

NIST ADVANCED MANUFACTURING SERIES 100-1

A Summary Report on the Model-Based Enterprise Capability Index and Guidebook Workshop

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NIST
**National Institute of
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Penny Pritzker, Secretary

National Institute of Standards and Technology
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Notes

Nomenclature and acronyms are not defined in the body of the text. Refer to Appendix 5.C for a list of all nomenclature and acronyms.

1. Introduction

1.1. Overview

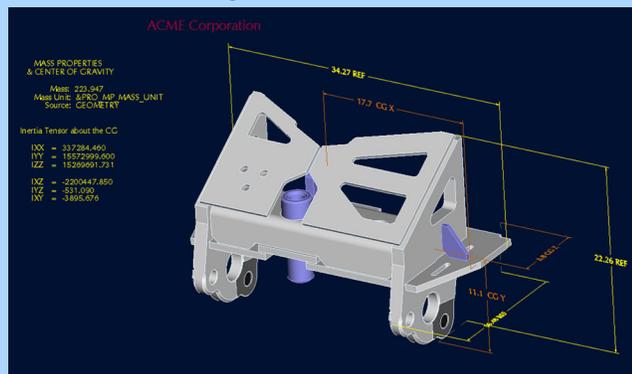
A Model-Based Enterprise (MBE) is “an integrated and collaborative environment, founded on 3D product definition shared across the enterprise, enabling rapid, seamless, and affordable deployment of products from concept to disposal,” (Model Based Enterprise, 2014). When an organization operates under an MBE, their divisions, branches, etc. operate under a single source of truth: the product model. The model could be an annotated computer-aided design (CAD) model or a model-based systems model defined in SysML. Regardless of the model’s form, an organization operating under these conditions could eliminate the inefficiencies and opportunities for errors of recreating domain-specific or “silo-ed” drawings. A study showed that a MBE approach results potentially in a 75% average reduction in cycle-time over a drawing-based approach (Hedberg Jr, Lubell, Fischer, Maggiano, & Barnard Feeny, 2016). In addition to bringing products to market quicker and cheaper, an additional benefit of MBE is the ability to potentially reduce the cost of supporting and maintaining the product throughout its life (Model Based Enterprise, 2014)

The National Institute of Standards and Technology (NIST) held a “Model-Based Enterprise Summit” from April 12 – 14, 2016. The goal of the summit was to identify challenges, research, implementation issues, and lessons learned in manufacturing and quality assurance where a digital three-dimensional (3D) model of the product serves as the authoritative information source for all activities in the product’s lifecycle. This 3D model is considered a model-based definition (MBD) and acts as

Model-Based Enterprise

is an integrated and collaborative environment, founded on 3D product definition shared across the enterprise, enabling rapid, seamless, and affordable deployment of products from concept to disposal. (Model Based Enterprise, 2014)

MBE 3D Drawing



Example of a model-based definition acting as the authoritative information source for all activities in the product’s lifecycle. (Model Based Enterprise, 2014)

a “digital thread¹” of sorts to weave and link all the phases of the product lifecycle together. The U.S. Department of Defense (DoD) and NIST developed a tool to help organizations assess whether they are ready for an MBE or smart manufacturing platform. The tool was named: “MBE Capability Index Assessment Tool.” As part of the summit, NIST was also interested in collecting input specific to the MBE Capability Index Assessment Tool and the consideration for developing a guidebook for the tool.

1.2. Workshop Scope and Objectives

NIST hosted the *Measurement Science for Model-Based-Enterprise Capabilities Workshop* on April 15, 2016 to better assess the MBE Capability Index and gather input for a potential guidebook. The workshop brought together experts from industry, government, and academia to identify the barriers, needs, and recommendations for developing a MBE Capability Index Assessment Tool guidebook. The purpose of the guidebook is to help an organization navigate and effectively use the MBE Assessment tool. This includes assessing MBE capabilities, interpreting assessment results, determining actions the organization could take, and outlining a minimum set of requirements to qualify as a model-based enterprise.

MBE Capability Index & Guidebook Workshop



Participants of the *Measurement Science for Model-Based-Enterprise Capabilities Workshop* (April 15, 2016) pose with the discussion storyboards.

