Planning model architecture and modeling patterns for ISO 26262 compliance

Dr. Tjorben Groß – MathWorks
ISO 26262 “Road Vehicles - Functional Safety”

- ISO 26262 is a functional safety standard for road vehicles
- Facilitates modern software engineering concepts such as
  - Model-Based Design
  - Early verification and validation
  - Code generation
- MathWorks IEC Certification Kit Compliant with ISO 26262 2nd Edition
## ISO 26262:2018 Structure

| ISO 26262-1 | • Vocabulary |
| ISO 26262-2 | • Management of functional safety |
| ISO 26262-3 | • Concept phase |
| ISO 26262-4 | • Product development: system level |
| ISO 26262-5 | • Product development: hardware level |
| ISO 26262-6 | • Product development: software level |
| ISO 26262-7 | • Production, operation, service and decommissioning |
| ISO 26262-8 | • Supporting processes |
| ISO 26262-9 | • ASIL-oriented and safety-oriented analyses |
| ISO 26262-10 | • Guidelines on ISO 26262 |
| ISO 26262-11 | • Guidelines on application of ISO 26262 to semiconductors |
| ISO 26262-12 | • Adaptation of ISO 26262 for motorcycles |

### Key Features
- **Model-Based Design**
- **Early verification and validation**
- **Code generation**
- **Tool classification and qualification**
Common questions regarding ISO 26262

- Is Simulink suitable for use for ISO 26262?
- Do I have an ISO 26262 compliant workflow?
- How to efficiently reach unit testing coverage criteria?
- How to achieve freedom from interference?
- Can we use AUTOSAR and meet ISO 26262 at the same time?
KOSTAL Asia R&D Center Receives ISO 26262 ASIL D Certification for Automotive Software Developed with Model-Based Design

Challenge
Develop automotive electronic steering column lock software and certify it to the highest-level functional safety standard

Solution
Use Model-Based Design to design, implement, and verify the application software via back-to-back PIL testing required for ISO 26262 ASIL D certification

Results
- Development and certification time cut by 30%
- 80% of errors identified in modeling phase
- PIL test framework for ISO 26262 established

“Using Model-Based Design to design, implement, and verify our software for the highest functional safety standard enabled our team to save costs, increase efficiency, and ensure software quality. Without Model-Based Design, more engineers would be needed to complete the project in the same time frame.”

– Cheng Hui, KOSTAL
# ISO 26262-6:2018 Update for MathWorks tools

Table 2 Software Architecture Design Notations has similar suitability wording for use of Simulink and Stateflow.

## Table 5 — Notations for software unit design

<table>
<thead>
<tr>
<th>Notations</th>
<th>ASIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>1a Natural language*a</td>
<td>++</td>
</tr>
<tr>
<td>1b Informal notations</td>
<td>++</td>
</tr>
<tr>
<td>1c Semi-formal notations*b</td>
<td>+</td>
</tr>
<tr>
<td>1d Formal notations</td>
<td>+</td>
</tr>
</tbody>
</table>

*a Natural language can complement the use of notations for example where some topics are more readily expressed in natural language or provide an explanation and rationale for decisions captured in the notations.

EXAMPLE To avoid possible ambiguity of natural language when designing complex elements, a combination of an activity diagram with natural language can be used.

**Simulink® and Stateflow® are examples of suitable products**

Information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

**NOTE**

In the case of model-based development with automatic code generation, the methods for representing model which serves as the basis for the code generation...
### ISO 26262-6:2018 Methods and Model-Based Design

#### Table 9 — Structural coverage metrics at the software unit level

| Methods                                      | ASIL |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----------------------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1a Statement coverage                        | A    | B    | C    | D    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 1b Branch coverage                           | ++   | ++   | +    | +    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| 1c MC/DC (Modified Condition/Decision Coverage) |     |     |     |     | ++  | ++  | +    | +    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

#### Key
- **Supported by MBD**
- **++** Highly Recommended
- **+** Recommended
- **o** No Recommendation
Common questions regarding ISO 26262

- Is Simulink suitable for use for ISO 26262?
- Do I have an ISO 26262 compliant workflow?
- How to efficiently reach unit testing coverage criteria?
- How to achieve freedom from interference?
- Can we use AUTOSAR and meet ISO 26262 at the same time?
Use Model Reference for Unit Level Model

▪ Challenges:
  – Modularize algorithms for reuse
  – Perform unit level testing
  – Configuration management
  – Achieve freedom from interference

▪ Best Practice
  – Use model reference for unit level model
  – Group units to form functional hierarchy with virtual subsystems
Use Model References when splitting ASIL and QM

- **Challenges:**
  - Achieving freedom from interference
  - Integration of generated code

- **Best Practice:**
  - Generate code separately for each ASIL/QM component

<table>
<thead>
<tr>
<th>Model Hierarchy</th>
<th>Modeling Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top level (ASIL / QM)</td>
<td>Model Reference</td>
</tr>
<tr>
<td>Features</td>
<td>Subsystem</td>
</tr>
<tr>
<td>Unit</td>
<td>Model Reference</td>
</tr>
</tbody>
</table>
Establish Data Protection Between ASIL and QM Components

- **Challenge:**
  - How to provide signal protection between ASIL and QM components?

- **Best Practice**
  - Use Get/Set storage class for signals between ASIL and QM components
AUTOSAR Implications

- Best practices compatible with AUTOSAR

- Get/Set function can be implemented using Send/Receiver port

- Challenge: Ensure match between specification and implementation

  → Polyspace AUTOSAR
Summary

- MathWorks support for ISO 26262
  - IEC Certification Kit
  - Consulting

- Best practice
  - Freedom from interference
  - Unit testing
  - AUTOSAR
  - More information:
    - tgross@mathworks.com
    - uwahner@mathworks.com
    - MathWorks ISO 26262 landing page

- See us at the demo booth
  Discuss how we can support your ISO 26262 project