant diversity of business models and products represented by this group of early adopters (i.e., production quantities of millions/day vs. a few units/year and unit costs ranging from 25 cents for a diaper to $2.5B for an aircraft or a planetary spacecraft mission), they all were in concert about the business benefits and strategic importance of MBSE to their product and process development activities. They also acknowledged the challenges that exist on several dimensions to make MBSE the foundation for their future Systems Engineering activities.

Implementation challenges were highlighted in the areas of tools and technology, training and support, organizational and cultural change, and business metrics and ROI based on real use cases. In the area of tools and technology, end users were particularly concerned and quite vocal about the need for MBSE data exchange standards and interoperability of software tools across the engineering domains. It is evident that the scope of MBSE as envisioned by INCOSE and by industry is not likely to be served by any one software provider in the near future (if ever) so end users clearly want to be able to protect their investment in tools, IT infrastructure, and intellectual property as they begin to implement the MBSE approach. Knowledge capture and re-use across tools and processes is seen as a key factor in building ROI for business case justification for MBSE investments. The large PLM solution providers such as IBM Rational, Dassault Systèmes, PTC, and Siemens PLM Software as well as smaller MBSE providers and academia, such as InterCAX (SLIM), Modelon (FMI/FMU), Phoenix Integration (ModelCenter/MBSE Analyzer), Koneksys (OSLC4MBSE), and Georgia Tech (MBSE Center) are all actively working towards more open systems modeling environments based on industry standards. They shared their current product offerings and future research plans for addressing the openness and data interoperability requirements of end users. The innovative efforts of the smaller, niche MBSE providers hold great potential to accelerate the adoption rate for MBSE within a PLM framework, particularly in the area of cross-domain functional performance simulation and conceptual optimization.

All the presenters acknowledged the significant people, culture, and organizational challenges that exist in adapting today's systems engineering "best practices" into an MBSE framework. As with any significant process and technology change, there will be normal cultural resistance due to existing organizational processes as well as knowledge and information silos that run counter to the collaborative nature of an MBSE-centric process. Ultimately, MBSE will not be successful unless it helps break down communication barriers among all the stakeholders in the product development process. Realizing the benefits of having a common systems description for today's complex systems and even systems of systems (i.e., defining, updating, and tracking requirements over time, identifying design gaps and inconsistencies to minimize engineering change, supporting re-use of modeling and design information within and across domains, increasing trade space exploration at the conceptual stage, improving systems-level testing and validation, in-service maintainability and design upgrades, etc.) requires a next generation digital-based approach.

Resistance to change will also be present at the individual system engineer level. To address this reality, presenters highlighted the importance of training and education so that today's systems engineers clearly understand the benefits that can accrue to them (How does this make my job easier?) as well as to the organization (successful products). Providing MBSE mentors and technical support in early implementation projects is critical to make the systems engineer feel more productive using MBSE as a complement to their existing tools and deep process knowledge and to ensure successful MBSE implementations, including both hard and soft benefit metrics.

Presenters encouraged the "crawl-walk-run" model of MBSE implementation, which has historically been most successful in engineering domains when introducing new processes and technologies such as CAD, CAE, product data management (PDM), and product lifecycle management (PLM). Initial implementation projects must be realistically scoped and staffed and need passionate internal champions in senior engineering management as well as on the program team that will not allow the initial MBSE implementation projects to fail due to the inevitable organizational and cultural hurdles and related resistance to change. Success metrics and business benefits, both financial and non-financial, should be agreed upon up front with the team and then tracked carefully throughout the project to establish a baseline for ROI. These challenges must be addressed to realize INCOSE's Vision for MBSE, shown in Figure 1, within the next decade, resulting in the institutionalized application of MBSE across industry domains as well as academia.

