

The Journey towards Model Based Engineering

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INCOSE President



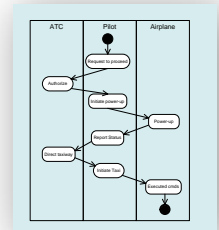
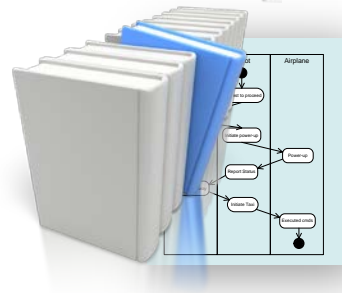
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Presentation Structure

- Our Journey
- INCOSE SE Vision 2025
- Where we are now
- How to get there?

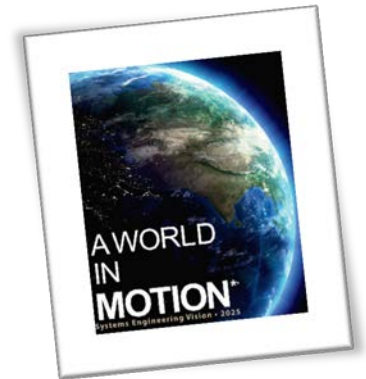
How do we get there?



Origins of SE

Emergence of MBSE

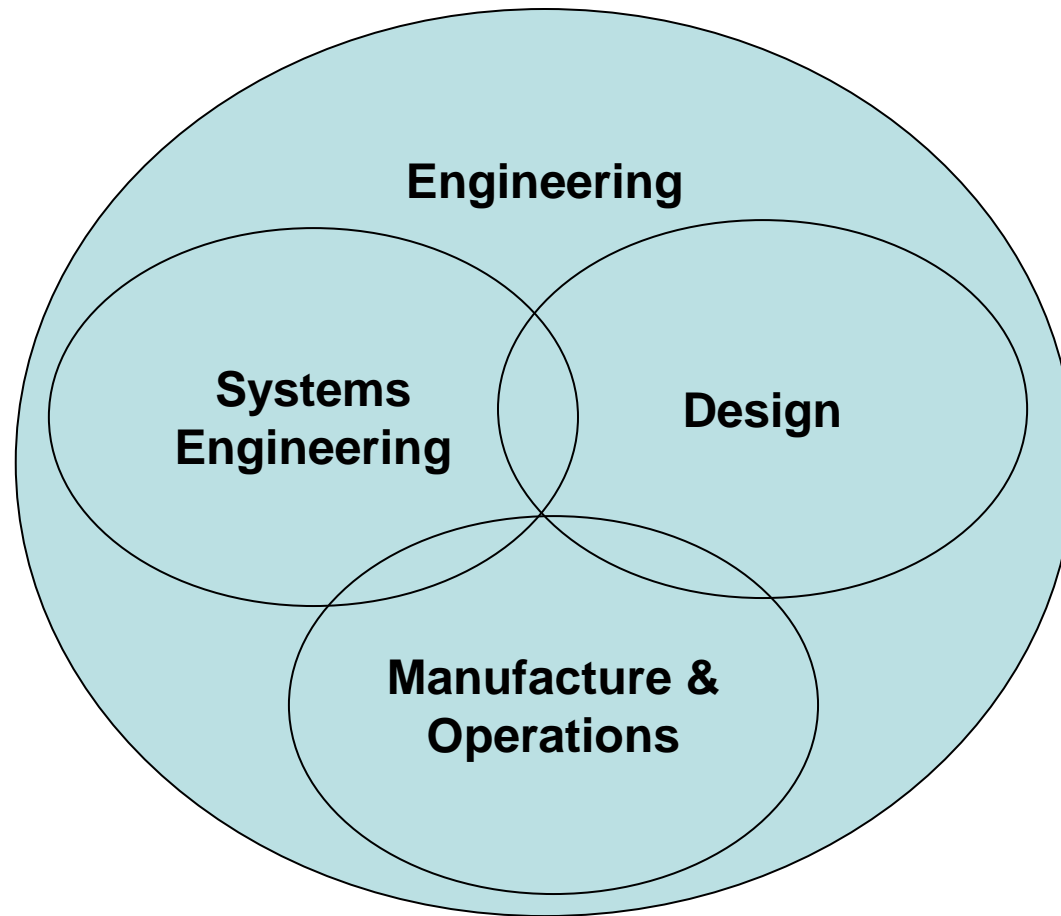
Now



