How to Build a Sustainable Modeling Culture

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Contents

I. Why Sustainable Modeling Culture is Key to MBSE success

II. Important Pitfalls to Avoid when Adopting MBSE

III. Recipes for Building a Sustainable Modeling Culture
MBSE is about driving systems engineering by modeling & models
Getting Value from Models and Modeling

- Manage Complexity
- Preserve knowledge
- Reuse
- Automate

Picture ≠ MODEL
Manage Complexity

10000 tons of steel and glass
20000 actuators, 1000 mirrors
50000 I/O points

http://mbse.gfse.de/extdocs/ape.html
A journey to MBSE is long (but rewarding), and you need a Sherpa!
Meet No Magic

Allen, TX, USA
Bangkok, Thailand

Domains and Products

- Systems engineering
- Software engineering
- Business process modeling
- Defense enterprise architecture

- 4000+ trainings
- 1,000,000+ installations
- 10,000 companies in 90 countries
Successfully adopted MBSE

Some facts about the project:

✓ 4 years
✓ 1 project
✓ 13% savings in time

Most experience is generic and does not depend on a particular modeling domain
Modeling Culture is a combination of a modeling, a model usage and a model governance that together provide a productive way for applying model-driven development in the context of a particular organization.
High Value from Modeling and Models
How to Build a Sustainable Modeling Culture

I. Why Sustainable Modeling Culture is Key to MBSE success

II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-patterns
B. Model Usage Anti-patterns
C. Model Governance Anti-patterns

III. Recipes for Building a Sustainable Modeling Culture
Why this Topic?

Fools Don’t Learn from Their Mistakes

Clever Ones Learn from Their Mistakes

Wise Ones Learn from Mistakes by Others
What Sometimes Happens in Modeling Practice

~450 Actions
~950 Control Flows

Some facts about the project:

- Model-driven development
- 50 engineers working 4 years
- 2000+ diagrams
- 30 modules
II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns
   1. Misuse of language concepts
   2. Abstraction level
   3. Too complex diagrams
   4. No reuse of model elements

B. Model Usage Anti-Patterns

C. Model Governance Anti-Patterns
Anti-Pattern #1: Misuse of language Concepts
Issues

✓ Inconsistency in modeling conventions
✓ Ambiguous understanding
✓ Redundant stereotyping
Best Practice #1

✓ Apply concise modeling method based on modeling language subset
Anti-Pattern #1: Misuse of language Concepts

Diagram:
- Student
- View Student Profile
- Take Test

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Anti-Pattern #1: Misuse of language Concepts

Student

- Select Test
- Start Test Assessment
- Answer the Question
- Take a Break
- Restart Test Assessment
- End Test Assessment

MagicTest

- Give Instructions
- Show Question
- Register the Answer
- Show Evaluation Results
- [timeout] [last question]
- [time left] [more questions]
- [break]
- [no break]

The Truth is in the Models®

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How to Build a Sustainable Modeling Culture

II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns

1. Misuse of language concepts
2. Abstraction level
3. Too complex diagrams
4. No reuse of model elements

B. Model Usage Anti-Patterns

C. Model Governance Anti-Patterns
Anti-Pattern #2: Abstraction Level
Issues

✓ Duplicating information available in code

✓ Dependence on technical platform

✓ Complex and difficult to read diagrams
Best Practice #2

✓ Raise level of abstraction
Anti-Pattern #2: Abstraction Level
II. Important Pitfalls to Avoid when Adopting MBSE

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B. Model Usage Anti-Patterns

C. Model Governance Anti-Patterns
Anti-Pattern #3: Too Complex Diagrams

```
req [Package] 00-Requirements [Requirements]

«requirement»
Simple Distiller
Id = "MR1"
Text = "The client would like ... extremely simple water distillers... economical ... and adaptable."
<deriveReqt>

«requirement»
Intuitive Operation
Id = "BR1.1"
Text = "The distiller ... must be intuitive to operate by untrained personnel."
<deriveReqt>

«requirement»
Local Operators
Id = "BR1"
RefinedBy = Operate Purifier
Text = "Sufficient human resources will be available locally to operate the distiller."
<deriveReqt>

«requirement»
Minimum Essential Complexity
Id = "SR1"
Text = "The distiller shall be constructed from a minimum essential set of parts."
<deriveReqt>

«block»
Purifier
proxy ports
dirty : Liquid
provided : Heat
pure : ~Liquid
<satisfy>

«requirement»
Gravity Feed
Id = "SR2"
Text = "The distiller shall accommodate gravity feed of water to be purified."
<copy>

«requirement»
Usability
<copy>

«requirement»
Gravity Feed
Id = "SR2"
Text = "The distiller shall accommodate gravity feed of water to be purified."
<copy>

«requirement»
Cooling
Id = "SR3"
Text = "The distiller shall cool the distillate so that it may be safely distributed."
<deriveReqt>

«requirement»
Boiling
Id = "SR4"
Text = "The distiller shall boil the water to sterilize it."
<deriveReqt>```
Issues

- Difficult to read and understand
- Hides incompleteness issues
- Difficult to maintain

Everything should be made as simple as possible, but not simpler. *Albert Einstein*
Best Practices #3

✓ Use several levels of detail

✓ One diagram = one aspect
Anti-Pattern #3: Too Complex Diagrams

