Systems Driven Product Development

UMTRI “Focus on the Future”
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The process of building vehicles has never been more complex

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Is the problem getting bigger?

Overall automotive software complexity is growing exponentially
- Number of Lines of Code is growing exponentially
- Number of distributed software-system solutions growing rapidly
- Number of system dependencies (coupling) growing
- Number of Customer input signals growing exponentially
Electronics failures...Pandemic?

Chrysler: recalls for brake computer systems
BMW 754i: Software error leads to recall
Ford: 3.6M vehicles recalled – for cruise control
Mercedes-Benz: $30M recall... Drive-by-wire problem
Toyota Prius: recall due to software in Hybrid Engine
Mercedes-Benz: “Useless” electronic features dumped

60%-90% of electronic failures in vehicles are because of mechanical issues - say due to vibrations and introduce a crack in the multi-module chip

“Failure Modes and Mechanisms in Electronic Packages”
By Puligandla Viswanadham and Pratap Singh
Is this an organizational issue?
Systems Engineering - an interdisciplinary field of engineering that focuses on how complex engineering projects should be designed and managed.

Or does it create more complexity?
Requirements Distillation & Decomposition

Customer requirements

Vehicle requirements
Plant, process requirements

System requirements

Sub-system requirements

Component requirements

Program Definition

Program Initiation

System Design

Sub-System Design

Component Design

System Validation

Sub-System Validation

Component Validation

Concept design

Preliminary design

Component detailing

Ideation

Theme development

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Impact Analysis – $RFLP^5$
Access the system affected by the new requirement
### Vehicle-level functions driving design process

*Requirements and Functional network, allocation to logical structure*

#### Vehicle Integration Area
- **Fuel Economy**

#### Engine Parameters
- Gross Torque
- Induction Losses
- Exhaust Losses
- Rotating Intertia
- Fuel Map
- Lugging Limits
- Idle Speeds

#### Trans. Parameters
- Gearing & Shift Schedule
- Trans. Losses
- Rotating Intertia

#### Torque Conv. Parameters
- Torque ratio/stiffness
- Rotating Inertia
- Torque Conv. Losses
- Torque Conv. Locking schedule

#### Driveline/ Final Drive Parameters
- Rotation Inertia
- Gearing
- Losses/ efficiency

#### FEAD Loads
- Power Steering Loads
- Compressor Loads
- Alternator Loads
- Fan Loads

#### Chassis Loads
- Brakes/ bearings
- Tires
- Rotating inertia

#### VIA
- Mass
- Aero Drag
  - Drag Coef
  - Frontal Area
System Integration Architecture and Physical Architecture make complexity manageable

**System Integration Architecture**

- Fuel Economy
- Engine Parameters
- Exhaust Losses
- Function

**Physical Architecture**

- PT
- Chassis
- Sub System
  - Component
  - Component
- Vehicle
- Body
- HVAC
- Wire Harness
- CAD part

Behavioral Model

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Architecture facilitates reuse
Key PLM Requirements to Deliver Systems-Driven Product Development
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Configuration

Systems Engineering
System-based design with consistent configuration management across all domains
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Change Management

Program Execution Management

1. Workflow Linked to Task. When task begins, workflow is initiated. Task automatically completes when workflow completes.

2. Deliverables. Schedule deliverables (documents, parts, assemblies) are linked to the schedule task.

3. Gate Criteria. Each gate has a set of criteria that must be met before proceeding. The review committee receives deliverables via workflow and votes on approval.

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Thank you! ありがとう!!

Merci! 고맙습니다!

谢谢！

Bedankt!

Danke!

Obrigado!

Tack!

Dêkuji!

Gracias!

Grazie!

Dziekuje!

谢谢！

תודה

धन्यवाद!