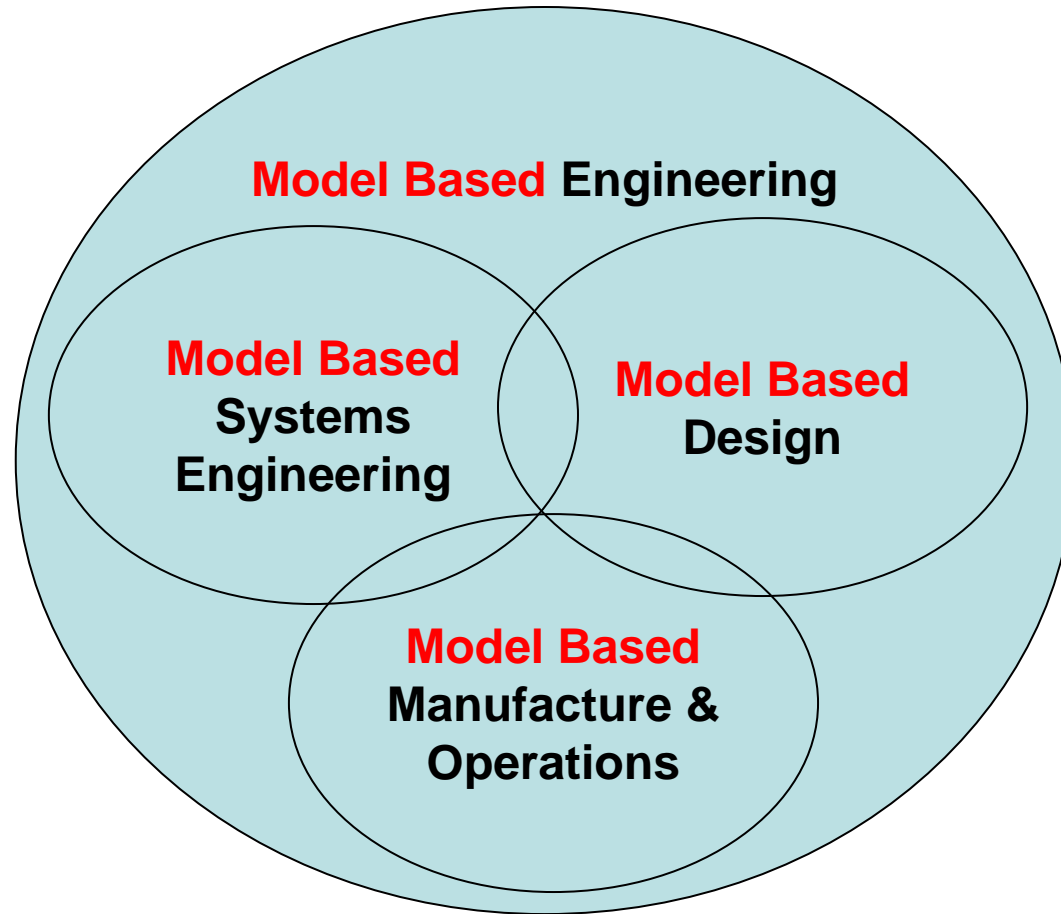
Tomorrow's SE

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SE and Engineering



SE and Engineering

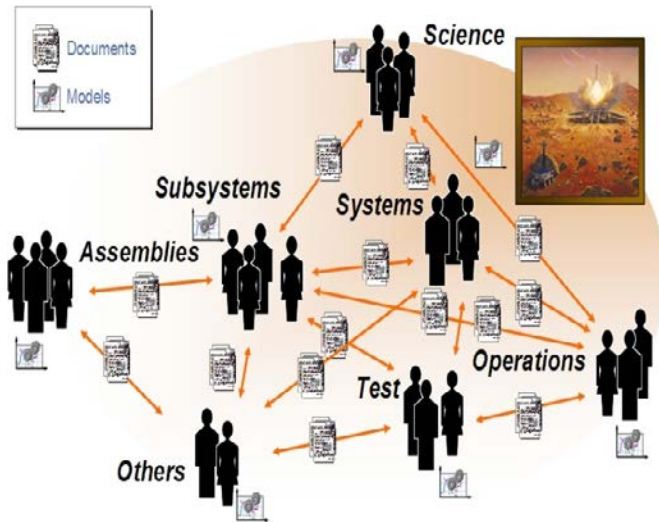


Definitions

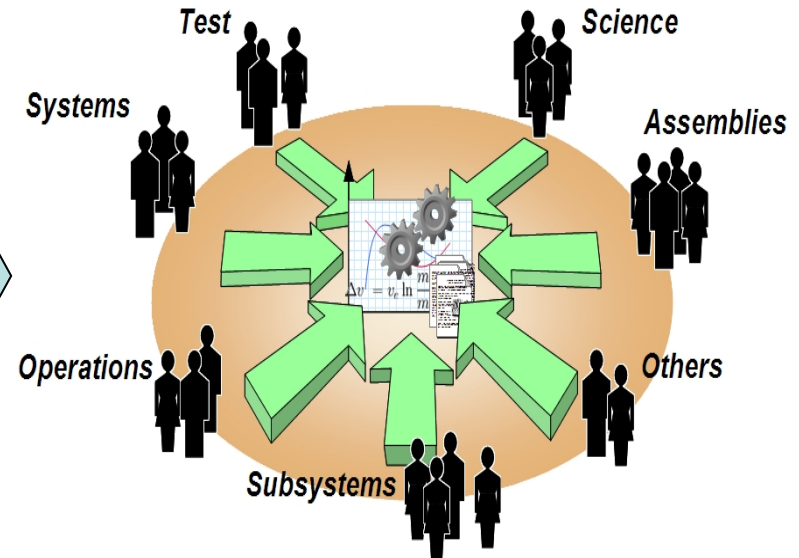
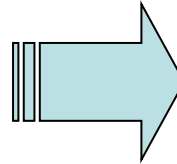
Model-Based Engineering (MBE): An approach to engineering that *uses models as an integral part of the technical baseline* that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle.

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.