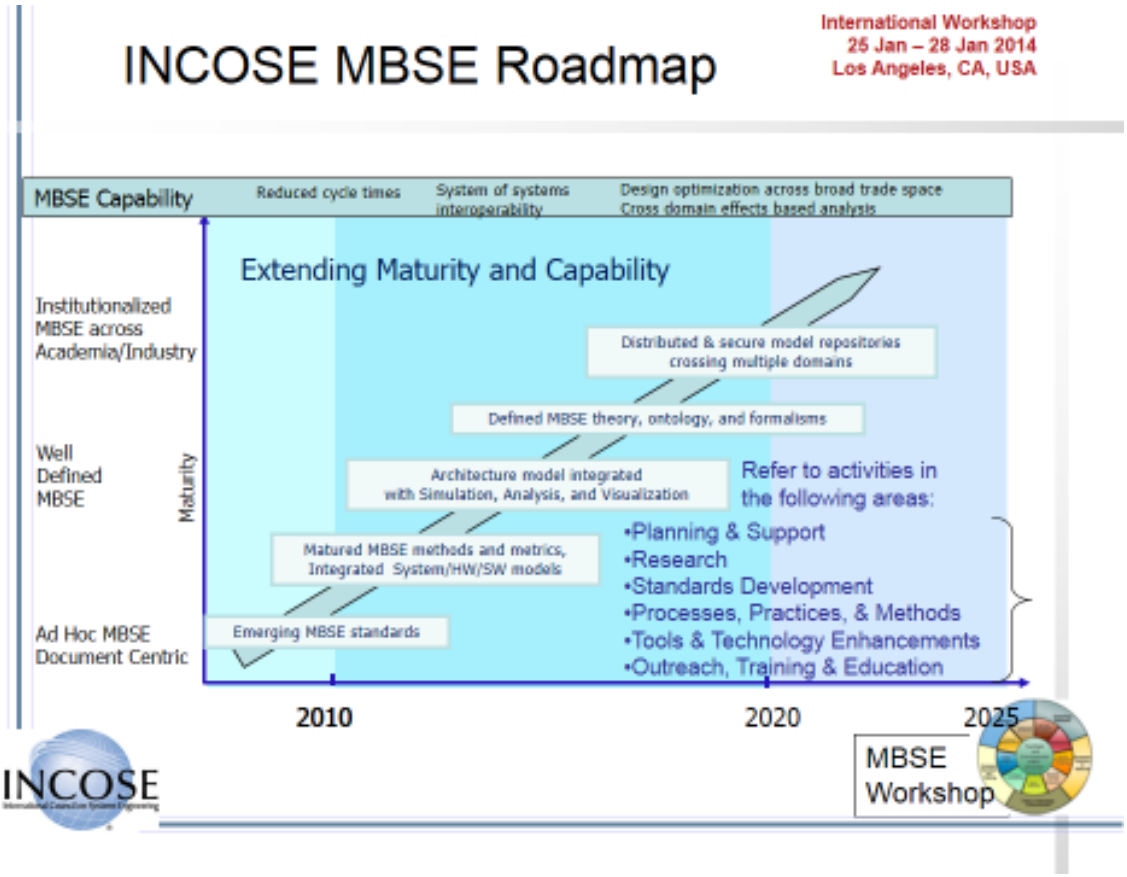

Figure 1—INCOSE MBSE Roadmap
(Courtesy of INCOSE)

For further details on the MBSE Workshop, many of the INCOSE Workshop presentations are available to both INCOSE members and the general public, go to http://www.omgwiki.org/MBSE/doku.php.

CIMdata conducts Knowledge Councils in a number of PLM related domains including Systems Engineering and Simulation & Analysis. In addition to research and consulting in these areas, CIMdata hosts annual Council Workshops where industry, government, software and service providers, and academia participate to discuss industry best practices, identify industry issues and requirements and exchange information on the challenges of practical

implementation of next generation methods, tools, and technologies. The next Systems Engineering Workshops will take place during the months of April and May 2014 in Germany and the United States. See http://www.cimdata.com/en/events/workshops for more information.

About CIMdata

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