¹ The digital thread is a concept for linking all phase of the product lifecycle together using 3D model-based definitions. In a manufacturing context, all of the machines would use the same set of digital instructions, errors would be caught automatically, ensuring the end result matches the intended design. For more information on the digital thread visit: <https://youtu.be/iGtM8VGLn5M>.

Participants of the workshop convened on NIST's Gaithersburg campus to participate in a facilitated discussion. The discussions were organized into four sessions:

- Capability Index
- MBE Capabilities Assessment
- Guidebook Needs
- Recommendations

The first two sessions primarily focused on evaluating the MBE Capability Index, itself, while the latter two sessions addressed needs and recommendations for developing a guidebook for the index. Participants were asked to write their ideas for each session on cards, which were then pinned to a storyboard at the front of the room. Similar ideas were categorized under appropriate topics to keep the discussion outcomes organized and transparent. The results of this exercise for all sessions are captured in this report.

The MBE Capability Index tool is available for free download at:

<https://github.com/usnistgov/DT4SM/tree/master/MBE-Capabilities-Assessment>

2. Review of Capabilities Index and Assessment

The workshop discussions began with a brainstorming session to get participants to think critically about the MBE Capability Index. Each participant was given an opportunity to share their ideas and engage fully in the discussion. The outcomes are summarized in the following sections.

2.1. Capability Index Suitability and Gaps

Subject-matter experts from the DoD and NIST brainstormed on focus areas prior to the workshop. The “Capability Index Suitability and Gaps” session included four guiding topic questions from the brainstorming:

1. Does the Capability Index meet your needs for measuring and assessing MBE capabilities and gaps in facilities?
2. Are the index capability goals appropriate, based on your experience?
3. Do you have suggestions for improving or revising the goals and baseline?
4. Has anyone developed their own assessment method using this index?

Suitability of Use

Discussions focused on the suitability and usability of the tool and mitigating factors such as clarity, complexity, terminology, definitions, etc. The tool was noted as suitable by the workshop participants for the following uses:

- Baseline current practices in MBE, i.e., a reference that an organization would built upon.
- Providing a consistent baseline that an organization would use to assess how capabilities have improved over a period of time.
- Starting point for focused discussions on MBE to help identify the current state of MBE in an organization.

While deemed suitable for use in some ways, and that the latest version is an improvement, a number of issues and challenges were identified. The main points that arose include the need for better defining terms; understanding, setting, and interpreting the different capability levels accurately; navigating the usability of the tool, given its complexity; and gaps in the existing framework of the tool. Table 2-2 summarizes the discussions and some useful improvements.

Table 2-1. MBE Capability Index Suitability and Gaps

MBE Levels	Definitions and Terminology	Complexity	Gaps
<ul style="list-style-type: none"> • Current index is high level, needs more detailed definitions and descriptions, explanations and interpretation • Logistics and change management aspects should be included in levels • Tool does not account for length of time required to be at a given level • Levels are helpful, but expert help is needed to understand how to get to future state • How to get to future state or next level is unclear 	<ul style="list-style-type: none"> • Specific details are lacking (too ambiguous) • Hard to describe the tool and its uses (e.g., for training staff) • Not enough detail is provided to identify gaps; more detail is required in boxes • Tool is not self-explanatory; lacks overall definitions • Product definition standard is incomplete and ambiguous • Lacks clarity – difficult to gain consensus on the outcomes 	<ul style="list-style-type: none"> • Extensive text is hard to follow • Too complex • Too complicated for a simple capability assessment • Useful, but really need SMEs to do an assessment (no experts on staff) 	<ul style="list-style-type: none"> • No option for N/A • Geared toward a specific type of company (suits large manufacturers rather than small shops/R&D companies) • Lacks assessment for product architecture (system engineering) • Does not address customized applications, like ship repair • Ability to cover multi-programs, new designs • Dynamic options, e.g., has to be a living document as technology changes
Suggested Improvements			
<ul style="list-style-type: none"> • Detailed questions to make steps clearer • Survey questions to interview people (detail lacking) • Meta model (to support well-defined relationships) • Use fewer levels to reduce complexity • Definitions, instructions, and details to make it easier to use; you have to be knowledgeable to self-assess • Explanation/interpretation for scores – score can have shock value • More graphics and data visualization – especially when incorporating supply chain aspects 			

MBE Goals

The goals discussion focused on the appropriateness of the goals as currently defined in the tool. Goals were deemed to be generally appropriate, but not customizable to individual situations. Some of the key issues and improvements identified are shown in Table 2-2.