Model Based Systems Engineering

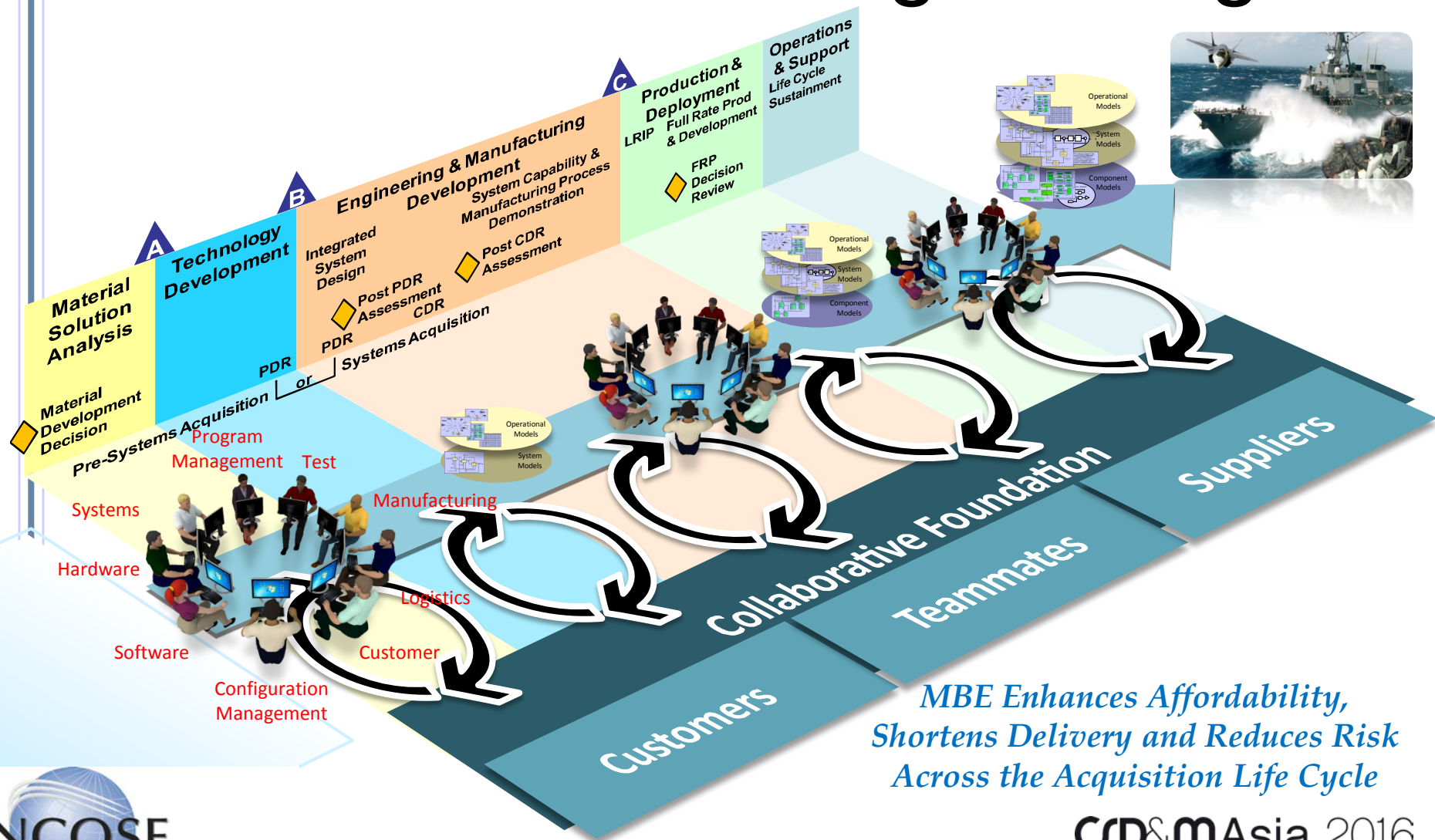


Today: Standalone models related through documents



Future: Shared system model with multiple views, and connected to discipline models

