Challenges of Automotive Product Development: Lean Development Using Modeling and Simulation Tools

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## Agenda

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# Automotive Trends and Technological Demands: Overview

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<th>Major Automotive Trends</th>
<th>Technological Demands</th>
<th>Developmental Challenges</th>
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<tr>
<td>Fuel Efficiency and environment friendliness</td>
<td>More sensors, actuators, electronification of accessories, light weighting, downsizing, complete combustions, hybridization and electrical drive</td>
<td>High level of complex interactions, multiple disciplines are interacting</td>
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<td>Connectivity and comfort</td>
<td>Continuous interaction with infrastructure and environment, Interfacing with consumer electronics, Driving distraction → autonomous driving, <strong>more is less</strong></td>
<td>Changes need to be brought faster but in more reliable and safer manner</td>
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<td>Active safety</td>
<td>driver assistance → autonomous driving, passive safety is hygiene</td>
<td>Changes need to be brought faster but in more reliable and safer manner</td>
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<td>Personalization</td>
<td>Freedom for configuration and adaptation</td>
<td>Transparent and reliable technology deployment</td>
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Need Highly skilled and stable workforce to realize the demand
# Development Challenges and Approach

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<th>Developmental Challenges</th>
<th>Development Approach</th>
<th>Potential Solutions</th>
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<tr>
<td>High level of complex interactions, multiple disciplines are interacting</td>
<td>Predefined interfaces Plug and play architecture Encapsulation</td>
<td>• Salable architecture</td>
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<td>Changes need to be brought faster but in more reliable and safer manner</td>
<td>Scalable architecture Systematic reuse Appropriate modularity</td>
<td>• Modularity in design</td>
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<td>Transparent and reliable technology deployment</td>
<td>Fail-safe integration Crazy complex combinations exploration Automated and quick validation</td>
<td>• Design by Reuse</td>
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<td>Less experienced and unstable workforce</td>
<td>Easy to develop, faster to validation and easy to maintain</td>
<td>• Standardized interfaces (AutoSAR)</td>
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<td>• Model Based Development</td>
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<td>• Model based automated testing</td>
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<td>• Full coverage in testing</td>
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<td>• High integrity standard for Functional Safety</td>
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Lean Development Approach: Focus on Reusability at all levels

- Reuse happens on opportunistic way
- Need a systematic approach for Reuse
- Design for reuse can only enable design by reuse
- Reuse need to happen at all levels
Lean Development Approach – Reuse Framework

Phase 1
Design for Reuse
- Domain Analysis
- Establish Discrimination
- Generalization
- Atomization
- Grouping
- Reusable Requirements
- Reusable Models
- Reusable Tests
- Implementation Rules

Phase 2
Design by Reuse
- Gap Analysis
- Acquiring Relations
- Artifacts Customization
- Specific Models
- Specific Tests
- New & Modified Requirements

Phase 3
Interaction Management
- Identify Dependencies
- Linking Requirements
- Linking Requirements & Model
- Linking Requirements & Test Cases
Lean Development Approach – MBD - Reuse Framework with Layers of Abstraction
Lean Development Approach: Model Based Testing

Reusability across development cycle
robust and systematic validation with incremental value addition
Lean Development Approach: Incremental validation

- **Record/Playback Scripts**
- **Mature Design/Model**
- **Expected Results**
- **Results Compare**
- **New Model (V1)**
- **Test Results**
- **Fixes Needed**
- **New Model (V2)**
- **New/Modified Test Script Needed**

**Steps:**
1. **Record/Playback Scripts**
2. **Mature Design/Model**
3. **Expected Results**
4. **Results Compare**
5. **New Model (V1)**
6. **Test Results**
7. **Fixes Needed**
8. **New Model (V2)**
9. **New/Modified Test Script Needed**

**Key Points:**
- During an unlock CAN message remains True (1) is a failure.
- During unlock both driver and passenger motors energize for a period of time is an accepted pass.
Lean Development Approach: Robust Validation for Functional Safety

Functional Safety implementation and validation with right level of ASIL requirements

Automatically Generate Test Cases for Equivalence Testing
- Quickly create a set of test cases that can be used for meeting the equivalence testing criteria in high-integrity application standards
  - ISO 26262
    - Software-in-the-Loop
    - Processor-in-the-Loop

Determine Unreachable or Dead Transitions/States Without Manually Generating Test Vectors
- Ensure algorithmic logic is structurally correct during design phase.
  - Early detection

Transition expression can never be True