Trend in Automotive Industry and its challenge

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Technology Megatrends Driving Automotive

1. Vehicle Electrification
2. Autonomous Driving
3. Connected Vehicles

Software everywhere
Software is reshaping the automotive industry

THE WALL STREET JOURNAL.

ESSAY
Why Software Is Eating The World
By Marc Andreessen
August 20, 2011

This week, Hewlett-Packard (where I am on the board) announced that it is exploring jettisoning its struggling PC business in favor of

Marc Andreessen
Founder of Netscape,
Renowned Venture capitalist

In the future every company will become a software company
Software is reshaping the automotive industry

Software Expertise Is Crucial for the Success of the Mobility Ecosystem

“Software is the oxygen for the mobility ecosystem”

Source: Continental’s 2019 Annual Shareholders’ Meeting
Software is reshaping the automotive industry

Augmenting control with machine learning (BMW)  
One Pedal Driving (GM)  
Autonomous driving (Voyage)
Models == Understanding
Impact of disruptive trends on us: what we see in the field

- Full vehicle simulation
  - System design and study
  - ADAS/AD virtual drive
Full vehicle simulation

- Click to edit Master text styles
  - Second level
  - Third level
  - Fourth level
Simulation Integration: Analyses

- Verification and Validation
- Design Optimization
- Sensitivity Analysis
- Virtual Calibration

- Fuel Economy
- Performance
- Energy Consumption
- Drivability
- Ride & Handling

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Atsumitech evaluated FCV system with MathWorks tools

FCV Hydrogen tank with electric components development

- Trade-off study for Hydrogen amount with various driving scenario
- Evaluate the required hydrogen amount while transient changes in pressure and temperature of the hydrogen tank
- Evaluate the effect of energy management, especially efficient use of hydrogen

Source: MathWorks Automotive Conference Japan 2018
Nissan deployed common plant models in the process

- Common Plant model in system requirement study, component and software integration test, and software quality verification

- Test cases are also commonalized through the process

- Fast simulation speed with high accuracy is the key

- Integrated with existing plant model with Powertrain Blockset

**Common plant model**

To verify the control algorithm, it is important to evaluate software accurately and quickly → **Lightweight and high-precision model**

- Devices, Transmission and low fidelity vehicle model built with Simulink
- Powertrain Blockset is used for Engine model

Plant model is commonly used for RCP, MIL and HIL
Simulink is Simulation Platform

152 Interfaces to 3rd Party Modeling and Simulation Tools
(as of March 2019)
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- Scaling up embedded software development
  - Agile development
  - System Architecture

Utilize simulation with limited resources

New approach to the new challenge
### Agile Values

<table>
<thead>
<tr>
<th>Values</th>
<th>Over</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individuals &amp; Interactions</td>
<td>over</td>
<td>Process and Tools</td>
</tr>
<tr>
<td>Customer Collaboration</td>
<td>over</td>
<td>Contract Negotiation</td>
</tr>
<tr>
<td>Working Software</td>
<td>over</td>
<td>Comprehensive Documentation</td>
</tr>
<tr>
<td>Responding to Change</td>
<td>over</td>
<td>Following a Plan</td>
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</table>

“While there is value in the items on the right, we value the items on the left more.”
Volvo cars conducts agile development with Model-Based Design

From planning to experimentation!

This is a software business trend, but we see it as well. Time is valuable and requirements change rapidly.

New function

Integrate hw & sw

New product

Small & Fast!!

Mechatronic, complex & sloow

MAC 2015, Multi-Domain Simulation for Electrical Propulsion Systems at Volvo Cars, Jonn Lantz, jonn.lantz@volvocars.com
Volvo cars conducts agile development with Model-Based Design
Linking top-down and bottom-up workflows
Systems engineering

Requirements

System Composer

Components
Systems engineering

Requirements

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Simulink를 이용한 AUTOSAR SW 개발
From Architecture to Design to Testing

류성현
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  - New approach to the new challenge

- Leveraging streaming and stored data
  - Data utilization in Model-Based Design workflow
  - Digital service for new businesses
  - Accelerate development and develop new business
Why Data, Why Now?