```mermaid
mermaid from the image
```
How to Build a Sustainable Modeling Culture

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A. Modeling Anti-Patterns

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2. Abstraction level
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4. No reuse of model elements

B. Model Usage Anti-Patterns

C. Model Governance Anti-Patterns
Anti-Pattern #4: No Reuse of Model Elements
Issues

✓ Duplicated/redundant information in separate architecture views

✓ Difficult to maintain consistent model
Best Practice #4

✓ Integrate architecture views
Anti-Pattern #4: No Reuse of Model Elements
How to Build a Sustainable Modeling Culture

II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns

B. Model Usage Anti-Patterns

1. Local model usage
2. Different roles are not involved
3. Complexity (views)
4. Tooling barrier

C. Model Governance Anti-Patterns
Local model usage

- Model is used for **drawing** diagrams
- Modeling champions
- Model is used to clarify some of the ideas in a small group of people.
Issues

✓ No reusability

✓ Overlapping models

✓ Difficult to maintain models
The Truth is in the Models®
Best Practices #1

✓ Make model a single source of data
✓ Use model in collaborative environment
II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns

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1. Local model usage
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C. Model Governance Anti-Patterns
Issues

✓ Gap between cross-functional teams

✓ Single aspect oriented model
Best Practices #2

✓ Teamwork – bring different roles together

✓ Pair modeling
How to Build a Sustainable Modeling Culture

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A. Modeling Anti-Patterns

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4. Tooling barrier

C. Model Governance Anti-Patterns
Complexity (Views)

- **Simple Distiller**
  - ID: "MR1"
  - Text: "The client would like ... extremely simple water distillers... economical ... and adaptable."

- **Intuitive Operation**
  - ID: "BR1.1"
  - Text: "The distiller ... must be intuitive to operate by untrained personnel."

- **Gravity Feed**
  - ID: "SR2"
  - Text: "The distiller shall accommodate gravity feed of water to be purified."

- **Minimum Essential Complexity**
  - ID: "SR1"
  - Text: "The distiller shall be constructed from a minimum essential set of parts."

- **Boiling**
  - ID: "SR4"
  - Text: "The distiller shall boil the water to sterilize it."

- **Cooling**
  - ID: "SR3"
  - Text: "The distiller shall cool the distillate so that it may be safely distributed."
Issues

✓ Model = Diagram

✓ View = Diagram
Best Practice #3

✓ Use different views to represent model data (view >= diagram)
## Complexity (Tabular View)

<table>
<thead>
<tr>
<th>#</th>
<th>ID</th>
<th>Name</th>
<th>Text</th>
<th>Derived From</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>BR1</td>
<td>Local Operators</td>
<td>Sufficient human resources will be available locally to operate the distiller.</td>
<td>MR1 Simple Distiller</td>
</tr>
<tr>
<td>2</td>
<td>BR1.1</td>
<td>Intuitive Operation</td>
<td>The distiller ... must be intuitive to operate by untrained personnel.</td>
<td>MR1 Simple Distiller</td>
</tr>
<tr>
<td>3</td>
<td>MR1</td>
<td>Simple Distiller</td>
<td>The client would like ... extremely simple water distillers... economical ... and adaptable.</td>
<td>MR1 Simple Distiller</td>
</tr>
<tr>
<td>4</td>
<td>SR1</td>
<td>Minimum Essential Complexity</td>
<td>The distiller shall be constructed from a minimum essential set of parts.</td>
<td>BR1.1 Intuitive Operation</td>
</tr>
<tr>
<td>5</td>
<td>SR2</td>
<td>Gravity Feed</td>
<td>The distiller shall accommodate gravity feed of water to be purified.</td>
<td>SR1 Minimum Essential Complexity</td>
</tr>
<tr>
<td>6</td>
<td>SR3</td>
<td>Cooling</td>
<td>The distiller shall cool the distillate so that it may be safely distributed.</td>
<td>SR1 Minimum Essential Complexity</td>
</tr>
<tr>
<td>7</td>
<td>SR4</td>
<td>Boiling</td>
<td>The distiller shall boil the water to sterilize it.</td>
<td>SR1 Minimum Essential Complexity</td>
</tr>
</tbody>
</table>
Complexity (Matrix View)

<table>
<thead>
<tr>
<th></th>
<th>MR1 Simple Distiller</th>
<th>BR1 Local Operators</th>
<th>BR1.1 Intuitive Operation</th>
<th>SR4 Boiling</th>
<th>SR3 Cooling</th>
<th>SR2 Gravity Feed</th>
<th>SR1 Minimum Essential Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR1 Simple Distiller</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>BR1 Local Operators</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>BR1.1 Intuitive Operation</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SR4 Boiling</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SR3 Cooling</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SR2 Gravity Feed</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>SR1 Minimum Essential Complexity</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>
