Model-Based Systems Engineering Deployment: Best Practices

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Typical Approach for Adopting MBSE Idea

1. **Believe**

2. **Management**

3. **Team of Engineers**

(bottom-up approach)
Towards Vision Transparency

- How long does it take?
- Is it worth the investment?
- What are the main phases?
- Who should take the lead?
- What are possible risks?
- What parties are involved?
- What are typical showstoppers?
- How many people are involved?
- Wait! What is MBSE?!
- How much work effort does it require in overall?
Typical Process and Parties Involved

Center of Competence

Believe
Understand
Build Proof of Concept (PoC)
Run Pilot
Institutionalize

Management
Experts
Regular employees
Center of Competence (CoC)

- The best chance for organizational transformation to succeed is when it is driven by leaders from within the organization

- CoC includes representatives of all the roles (Requirements Engineer, System Architect, Software Architect, Quality Engineer) that will be affected by adoption of MBSE

- When building proof of concept, CoC members are taken out of their routine activities

- When running the pilot project and institutionalizing, CoC train other company members, coach them, provide models reviews/audits, etc. of MBSE
Deliverables and Showstoppers

- **Believe**
  - Management commitment
  - MBSE CoC
  - SysML literacy

- **Understand**
  - Tool choice
  - Tool customizations
  - Methodology choice (reference model, modeling guidelines)

- **Build PoC**
  - Employee acceptance
  - Methodology evolution

- **Run Pilot**
  - SE = MBSE

- **Institutionalize**
  - Resistance to cultural change
  - Actual value is not proved

- No management commitment
- Underestimated scope
- Value is not proved

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Duration and Costs

- Believe: ~1 month
- Understand: ~3 months
- Build PoC: ~12 months
- Run Pilot: 6-18 months

Numbers may vary depending on many factors.
Modeling solution is a combination of a modeling language(s), a methodology and a modeling tool that together provide a productive infrastructure for applying model-driven development in the context of a particular organization.
### OMG Unified Architecture Framework

<table>
<thead>
<tr>
<th>Taxonomy</th>
<th>Structure</th>
<th>Connectivity</th>
<th>Processes</th>
<th>States</th>
<th>Interaction Scenarios</th>
<th>Information</th>
<th>Parameters</th>
<th>Constraints</th>
<th>Roadmap</th>
<th>Traceability</th>
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<tbody>
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<td>Metadata Processes Md-Pr</td>
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<td>Service States Sv-St</td>
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<td>Project Constraints Pj-Ct</td>
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<td>Actual Parameters Ar-Pm</td>
<td>Parametric Execution/Evaluation</td>
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### Simplified Framework for Systems Modeling

<table>
<thead>
<tr>
<th>Layer of Abstraction</th>
<th>Pillar</th>
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<tbody>
<tr>
<td>Concept</td>
<td>Requirements</td>
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<tr>
<td>C1 Stakeholder Needs</td>
<td>C2 Use Cases</td>
</tr>
<tr>
<td>Problem</td>
<td>P1 System Requirements</td>
</tr>
<tr>
<td>Solution</td>
<td>S1 Component Requirements</td>
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Success Story: MBSE Deployment at BOMBARDIER TRANSPORTATION
System Engineering Challenges & Goals
With respect to technology

- Reduce development costs while increasing quality of the design artefacts.

<table>
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<th>Challenge</th>
<th>Goal</th>
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<td>Complex products</td>
<td>Manage complexity</td>
</tr>
<tr>
<td>Distributed information sources</td>
<td>Share centralized information</td>
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<tr>
<td>Opportunistic, isolated reuse (copy past)</td>
<td>Managed, integrated reuse of development artifacts</td>
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System Engineering Challenges & Goals
With respect to people

- Reduce development costs while increasing quality of the design artefacts.

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<td>Distributed development</td>
<td>Enable collaboration</td>
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<tr>
<td>Multicultural teams</td>
<td>Improve correct understanding</td>
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MBSE at Bombardier Transportation

BT System Modeling Method at a glance

The BT System Modeling Method describes how BT engineers shall analyze, define and represent their system of interest using a Model-Based Systems Engineering approach. The purpose of the method is to manage complexity and increase quality of the design artefacts to reduce development costs.

The BT System Modeling Method consists of three main tasks. Each of them to analyze the system of interest on a different abstraction level.

**Operational Analysis**
- **OA - main deliverables**
  1. Context & scope
  2. Interactions between SOI\(^1\) and actors
  3. SOI use cases including their detailed behavior

**Functional Analysis**
- **FA - main deliverables**
  1. Functional architecture
  2. System of interest decomposition
  3. Allocation of Functional Blocks to the SOI’s parts

**Technical Analysis**
- **TA - main deliverables**
  1. Technical breakdown structure
  2. Technical architecture
  3. Allocation of functional blocks to technical blocks

\(^1\) SOI is the system of interest
MBSE at Bombardier Transportation
Integrated Tool Chain

- Linking hazard trees to requirements in doors and synchronizing safety information with Datalink Manager
- Requirements in DOORS
- Linking and synchronizing requirements from DOORS into MagicDraw in Cameo DataHub
- Hazard Analysis in Reliability Workbench
- System Modeling in MagicDraw
- Automatic document generation in MagicDraw
MBSE Lessons Learned

- Provide practice oriented methods
- Think big but start small
- Provide suitable tools to do the job
- Provide trainings, coaching and guidelines
Innovation drives success!

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This illustration is inspired by and in part derived from the work by Scott Simmerman, “The Square Wheels Guy” http://www.performancemanagementcompany.com/