Model Based Engineering



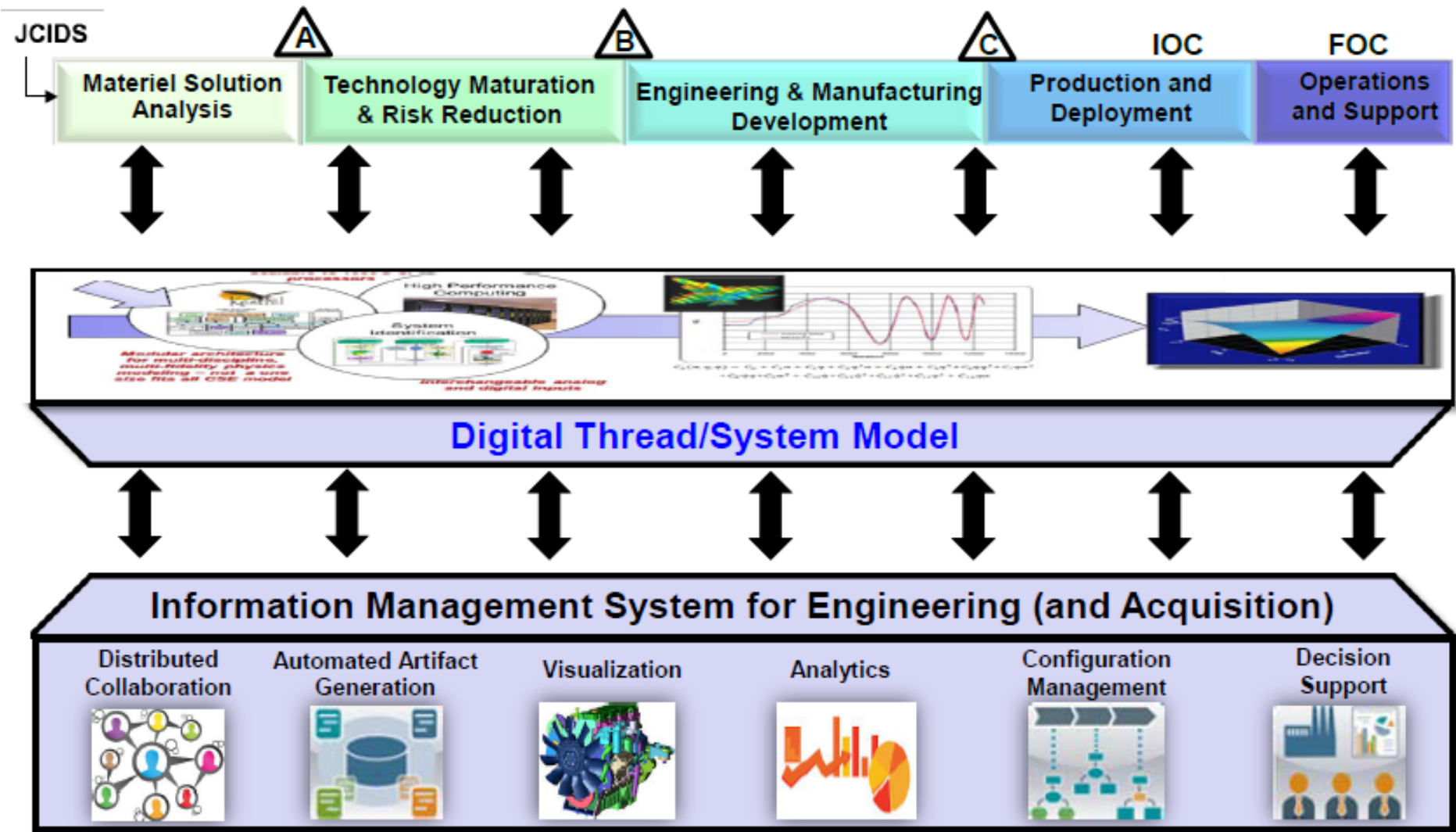
*MBE Enhances Affordability,
 Shortens Delivery and Reduces Risk
 Across the Acquisition Life Cycle*



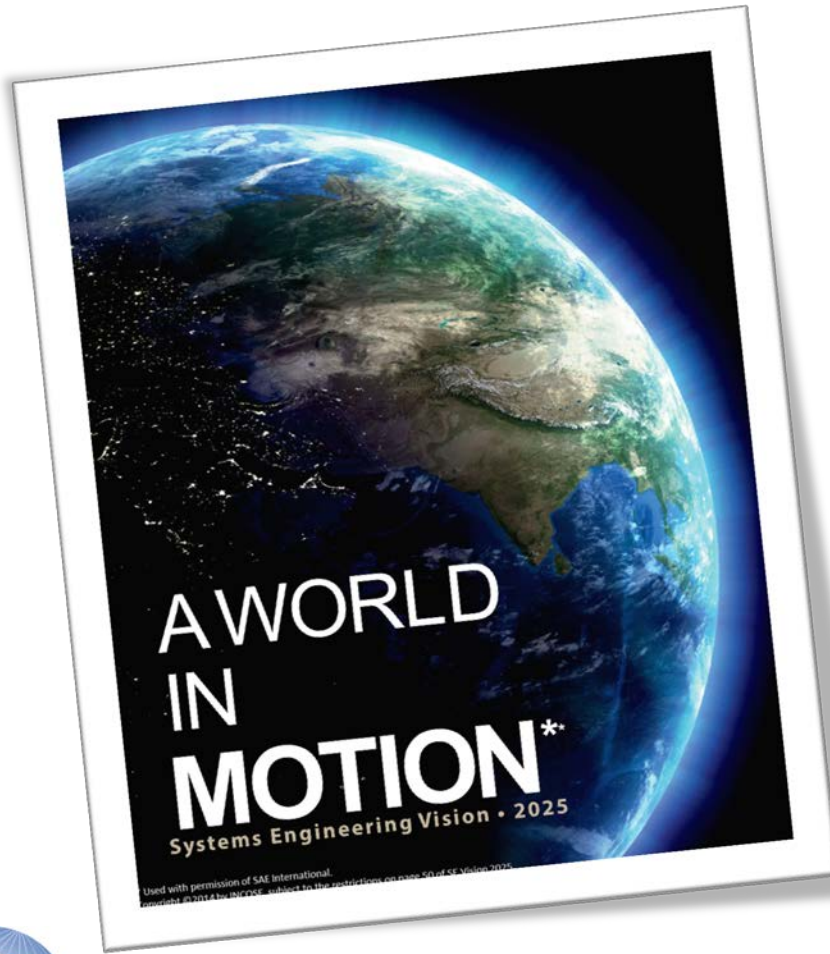
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US Air Force Digital Thread Concept



INCOSE SE Vision 2025



- Recognises the challenges for SE
- Future of SE must be model-based to address the challenges
- MBSE is a key enabler for MBE