Table 2-2. Suitability of MBE Capability Index Goals

Assessment of Performance/Economics	Customization of Goals
<ul style="list-style-type: none"> • Potential to apply goals to ROI • Use results / goals to develop ROI metrics • Goals should assess both capability and performance • Could identify business and operational drivers, and connect to goals, e.g.: <ul style="list-style-type: none"> ○ Standardizing processes ○ Aligning with value chain ○ Assessing agility and adaptability to change ○ Data reuse 	<ul style="list-style-type: none"> • Tool does not allow the assessor to tailor goals to the organization's situation • Actual goals are very industry specific and are dynamic; this could change as more companies adopt MBE • Goals should be designed to vary by supplier tier • Goals are suitable, but must be taken granularly and considered within the specific business environment • Goals currently do not capture enterprise needs or downstream re-use • Work collaboratively with key suppliers to take assessment
Suggested Improvements	
<ul style="list-style-type: none"> • Current commercially available tools cannot achieve level 6; would be good to use this to improve software • Write goals more as a capability • Goals are organization dependent, not definitive; a guide is needed for how a company should set their MBE goals • Could use another level to make comparisons between companies or facilities (although not the intended use) • Better ability for customization to specific facilities or business models 	

Current Experience with the MBE Capabilities Index

A number of organizations indicated they had used the tool and developed a methodology in their facility. Successful use cases included:

- Action Engineering – used the tool to develop an action plan for MBE; developed a tailored method
- Honeywell – used the tool in its current state; created a management level chart to convey levels and issues
- Mitutoyo America Corporation – As a supplier, used the tool in its current state
- Sandia National Laboratory - Used for design, as internal document (Concept of Operations), and to generate roadmap and baseline; added product architecture
- MBC360 LLC – Added detail and descriptions first to allow scoring by category

Cases where issues arose in use or the tool proved insufficient included:

- The U.S. Navy Shipyards – found the tool was not detailed enough, and rows would need different dimensions; this facility's environment was too radically different to utilize the tool

2.2. MBE Capabilities Index Applications

The applications discussion included the following topic questions:

1. How will you use a completed MBE assessment?
2. What knowledge do you expect to gain from a completed MBE assessment?
3. How will you apply the results of a completed assessment to help your facility achieve MBE?
4. Will you apply the results beyond internal use, for example, to customers and supply chains?

Results of the discussion are presented in the following sections.

Internal Uses for the MBE Capabilities Index

A number of useful applications were identified for the MBE Capabilities Index. In addition to bringing organizations up to MBE requirements, the tool could potentially be used to justify investments in MBE, communicate MBE considerations to management, enable organizations to measure progress toward MBE goals, and to assess the MBE capabilities of suppliers. Some improvements are needed to enable the more wide-ranging applications. Table 2-3 summarizes the highlights of discussions.

Table 2-3. Applications of MBE Capabilities Index Results

MBE Uses and Internal Application of Results	
Program Management and Communications	<ul style="list-style-type: none"> • Communicating to management on MBE actions, goals, and investment requests • Identifying, justifying, and legitimizing areas for investment • Supporting documentation for ROI for reaching next level (not currently in tool) • Educating others on what MBE is and where we need to be; educating value-stream subject matter experts and management via the assessment process • Better understanding MBE scope progression • Creation of unified vision for MBE initiatives • Build consensus of MBE goals • Inter-facility communication on all aspects of MBE • Documentation of processes, tools, common methods, media training and facility • Prioritization of tasks for MBE • Establishment of metrics for MBE and analysis of progress toward goals • Rating facility capability versus practice • Consensus and team building on MBE aspects; create impetus and understanding of need for cultural changes • Improving digital thread of big data development plan for facility
Baselining or Benchmarking	<ul style="list-style-type: none"> • As a driver and record for measuring progress • Documentation of current state • Baseline process for MBE; also as a baseline to develop ROI metrics • As a dual view of MBE assessment: bottom up – capabilities; top down – practices • More complete understanding of internal system capabilities • Framework for a benchmark used in the acquisition of a new CAD/PDM/PLM system

