



MbD for powertrain systems

From concept to production

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Agenda



- Introduction
- Motivations and challenges
- Model-based Design: why's necessary?
- Product Innovation
- PowerTrain MbD toolchain
- Future developments

Introduction



MOTIVATIONS

What we make different



Innovation

Develop exclusive Lamborghini software functions and Keep know-how in house

Interfunctional

Reduce dependency on hardware and software suppliers



Independence

Possibility to develop single software functions to use in different applications



Integration

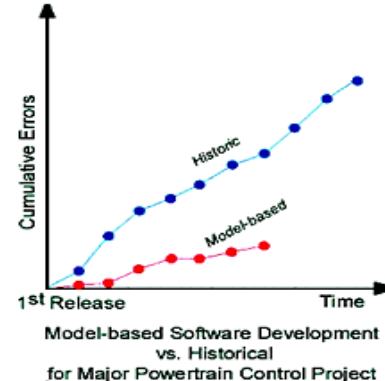
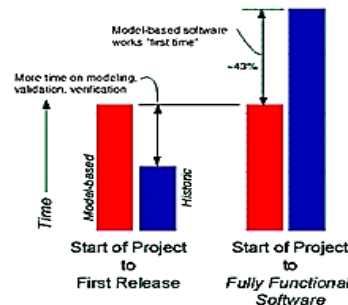
Share software libraries within VW group

CHALLENGES

- Brake with the past adopting a formal method to the software development
- SW functionalities development in-house
- Internal and external collaboration
- Cost and time development savings

Over the years Lamborghini Powertrain team has implemented Model Based Design (MBD) methodologies for in-house software development

Model-based Software Development vs. Historical for Major Powertrain Control Project



The MbD methodologies is able to achieve the PWT objectives:

- Saving development time and costs
- Gaining **know-how** internally
- **Re-use** know-how for different project

Motivations & challenges



- Speed up development of new concepts
- Methodologies and unified toolchain for code production



Competitiveness



Intellectual
property



Technology
know-how



Exclusive
product

Model-based Design: why's necessary?

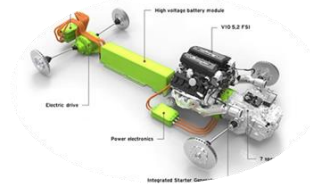


Why Model based design is useful

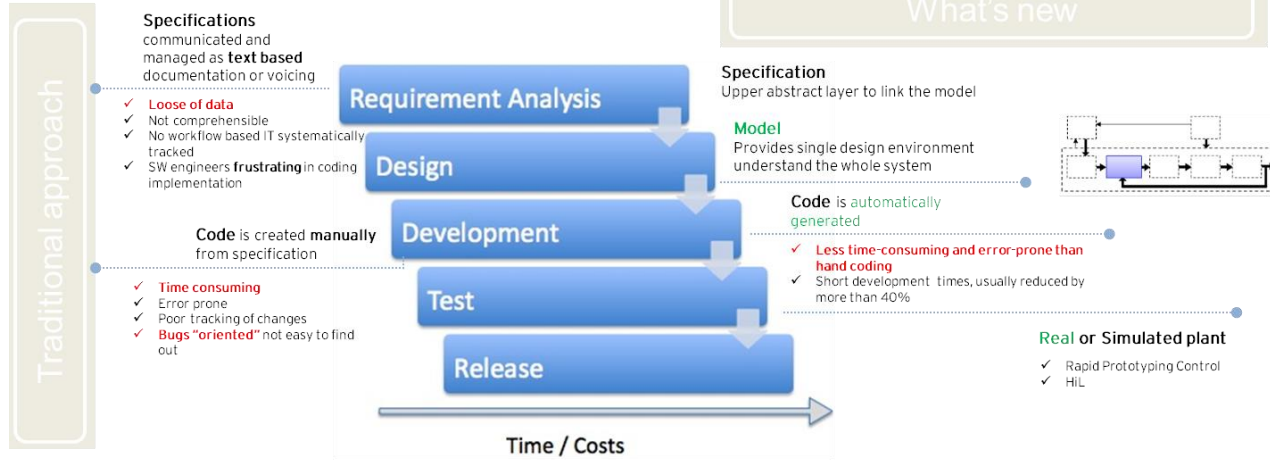


COMPLEXITY

- of component and technology driven mainly by customer functions and efficiency requirements.
- of innovative technologies show several component updates during the vehicle life cycle
- of function network for torque control management



