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

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

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<td>1 Automotive Trends and Technological Demands</td>
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<td>2 Development Challenges and Potential Approach</td>
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<td>3 Possible solutions by Model based Development</td>
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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

### Developmental Challenges

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<th>Developmental Challenges</th>
<th>Development Approach</th>
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<tr>
<td>High level of complex interactions, multiple disciplines are interacting</td>
<td>Predefined interfaces</td>
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<td>Changes need to be brought faster but in more reliable and safer manner</td>
<td>Plug and play architecture</td>
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<td>Encapsulation</td>
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<td>Transparent and reliable technology deployment</td>
<td>Scalable architecture</td>
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<td>Systematic reuse</td>
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<td>宜当的模块化</td>
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<td>Less experienced and unstable workforce</td>
<td>Fail-safe integration</td>
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<td>Crazy complex combinations</td>
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<td>exploration</td>
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<td>Automated and quick validation</td>
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<td>Easy to develop, faster to validate and easy to maintain</td>
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### Potential Solutions

- Salable architecture
- Modularity in design
- Design by Reuse
- Standardized interfaces (AutoSAR)
- Model Based Development
- Model based automated testing
- Full coverage in testing
- High integrity standard for Functional Safety
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

Reusability Pyramid
Lean Development Approach – Reuse Framework

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

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

**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

Application in Target Hardware

Implementation Model

Hardware Level
CAN &LIN Level
Input

CORE FEATURE SET

Feature

Feature

Feature

CAN &LIN Level
Output

Hardware Level

Input

FILTER INPUT

FILTER OUTPUT
Lean Development Approach: Model Based Testing

Reusability across development cycle
robust and systematic validation with incremental value addition

Component Model Verification and Validation

Component Testing Workflow – Reuse!
Lean Development Approach: Incremental validation

Record/Playback Scripts | Mature Design/Model | Expected Results
------------------------|---------------------|-------------------
New/Modified Requirements | New Model (V1) | Test Results
Original + Additional Playback Scripts | New Model (V2) | Fixes Needed
New/Modified Test Script Needed

During 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