MBE Uses and Internal Application of Results

Roadmapping / Implementation	<ul style="list-style-type: none"> • Roadmapping - how to reach to next MBE level (i.e., reach the desired level, given the baseline or current state) <ul style="list-style-type: none"> ○ Identifying/ investigating obstacles to reaching the next level (social, technological, etc.) ○ Plan and strategy (goals and objectives) for reaching next level ○ Identifying needs, resources, and actions/next steps for MBE implementation ○ Understanding the right progression of steps • Educating decision makers on plan/steps to reach the next level
Gap Analysis	<ul style="list-style-type: none"> • Analysis of gaps between current and desired states <ul style="list-style-type: none"> ○ Facility-level ○ Enterprise-level ○ Between programs • Comparison of roadmap goals and plan for achieving goals (where gaps exist)

External Uses for MBE Capabilities Index

A few external uses were identified for the MBE Capabilities Assessment tool, primarily for the assessment of suppliers. These include:

- Supplier and partner readiness for MBE
 - Working directly with partners, going through the assessment and gaining agreement on levels and objectives
 - Using results for downstream partner alignment and assessment
 - Identifying where and how to improve the external supply chain
 - Identification of supplier capabilities during MBE pilot projects to optimize project activities
 - Benchmarking among similar manufacturers / suppliers
 - Assessing the ability of supply chain to accept 3D models
 - Supplier software selection
- Communications – providing common terminology for discussions with suppliers; data exchange could be an issue.
- Benchmarking among similar manufacturers / suppliers, or outside organizations
- Compliance with regulatory entities (e.g., UL, FAA)
- Assessment to meet sponsor date or other requirements (e.g., government)
- Sustainment, e.g., government purchase of spare parts, to sustain the product as far as possible

3. Guidance Needs and Requirements

The third session, titled “Guidance Needs and Requirements” encouraged a deep-dive to collect input for developing a guidebook for the MBE Capability Index. The facilitator introduced this session with three new guiding topic questions:

1. What kind of general guidance do you think will be most useful to you?
2. What further guidance is needed to enable effective use of the capability index?
3. Can you identify needed guidance requirements specific to Design, CM/DM Activities, Manufacturing Planning, Quality Requirements/Planning, and Enterprise Activities?

Results of the discussion are presented in the following sections.

3.1. General Guidance Needs

Additional guidance is needed to effectively implement the MBE Capability Index as an assessment tool. A number of key areas were identified where guidance would be especially valuable. These include definitions, use cases and examples of best practices, how to best implement the assessment process, explanation and interpretation of levels, and how to effectively connect the assessment to MBE investments. A key consideration is how to tailor and apply the tool to various types of organizations. Highlights of discussions in each of these areas are provided in Table 3-1Table 2-3.

Table 3-1. Suggested Inputs to the MBE Capabilities Assessment Guidebook

Guidance Needs	
General Guidance	<ul style="list-style-type: none"> • Concise and well-written • Searchable • User-friendly, understandable by non-experts, cover all levels of users • Checklist and other templates • Publish a new index (quickly, not perfect)
	<ul style="list-style-type: none"> • Rules and controls • Ease of use • Relevant information is provided • Capability to null out a line item • Acknowledge PMI levels • Work toward 80% completion of the guidebook (it need not be perfect on first go)