What's new



Model-Based Systems Engineering is the formalized application of **modeling** to support system requirements, **design**, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)

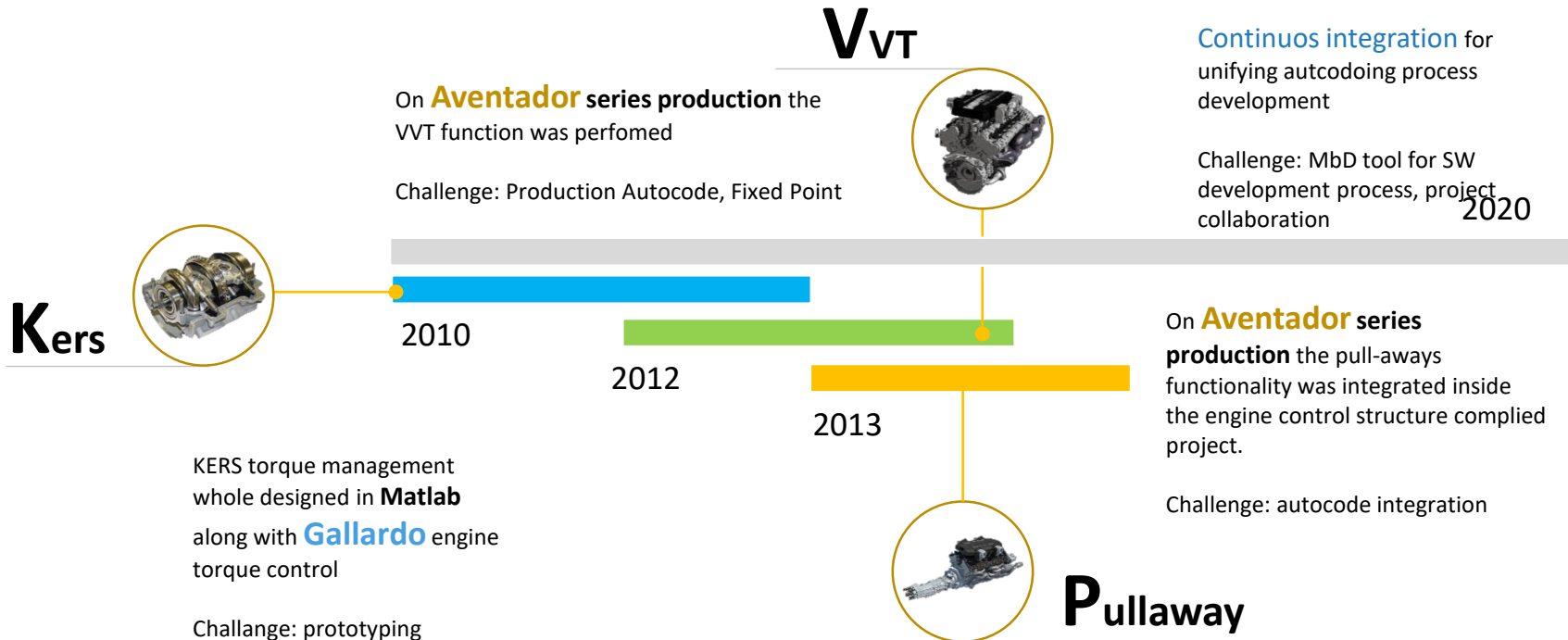
	Document Based	MBSE Based
Information	- Mostly Text - Add Hoc Diagrams - Loosely coupled, repeated in multiple documents	- Visual and Textual - Constructs Defined once and re-used - Shared across Domains - Consistent notation in diagrams - Defined relationships
Information Views	- By Document	- Provides Viewpoints - Filters By Domain, Problem Space, etc.
Measuring Change Impact	- Spans across Multiple Documents - Often Text Reqs. Are isolated from Structure and Behavior	- Relationships define traceability paths - Natural part of the modeling process - Programmatically Automated
Measuring Integrity - Completeness, Quality & Accuracy	- By manual inspection	- Programmatically Automated - Animation of Spec

MBSE allows productive cooperation with stakeholders, improving quality, increasing productivity and reducing risk.