Complexity (Graph View)
How to Build a Sustainable Modeling Culture

II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns

B. Model Usage Anti-Patterns

1. Local model usage
2. Different roles are not involved
3. Complexity (views)
4. Tooling barrier

C. Model Governance Anti-Patterns
Tooling Barrier
Issues

✓ Stakeholders can not/do not want to read models

✓ Limited number of tool licenses
Best Practice #4

✓ Generate Documents out of model

✓ Publish model online
How to Build a Sustainable Modeling Culture

II. Important Pitfalls to Avoid when Adopting MBSE

A. Modeling Anti-Patterns

B. Model Usage Anti-Patterns

C. Model Governance Anti-Patterns

1. No model ownership
2. Lack of quality management
3. Improper configuration management
4. Lack of change management
No model ownership

Each model needs an owner

Model owner responsibilities:

- Assign users to the project
- Guide other contributors to the model
- Perform model change / impact analysis
- Perform regular model reviews
- Perform cross-model refactoring when needed
Issues

✓ Inconsistent model
Best Practice #1

✔ Assign owner for each model
How to Build a Sustainable Modeling Culture

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1. No model ownership
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3. Improper configuration management
4. Lack of change management
Lack of quality management

- Regular model reviews

- Internal reviews
  - Performed by model owner and focusing on the **content**
  - Some model reviews may be performed using on reports
  - Suggests improvements in model content and conformance to accepted modeling guidelines

- External reviews
  - Performed by consultants and focusing on the **form**
  - Suggests improvements in modeling approach and use of modeling tool
Form vs. Content
Issues

✓ Faulty model

✓ Unreadable model
Best Practice #2

✓ Perform regular model reviews
How to Build a Sustainable Modeling Culture

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3. Improper configuration management
4. Lack of change management
Improper configuration management

- Level of Granularity for Model Decomposition
- Model Version Management
- Model Users Administration
- Control of Model Encapsulation
- Differentiation between long-term and throwaway models
How Granular My Models Should Be?
It Depends ...
Improper configuration management

~700 models
~100000 cyclic usages
Issues

✓ Incorrectly chosen level of granularity for model decomposition
✓ Poor version management
✓ Poor users administration
✓ No or poor control for model encapsulation
✓ No differentiation between long-term and throwaway models

Failure!
Best Practice #3

✔ Agree on level of granularity as one of the principles (*model size* $\leq$ 100 diagrams)

✔ Commit only when you completed a consistent model update

✔ $5 \pm 2$ people contributing to the same model is optimal

✔ Stay away from cyclic dependencies between models

✔ Do not forget to throw throwaway models away
How to Build a Sustainable Modeling Culture

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C. Model Governance Anti-Patterns

1. No model ownership
2. Lack of quality management
3. Improper configuration management
4. Lack of change management
Lack of change management
Issues

✓ The truth is in the models

Is it..?
Best Practice #4

✓ Implement changes in the timely manner

✓ Once more: make sure the model is a single source of data
How to Build a Sustainable Modeling Culture

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C. Model Governance Anti-Patterns

III. Recipes for Building a Sustainable Modeling Culture
Modeling Culture

High Value from Modeling and Models
The Recipe for Success

think BIG
start SMALL
and EVOLVE
A good beginning makes a good end!
CoE & Principles

- Establish Center of Excellence
- Establish Modeling Guidelines
  - Reference model
  - Textual document
  - Automated model validation rules
- Tailor Modeling Tool
- Assign Model Owners
- Decide on Configuration Management
- Adopt Best Practices
Modeling Culture

High Value from Modeling and Models
Top 4 Best Practices in Modeling

1. Apply concise modeling method based on a language subset
2. Raise level of abstraction
3. Use several levels of detail
4. Integrate architecture views
Modeling Culture

High Value from Modeling and Models
Top 4 Best Practices in Model Usage

1. Make model a single source of data
2. Use model in collaborative environment
3. Use different views to represent model data (\texttt{view} \texttt{>=} \texttt{diagram})
4. Publish model (\texttt{online, as a document})
Modeling Culture

High Value from Modeling and Models
Top 4 Best Practices in Model Governance

1. Assign owner for each model
2. Perform regular model reviews
3. Decompose model
4. Do not forget to throw throwaway models away

✓ Once more: make sure the model is a single source of data
The End

Thank You for Attention!

Questions

Let’s Keep in Touch!

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