Guidance Needs	
Definitions/ Descriptions	<ul style="list-style-type: none"> • Definitive explanation of terms and processes • Survey to aid in answering questions • Interviews (e.g., day in the of life of a part) • Unambiguous directions / instructions for use • Well-described levels with constraints, attributes, definitions, and goals • Description of the lifecycle phases of MBE: <ul style="list-style-type: none"> ○ Assessment ○ Analysis of assessment ○ Roadmap for implementation ○ Evaluation of changes and impacts
Examples/ Use Cases	<ul style="list-style-type: none"> • Representative assessment results (but ensure this does not drive outcomes) • Best practices • Use cases • Recommended practice for each category in the tool, within the scope
Planning Guidance	<ul style="list-style-type: none"> • How to design assessment process <ul style="list-style-type: none"> ○ Scope – identify what is in/out of scope ○ Guide to help companies set individual goals, determine level appropriate to business model ○ Guide for different industry types ○ How to create architectural map with data elements, consumption framework ○ Typical stakeholder list (entire enterprise)
Next Steps, Advancing Levels	<ul style="list-style-type: none"> • Easy way to assess your baseline to incremental assessments along the way • How to proceed after gaps are identified, including prioritization of next steps • Next step guidance: steps to go from one level to another; identifying gaps, then creating milestones, project plans, tasks; how to build an actionable plan based on assessment outcomes • Examples of how to move up to the next level for each category • Guidance for selecting the appropriate future state level • Sample roadmaps and expected challenges to get from level to level (e.g., from 1.5 to 4.5 overall)

Guidance Needs	
Communication	<ul style="list-style-type: none"> • MBE communication strategy at all levels • How to convince executives, employees, partners, software vendors that MBE is worthwhile investment
Interactive Guidance	<ul style="list-style-type: none"> • Robust messaging for MBE • Consensus building amongst designers and implementers of intentions and use of tool
Trainings/ Information Exchange	<ul style="list-style-type: none"> • Describes technologies that help with implementation • Structure tool and guidebook similar to TurboTax® – have a structured “interview” guide to lead companies through the tool and answer questions
Resources	<ul style="list-style-type: none"> • Dynamic and interactive document • Incorporate web links, 3D PDFs • Use WiKi – identify pages that need work (could be crowd-sourced) • Live interactions – WiKi type forum • Identify potential technical issues for software vendors, e.g., data conversion of semantic PMI
Resources	<ul style="list-style-type: none"> • Training on how to use the guidebook; certified MBE guidebook instructors • Contact information for questions (and a mechanism for such assistance)
Resources	<ul style="list-style-type: none"> • Help in identifying the appropriate and qualified facilitators or experts • Workshops among different disciplines to share needs, concerns, understand big picture
Resources	<ul style="list-style-type: none"> • List of references (standards) that the guidebook is referring • How standards can be applied to help with advancing MBE capabilities
Resources	<ul style="list-style-type: none"> • Industry references, such as MBE, PLM, etc. • Cyber-physical security

3.2. Guidance Needs Specific to Design, Engineering, and Planning

A number of guidance requirements specific to Design, Change Management (CM) and Data Management (DM) Activities, Manufacturing Planning, Quality Requirements and Planning, and Enterprise Activities were identified. These results can be seen in Table 3-2, organized by function.

Table 3-2. MBE Guidebook Needs for Design, Engineering, and Planning

Manufacturing Planning	Quality Requirements / Planning	Enterprise Activities	CM / DM Activities	Design Guidance
<ul style="list-style-type: none"> • Manufacturing and Quality – share in detail how to design models to be machine-interpretable • Incorporate new technology, e.g., additive manufacturing, into manufacturing design • Revision and change control guidance • Synchronization of data • Tracking and progressing toward levels • Dependency mapping between areas 	<ul style="list-style-type: none"> • Conducting quality requirements planning concurrently with design and manufacturing in a virtual MBE environment • Ways to computer-enable reading and generating the quality BoC 	<ul style="list-style-type: none"> • Matching products to characteristics • How to communicate information back to management dashboards/ maps • Product field LoTAR surveillance to meet regulations (how to incorporate information in a MBE) • Feedback on as is, as used, end of life, etc. 	<ul style="list-style-type: none"> • Needs to be more granular; more detail for this category • How to assess changes, conduct impact studies • Change control aspects 	<ul style="list-style-type: none"> • Convey design intent for downstream consumption “break down the brick wall” • Working MBE into product architecture • Levels of PMI that are more expressive

4. Recommendations

The guiding question for this session focused on pulling a final set of recommendations for developing an effective guidebook:

1. What overall recommendations do you have for developing a useful, effective Guidebook for assessment of MBE capabilities?

Recommendations were generated in two basic categories: 1) overall governance, format, and outreach for the guidebook, and 2) guidebook content. These are described in the following sections.