Product Innovations



«**Model Based Design** has allowed evident benefits in function development producing a new mentality to the software design»

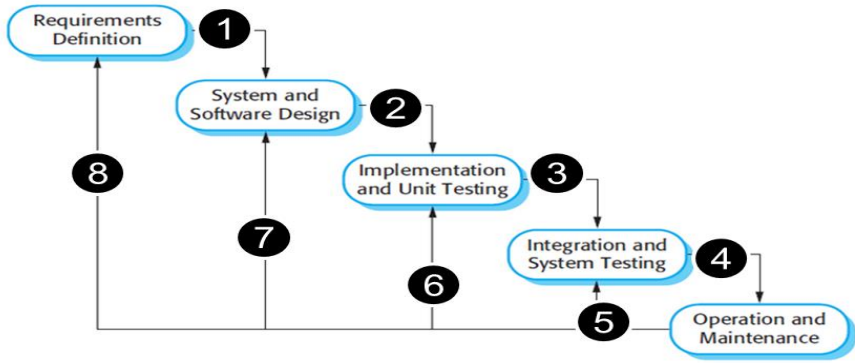


Software Development Process



MbD approach has allowed to establish the links between the different steps automatizing the methods gaining in benefits in respect of the customer demand's coming up like

- Compliancy (ISO26262, ISO 15288)
- Product Quality (ISO9001)



PWT SW Development steps	
Requirement Management	Tools
Definition of specification document based	MS Word
Traceability between model and specification	Mathworks
Design	
Autocoding implementation	ETAS
Rapid Control Prototyping	
Implementation	External consultants
Code compiling (SW release)	
Testing	National Instruments
Code integration and system testing	
Validation	vehicle

Problem	Solution	Implementation
No model control versioning produced mismatching with SW release.	Versioning tool envirominent linked with Simulink tool	Tortoise SVN installation

PowerTrain MdB Tool



How tool works

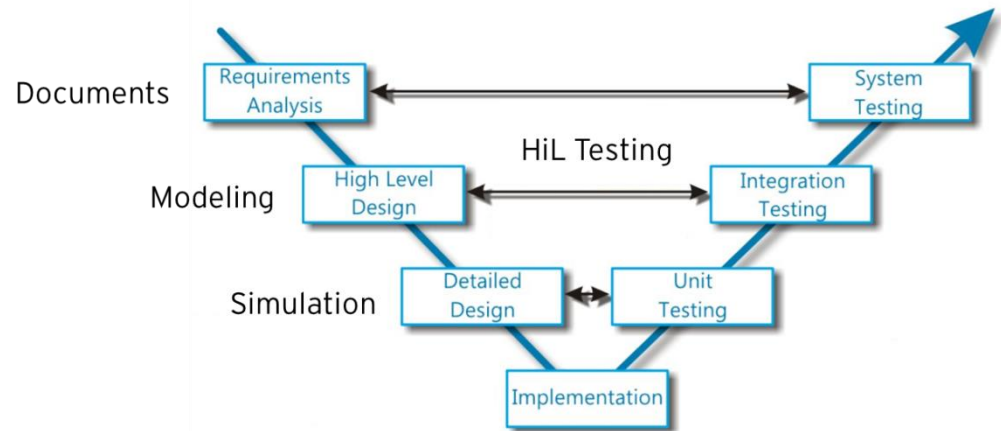
- Linking requirement to documentation (V&V)
- Model (SLK, ML, SF)
- Implementation
 - MAAB rules guideline check
- Sync model version to GitHub
- Analysis (V&V)
 - MIL vs. SIL
 - Test coverage
- SW Specification (ReportGen)
- Code Generation (ECodeur)
 - Target customization
 - Library implementation

Features

- Distributed app

Is it possible integrate data for function development?

«By using Mathworks products the function development process automation it was possible raising in effectiveness and efficiency in the early stage of development»



PowerTrian Mdb tool in action



- Video 1_Tracebaility (model, requirements, code)
- Video 2_Testing Model (Coverage Analysis)

Future developments



PowerTrain MbD toolchain enhancements:

- System Architecture (database)
- Model Requirements
- Consistency checks of custom MAAB rules
- Distribute App
- Project Collaboration



Thanks for your patience