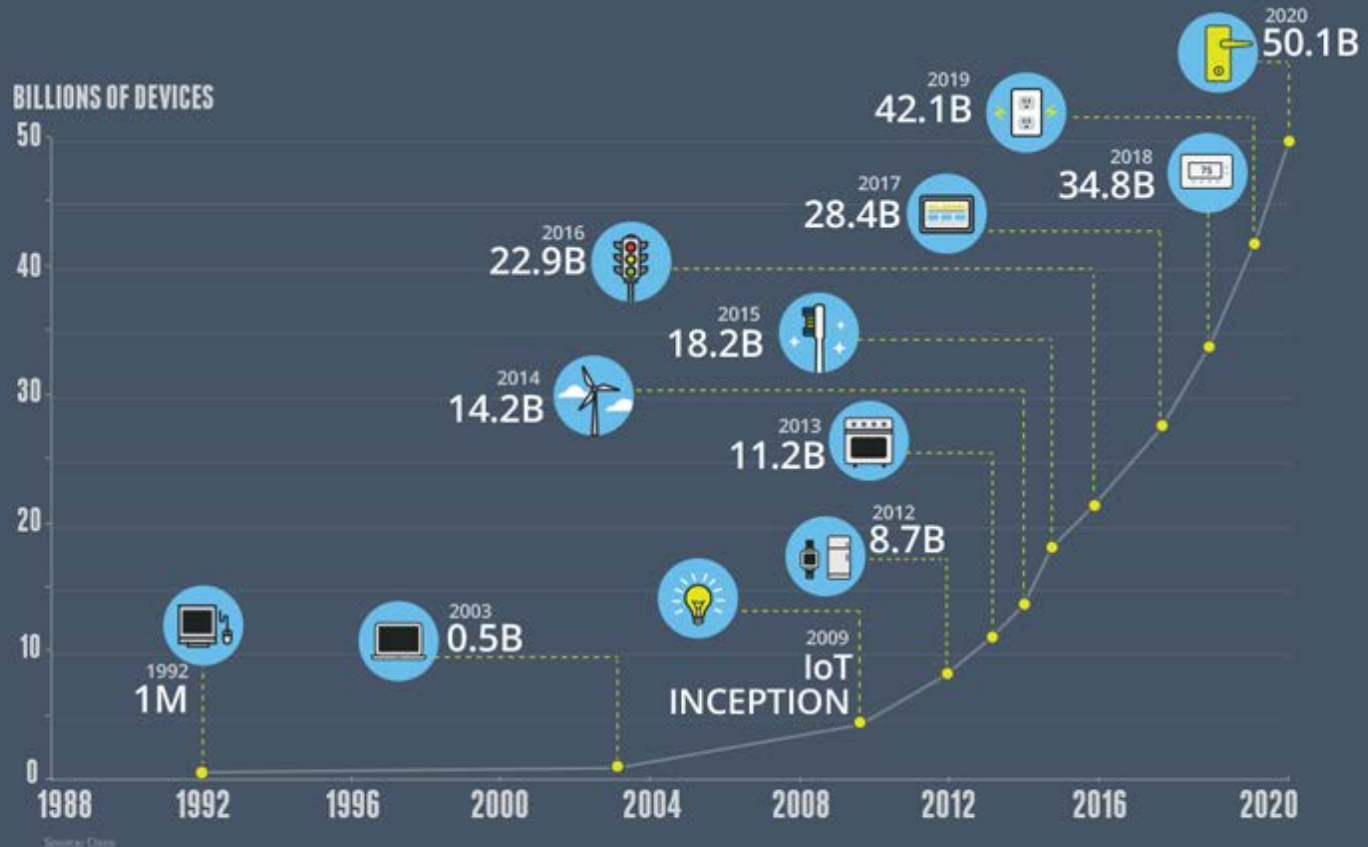
Today's Global Challenges

- Food and Shelter
- Clean water
- Health environment
- Access to healthcare
- Transportation and mobility
- Economic security & equity
- Security and safety
- Access to info, communications, education



