Learnings from Process Assessments

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Model-Based Design Maturity Framework™
First Digital Transformation: Adding Embedded Software to Everything

Design complexity
Digital transformation is raising new questions about tools and processes

- Vehicle Electrification
- Automated Driving
- Connected Vehicles
Questions to Answer

How well is your verification and validation process capable of meeting ISO 26262?

Why is integration level testing not being leveraged?

Are models leveraged for validation and analysis beyond code generation? How are they being maintained?

Are processes and tools being evolved to meet the application needs?
Objective for Today

- Over the years, MathWorks have conducted numerous Process Assessments across various industries around the world.

- Share findings including general trends and correlation with opportunities for tool and process improvements with a focus on Automotive Industry.
Assessment is based on Model-Based Design Maturity Framework™

- **Key Features**
  - Comprehensive measurement of capabilities
  - Independently measures each capability
  - Applies to any level of expertise

Supporting Competency “Scalability”
Model-Based Design Maturity Framework™
Modeling Pillar Example

- Maturity determined by rating:
  - 6 Pillars
  - 28 Key Process Groups
  - 200+ Attributes
Process Assessment Execution

1. Review workflow and tool usage
2. Determine gaps against MBD Maturity Framework
3. List pros/cons of workflow and usage
4. Develop recommendations
5. Create Implementation Plan
How Did We Review the Data?...Simple Example

- **Observation**
  - Strong in Implementation (code generation)
  - Verification and Validation, and Simulation and Analysis not fully leverage
  - Model-Based Design focuses on software creation
Process Assessment – Data Analysis

- Quantitative analysis
  - Plots of Process Assessment data

- Qualitative analysis
  - Analysis of detail report
How well is your verification and validation process capable of meeting ISO 26262?
Verification and Validation Pillar Mapping with ISO 26262-6

<table>
<thead>
<tr>
<th>VV Pillar</th>
<th>ISO 26262</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Level Testing</td>
<td>ISO 26262-6 Clause 9 Software Unit Verification</td>
</tr>
<tr>
<td>Integration Level Testing</td>
<td>ISO 26262-6 Clause 10 Software Integration and Verification</td>
</tr>
<tr>
<td>Vehicle and HIL Testing</td>
<td>ISO 26262-6 Clause 11 Testing of Embedded Software</td>
</tr>
<tr>
<td>Regression Testing</td>
<td>ISO 26262-8 Clause 9 Verification</td>
</tr>
</tbody>
</table>

*Average maturity rating V&V pillar normalized against Vehicle Testing
Verification and Validation Pillar Status and Trends

- Vehicle and HIL Testing are strong due to legacy reasons
- Low maturity in the other 3 process groups shows difficulty for meeting safety standards such as ISO 26262

*Average maturity rating V&V pillar normalized against Vehicle Testing
Verification and Validation Pillar Status and Trends

- Positive trend:
  - Increasing rigor for Unit Testing and Regression Testing
  - Cause:
    - Increase system complexity
    - Standards such as ISO 26262 and ASPICE
  - Expectation is a maturity increase due to complex application – AV/ADAS/AD
- Puzzle: What about Integration Level Testing?

*Average maturity rating V&V pillar normalized against Vehicle Testing*
Verification and Validation Pillar
Status and Trends

*Average maturity rating V&V pillar normalized against Vehicle Testing
Why is integration level testing not being leveraged?
Why Is Integration Level Testing Important?

- Safety standard
  - Detail unit level verification
  - Ensure unit working together through integration testing

- Requirement validation
  - Top-down design approach
  - Ensuring requirement is correct

- 50% of defects are from requirement
- 38% of software issues were system-related
Key Components for Building Integration Level Model

- Automatic integration of unit level models
- Stronger integration with Software/Model repository
- Out of box solution for Plant Model
- Simulation in scalability
- Matching software construct such as scheduler
- ....etc.
Development for Integration Level Testing

R2016b release – Powertrain Blockset
R2018a release – Vehicle Dynamic Blockset
Enable Integration Level Testing

MathWorks Consulting Services

- Provide expert-level guidance
- Automate workflows
- Develop custom UI's

Virtual vehicle

- Sensors
- Controllers
- Powertrain
- Environment
- Driver
- Vehicle

Out-of-the-box capability

R2016b release – Powertrain Blockset
R2018a release – Vehicle Dynamic Blockset

Custom virtual vehicle solution
Are models leveraged for **validation** and **analysis** beyond code generation? How are they being maintained?
Model Usage

- Most companies develop model for algorithm development.

- Leading companies also develop models for
  - Requirement validation
  - Performance optimization

- Leading companies maintain models and
  - Gather metrics and reports
  - Optimize simulation speed

- Usage of models is an area that exhibits wide differences between leaders and laggards

* Part of the Model Pillar
** Part of the Simulation Pillar
Model Lifecycle Management Through Metrics

- Out-of-the-Box
  - Model Metric Dashboard
Model Lifecycle Management Through Metrics

- Out-of-the-Box
  - Model Metric Dashboard

- Industry partnership
  - Model Quality Objectives
Model Lifecycle Management Through Metrics

- Out-of-the-Box
  - Model Metric Dashboard

- Partnering with industry
  - Model Quality Objectives

- Customized solution - Consulting
  - Custom report with integration to Jenkins
  - Embedded pass/fail thresholds
Are processes and tools being evolved to meet the application needs?
Version Upgrade – MathWorks Advisory Board (MAB) Survey

MATLAB Upgrade frequency

- Twice per year: 18%
- Once per year: 31%
- Every 2 years: 27%
- Every 5 years: 13%
- Every 4 years: 4%
- More than 5 years: 6%

Average: 1.9 years

Upgrade process compared to five years ago

- Once per year: 31%
- Every 2 years: 7%
- Every 3 years: 10%
- Every 4 years: 8%
- 5 or more years: 6%

Gets harder the longer you wait
Effect of Supporting Competency

EM ➔ Management Sponsorship

PTI ➔ Process/Tool Investment
Summary

- Improve Verification and Validation process to meet safety standards
- Leverage Integration Level Model for requirement validation
- Ensure models are used for analysis and are maintained using leading indicator metrics
- Invest in processes and tools
Thank You for Your Attention!

- Poll Questions
  - Are you interested in learning more about Process Assessment?
    - Yes
    - No
  - I am interested in Process Assessment for this reason
    - Gap analysis against standard such ISO 26262, ASPICE, …etc.
    - Optimize existing process
    - Establish a new process
    - None

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