4.1. Recommendations for Governance, Format, and Outreach

Five overall recommendations were identified, as shown in Tables 4.1 – 4.5. These illustrate the importance of collaboration among stakeholders in developing the guidebook; the need for oversight and governance in general; and the need for improvements to create an effective, customizable, and usable MBE Capabilities Assessment tool.

Table 4-1. MBE Guidebook Recommendation #1

Recommendation #1: Develop a collaborative website connected to a core information center and subject matter experts.		
Platform Ideas	General Guidance	Strategy
<ul style="list-style-type: none"> • Wiki • Google docs 	<ul style="list-style-type: none"> • Must be connected to core information center and/or subject matter experts • Snapshot in time of issues / solutions • Public-facing • Develops rules for consensus • Must be encrypted • Requires some control/standards • Public / expert opinion carries weight 	<ul style="list-style-type: none"> • Individual working group for each category • Editable documents on the site by working group members • Declare successes by letting community modify it

Table 4-2. MBE Guidebook Recommendation #2

Recommendation #2: Organize a discussion working group with governance.	
Structure	Process for Consensus
<ul style="list-style-type: none"> • Public forum with rules on final consensus/ censorship • Moderated group who says yes/no • Governing Board provides weight to opinions • Includes 4-5 basic concepts • Self-sustaining (at some point) 	<ul style="list-style-type: none"> • Define metric for consensus (e.g., 1,000 people?) • Popular vote-based (not rigorous consensus) • Send to Governing Board for final decision • Make sure no conflicts are present

Table 4-3. MBE Guidebook Recommendation #3

Recommendation #3: Develop guidebook with inputs from original developers, using an interactive TurboTax®-like format.	
Structure	Resources
<ul style="list-style-type: none"> • In the public domain • Build guidebook similar to TurboTax® user interface and guidance • Include apps • NIST to develop governance policy • NIST to give weight for adoption • Initial draft in one year 	<ul style="list-style-type: none"> • Information from original developers • Input from more SMEs (e.g., quality) – plus core SMEs for each domain • Supplement with working groups • Aggressively pursue information • Find a champion/shepherd • Elevate to authoritative document

Table 4-4. MBE Guidebook Recommendation #4

Recommendation #4: Establish an oversight entity.
Structure
<ul style="list-style-type: none"> • Formalize structure/ground rules for contributing content and adjudicating • Develop a roadmap for the guidebook • Create a release schedule, as well as an update and maintenance schedule • Avoid analysis paralysis – work toward “a minimally viable product”

Table 4-5. MBE Guidebook Recommendation #5

Recommendation #5: Develop a multi-media communications and outreach plan.
Outreach Methods
<ul style="list-style-type: none"> • Connect/raise awareness at conferences, trade shows, through professional societies, and via web presence • YouTube™ videos • Interviews with industry • Manufacturing minute podcast • Messaging in all media • Broadly disseminated • MBE collaborative website (needs a sponsor)

4.2. Recommendations for Guidebook Content

Table 4-6 summarizes the recommendations that relate to guidebook content. These combine many of the ideas expressed throughout the prior working sessions, but are not all-inclusive.

Table 4-6. Additional MBE Guidebook Recommendations from Previous Sessions

Recommendation	Details
1. More detail and better definition of requirements	<ul style="list-style-type: none"> Better define requirements, terms, and levels in the tool
2. Leverage examples, case studies and infographics	<ul style="list-style-type: none"> Best practice examples Recommended practice for each category in the tool Use case templates for differing downstream uses
3. Simplify Index	<ul style="list-style-type: none"> Recommend using fewer levels in the tool
4. Guidance to tailor tool to different types of organizations	<ul style="list-style-type: none"> Have guide to help company set individual goals Guidance for determining the appropriate level for a given business model
5. Instructions for next steps and interpreting results	<ul style="list-style-type: none"> How to interpret the results and build an actionable plan from the assessment
6. Communications guide	<ul style="list-style-type: none"> Include MBE community strategy at all levels e.g., management, staff, etc.
7. Guide should include additional resources - references and standards	<ul style="list-style-type: none"> List of references How standards can be applied to help advancing MBE capabilities
8. Well defined meta model with well-defined relationships	<ul style="list-style-type: none"> Well-described level with constraints attributes, definitions, goals, etc. Meta model XMI