GROWTH IN THE INTERNET OF THINGS

THE NUMBER OF CONNECTED DEVICES WILL EXCEED **50 BILLION** BY 2020

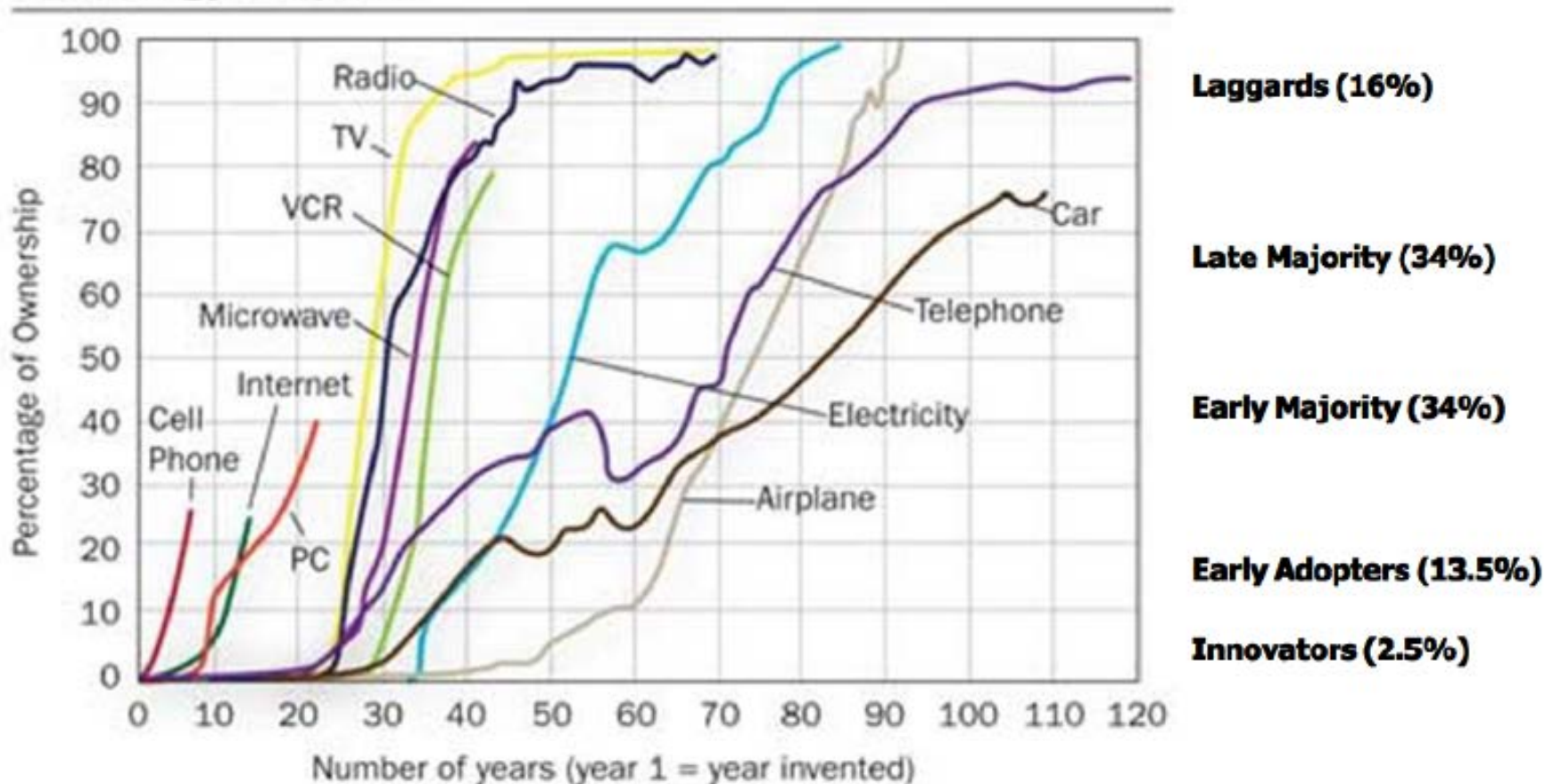


SE in the future will be

- Relevant to a broad range of application domains
- Applied more widely to support policy decisions
- Comprehensively integrating stakeholder demands
- Support collaboration across organizational, regional and discipline boundaries
- Education stresses systems thinking and analysis
- Practiced by a growing cadre of professionals with technical acumen and mastery of tools and methods
- Supported by more encompassing foundation of theory and **sophisticated model-based methods and tools allowing understanding of increasingly complex systems and decisions in the face of uncertainty**

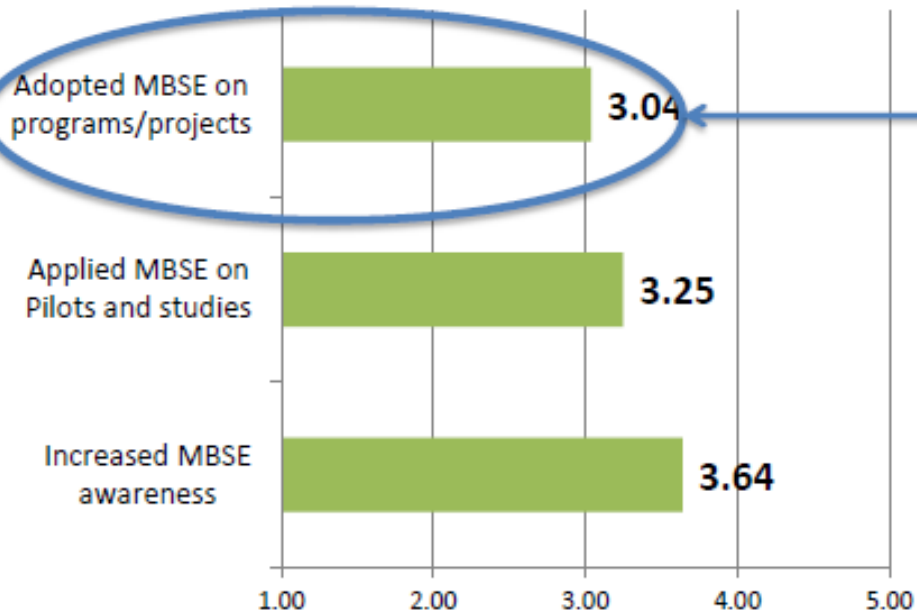
**Systems Engineering, and MBSE, are somewhere
On their way up their own technology adoption curve**

Technology Adoption



Source: Forbes Magazine

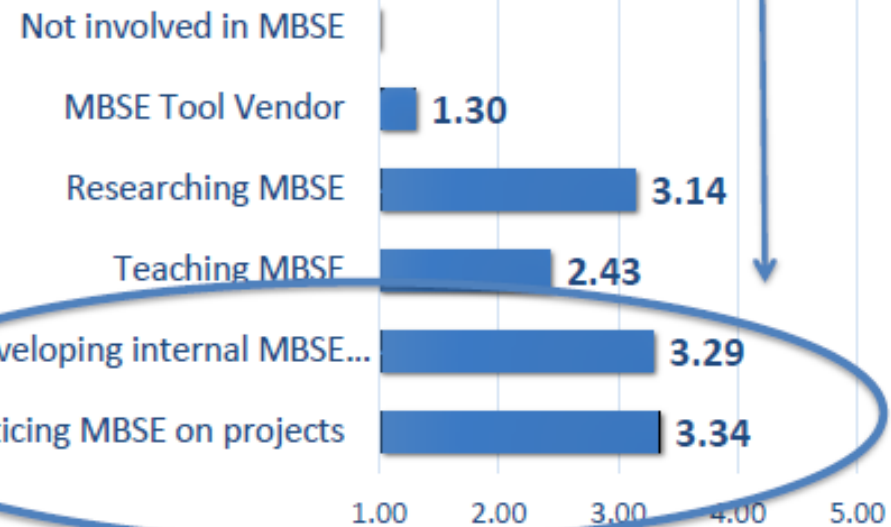
2013 To what extent in the last 3 years has your company/organization:



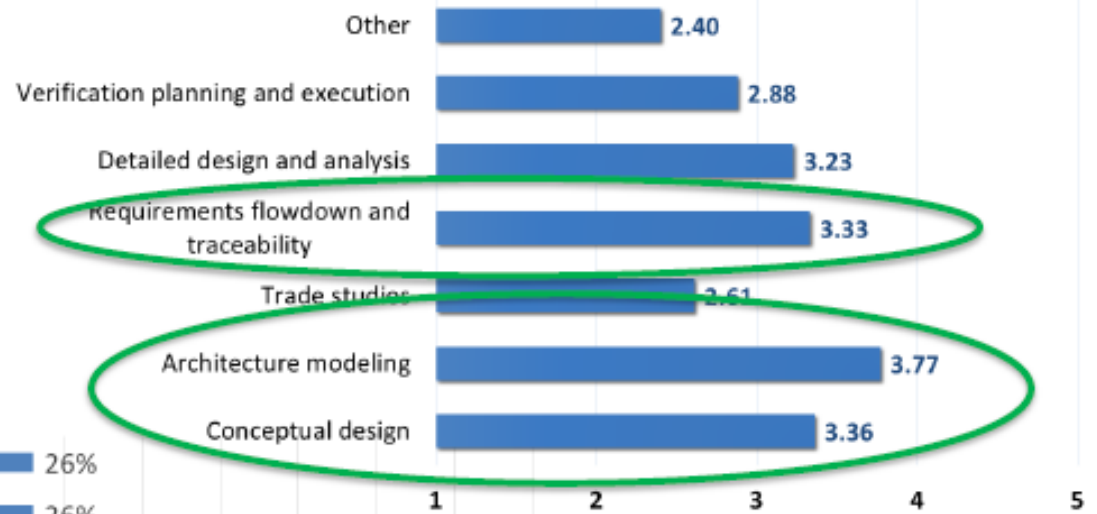
We see that since the last survey, there is an increase in the number of companies practicing MBSE & Developing internal MBSE methods, tools, and training.

2014 Survey

To what extent have you participated in MBSE activities during the last 5 years?

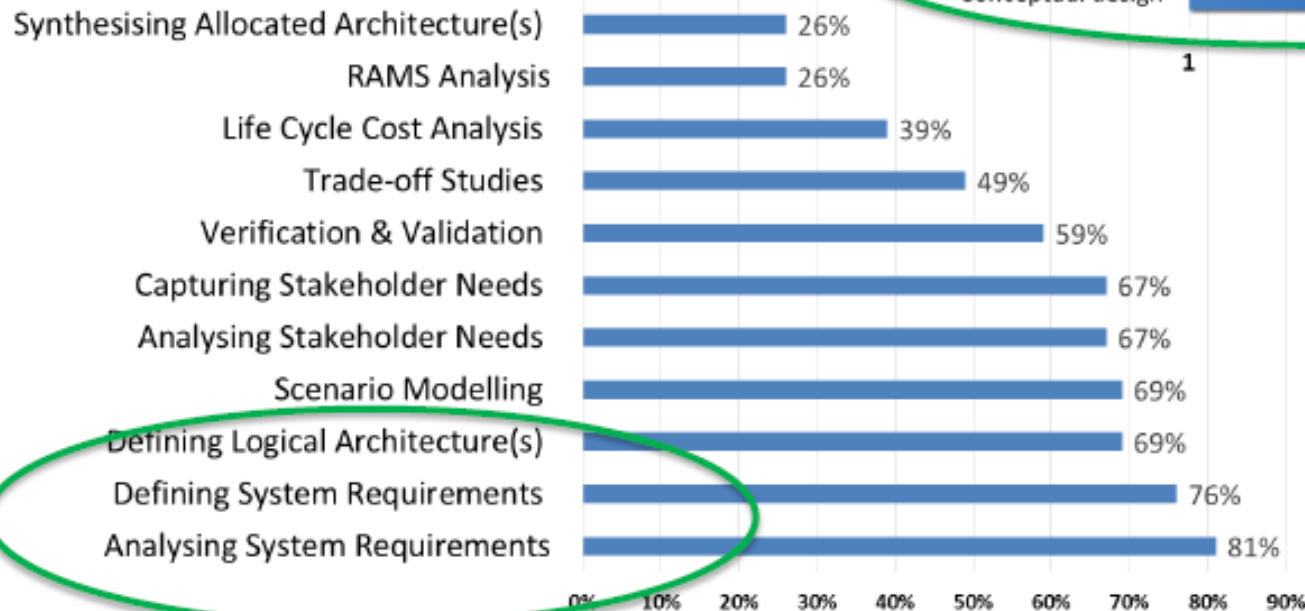


What is the relative focus of the MBSE effort in your organization to support each of the following?