- Exponential rise in data intake

  Connected vehicles will each generate data every 100 milliseconds while being driven, resulting in more than 10 Petabytes by 2020; Pilot (<3000 vehicles) >18 Terabytes per month being collected

- Commoditization of computing
  - Cost of storage drives towards zero
  - Cloud enables massive parallel computing
  - GPU offers computing power at density

- Machine learning and deep learning are maturing
  - MATLAB makes them accessible to engineers
Volkswagen Data Lab develops driver recognition algorithms with MATLAB

Develop technology building block for tailoring car features and services to individual

- Need to identify individual drivers based on their driving behavior using collected data

Challenges

- Accuracy despite low training data
- Robustness despite environmental conditions
- Computing time

Data sources

- Logged CAN bus data and travel record

Source: "MATLAB EXPO Germany, June 27, 2017, Munich Germany"
Suzuki motors developed drivability assessment framework with Machine Learning

- Extract features from longitudinal acceleration timeseries of driving behavior and build predictive model for drivability score calculation using Machine Learning
- Optimize vehicle drivability performance by optimizing calibration parameters with Model-Based Calibration approach
Machine learning adoption in new fields

BMW Uses Machine Learning to Detect Oversteering

**Challenge**
Develop automated software for detecting oversteering, an unsafe condition in which rear tires lose their grip during a turn.

**Solution**
Use MATLAB to develop, train, and evaluate a variety of supervised machine learning classifier types, including KNN, SVM, and decision trees.

**Results**
- Oversteering identified with greater than 98% accuracy
- Multiple machine learning classifiers trained automatically
- Code generated and deployed to an ECU for real-time, in-vehicle testing

"Working in MATLAB, we developed a supervised machine learning model as a proof of concept having little previous experience with machine learning, in just three weeks we completed a ECU prototype capable of detecting oversteer over 98% accuracy.

- Tobias Freiherr, BMW Group

Machine Learning for OBD
**Background: On-Board Diagnostics & Boundary**

- Separation is needed to minimize:
  - False failure
  - False pass
- Diagnostic should run consistently on:
  - The certification test cycle: FTP75
  - In the field: In Use Monitoring Performance Ratio (IUMPR)
Data utilization in Model-Based Design workflow

- Field Data
- Synthetic Data
- Simulated Usage
- Usage
- Better Algorithms

27
One example of leveraging simulation for data synthesis

Traditional deep learning workflow

Record  Label  AI model
One example of leveraging simulation for data synthesis

**Traditional deep learning workflow**
- Record
- Label

**Simulation-based workflow**
- Simulate
- Auto-label
Leveraging MATLAB-Simulink in Building Battery State-of-Health Estimation Pipelines for Electric Vehicles

Challenges

• In the product design phase, battery data is available only under laboratory and limited driving conditions.

Vehicle Simulation Summary

- Electrical
  - Cell models and battery configuration
- Simulation
  - Real-time simulation
- Data Storage
  - Data analytics and insights
- Visualization
  - Grafana
- Elastic
  - Simulated Fleet

In electric vehicles, understanding battery State-of-Health (SOH) is critical.
Large Scale Automotive Data Analytics: GM

- OnStar™ Proactive Alert – A new customer care service
  - Alert before failure happens
  - Transform an emergency repair to planned maintenance
  - Enhance ownership experience - a delight to customers

**PROGNOSTIC ALGORITHM DEVELOPMENT**

Physical-model based algorithm generation:
- Study failure modes - FMEA
- Model physics of failure
- Generate fault signatures and failure precursors
- Develop prognostics algorithm
- Validate concept on benches and test vehicles

Big-data based algorithm validation:
- Collect data from >1M vehicles
- Analyze warranty return parts
- Correlate algorithm outputs with engineering assessment
- Calibrate algorithm parameters
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Enjoy the conference