5. Appendices

This publication is available free of charge from: <http://dx.doi.org/10.6028/NIST.AMS.100-1>

A. Workshop Agenda

MBE Summit MBE Capability Index & Guidebook Workshop NIST, Gaithersburg, MD

Friday, April 15, 2016

Time	Topic	Speaker(s)
0830-0840	Welcome and Overview	Allison Barnard Feeney and Tom Hedberg, NIST
Facilitated Sessions		
0840-0940	Capability Index <ul style="list-style-type: none"> • Does the Capability Index meet your needs for measuring and assessing MBE capabilities and gaps in facilities? • Are the index capability goals appropriate, based on your experience? Do you have suggestions for improving or revising the goals and baseline? • Has anyone developed their own assessment method using this index? • What further guidance is needed to enable effective use of the capability index? 	Joan Pellegrino and Yannick Tamm, Energetics Incorporated (Facilitators)
0940-1040	MBE Capabilities Assessment <ul style="list-style-type: none"> • How would you define/describe what an assessment is? • How will you use a completed MBE assessment? • What knowledge do you expect to gain from a completed MBE assessment? • How will you apply the results of a completed assessment to help your facility achieve MBE? • Will you apply the results beyond internal use, for example, to customers and supply chains? 	
1040 1050	Break	
1050-1150	Guidebook Needs <ul style="list-style-type: none"> • What kind of general guidance do you think will be most useful to you? • Can you identify needed guidance requirements specific to Design, CM/DM Activities, Manufacturing Planning, Quality Requirements/Planning, and Enterprise Activities? 	
1150-1220	Recommendations <ul style="list-style-type: none"> • What overall recommendations do you have for developing a useful, effective Guidebook for assessment of MBE capabilities? 	
1220-1230	Next Steps and Adjourn	

B. Participant List

Name	Affiliation
Allison Barnard Feeney	NIST
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Rick Eckenrode	RECON Services
Katie Farris	Newport News Shipbuilding
Lyle Fischer	CAPVIDIA
Denise Fitzgerald	MIT Lincoln Laboratory
Bob Goosen	Purdue MEP
Andrew Hall	Rolls Royce
Greg Harris	U.S. Army/DMDII
Thomas Hedberg	NIST
Don Hemmelgarn	ITI
Jennifer Herron	Action Engineering
Anthony Holden	U.S. Army
Paul Huang	NIST/ONR
Hui-Min Huang	NIST
Lorenzo Landin	Boeing
Ben Kassel	U.S. Navy
Kong Ma	Rolls Royce
Larry Maggiano	Mitutoyo America
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Ram Pentakota	Johnson Controls
Gene Peppe	Naval Air Warfare Center
Jason Presler	Rockwell Collins
Michael Shaw	Rolls Royce Corp.
Atsuto Soma	Elysium Co. Ltd.
Genevieve Teel	U.S. Army/IRTC
Phil Teuscher	NAWC WD China Lake
Denise Welch	Honeywell FM&T
Mike Werkheiser	PRATT & Whitney
Roy Whittenburg	MBD360
Brent Woodhouse	Newport News Shipbuilding

C. Acronyms

Acronym	Definition
3D	Three Dimensional
BoC	Bill of Characteristics
CAD	Computer-Aided Design
CAO	Conception Assistée par Ordinateur (French: Computer-Aided Design)
CM	Change Management
COP	Conference of Parties
DM	Data Management
DoD	Department of Defense
FAA	Federal Aviation Administration
LoTAR	Long-term archival and retrieval
MBD	Model-Based Definition
MBE	Model-Based Enterprise
NIST	National Institute of Standards and Technology
OMG	Object Management Group
PDF	Portable Document Format
PDM	Product Data Management
PLM	Product Lifecycle Management
PMI	Product and Manufacturing Information
QIF	Quality Information Framework
R&D	Research and Development
ROI	Return on Investment
SME	Subject Matter Expert
SysML	Systems Modeling Language
UL	Underwriters Laboratories
Wiki	A website that allows collaborative editing
XMI	XML Metadata Interchange

D. References

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