INCOSE UK MBSE 'State of the Nation'*

Q2.4 - In which SE activities do you use modelling?



- The top 5 barriers have not changed much

Cultural and general resistance to change

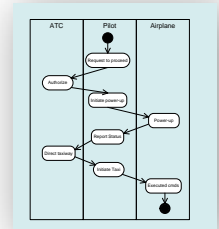
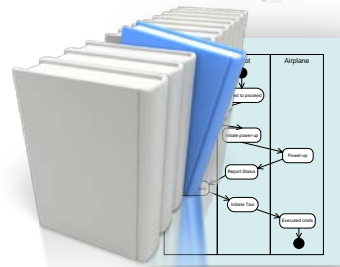
MBSE Learning curve

Availability of Skills

Lack of Perceived value

Lack of management support

Where are we now?



Origins of SE

Emergence of MBSE

Now



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So are we on this journey?

- “Transition to MBE started many years ago with introduction of Computer Aided Design tools”
- “Usage of models that depict systems physical behaviour using mathematical equations is quite mature”
- “We are seeing people adopting more MBSE techniques and this is not because of any fad, but because it is necessary”
- “MBE has become a focus, putting engineering back into SE which had become too process orient and based on SME input”
- “MBSE mostly limited to up-front SE but little follow through to the rest of the system life cycle”
- “There are real barriers in terms of the IT infrastructure and the expense of the software required”

Key Progress and indicators

- “Over five years ago, the argument was whether we should model or not. This argument has now been won. The challenge now is how do we model effectively and efficiently?”
- “The increasing use of ontologies, frameworks and processes that are enabled by MBSE in industry.”
- “The progress in the MBE is evident if one looks at the specialized and validated tools in many area”

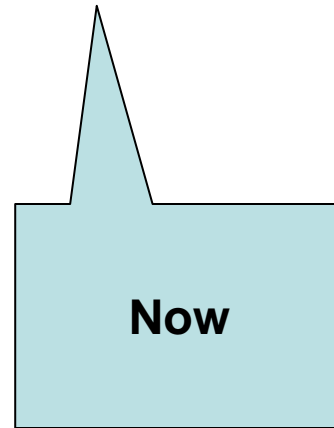
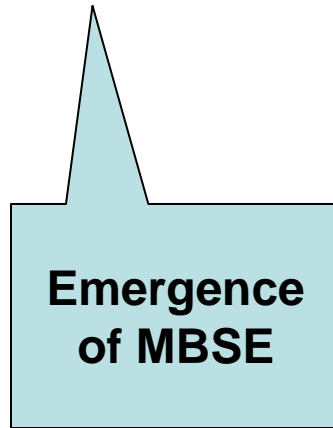
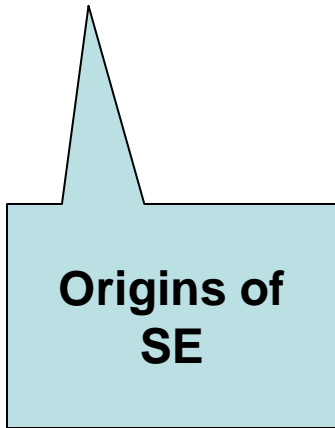
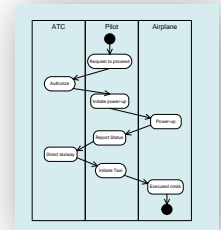
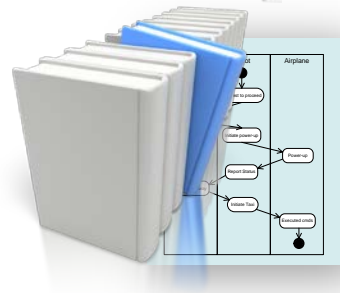
Blockers we still face

- Cultural and General Resistance to change
 - “Cultural resistance”
- Investment
 - “Required investment and effort to actually change the way of working”
- MBSE learning curve
 - “Training and where necessary education of current workforce”
 - “Lack of effective tools and skills to use them”
- Availability of skills
 - “Lack of sufficiently educated staff”
 - “Model outputs (e.g.SysML) are unreadable to non-specialists”
- Lack of perceived value
 - “Up-front investment needed where benefits are seen as medium-term”

Primary Gaps That Must Be Closed

- **Policy**
 - Policy / contracting mechanisms
 - Business model(s) that incentivize MBE adoption
- **Processes/Methods**
 - Currently, models (other than CAD) are not part of the Technical Baseline
 - Model / data/ tools management (GOTS and COTS)
 - Information management
 - Model-based methods
- **Tools/Technologies/Standards**
 - Domain specific language and data standards
 - Formal semantics
 - Data rights protection in an open architecture environment
 - Model interconnect and interchange
- **People**
 - Workforce gaps across stakeholder communities
 - Acceptance of the use of models as a business practice
 - Model validation and confidence (reputation management; evidence based credibility)
- **Infrastructure/Environment**
 - Easy access to models / content developed by others
 - Lack of common, shared Operational Scenarios
- **The Business Case for MBE**

How do we get there?



Tomorrow's SE

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EVOLVING THE VISION THROUGH COLLABORATION



ASSESSING
THE CURRENT
STATE

DEVELOPING
DETAILED
ROADMAPS

EXECUTING
FOR
ACHIEVEMENT

- Forseen by INCOSE SE Vision
- Marathon not sprint
- Grows the “pull” for MBE as well as the capability “push”
- Must be done in collaboration with industry, government and academia leads
- Informs INCOSE priorities and plans

Thank-you

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