



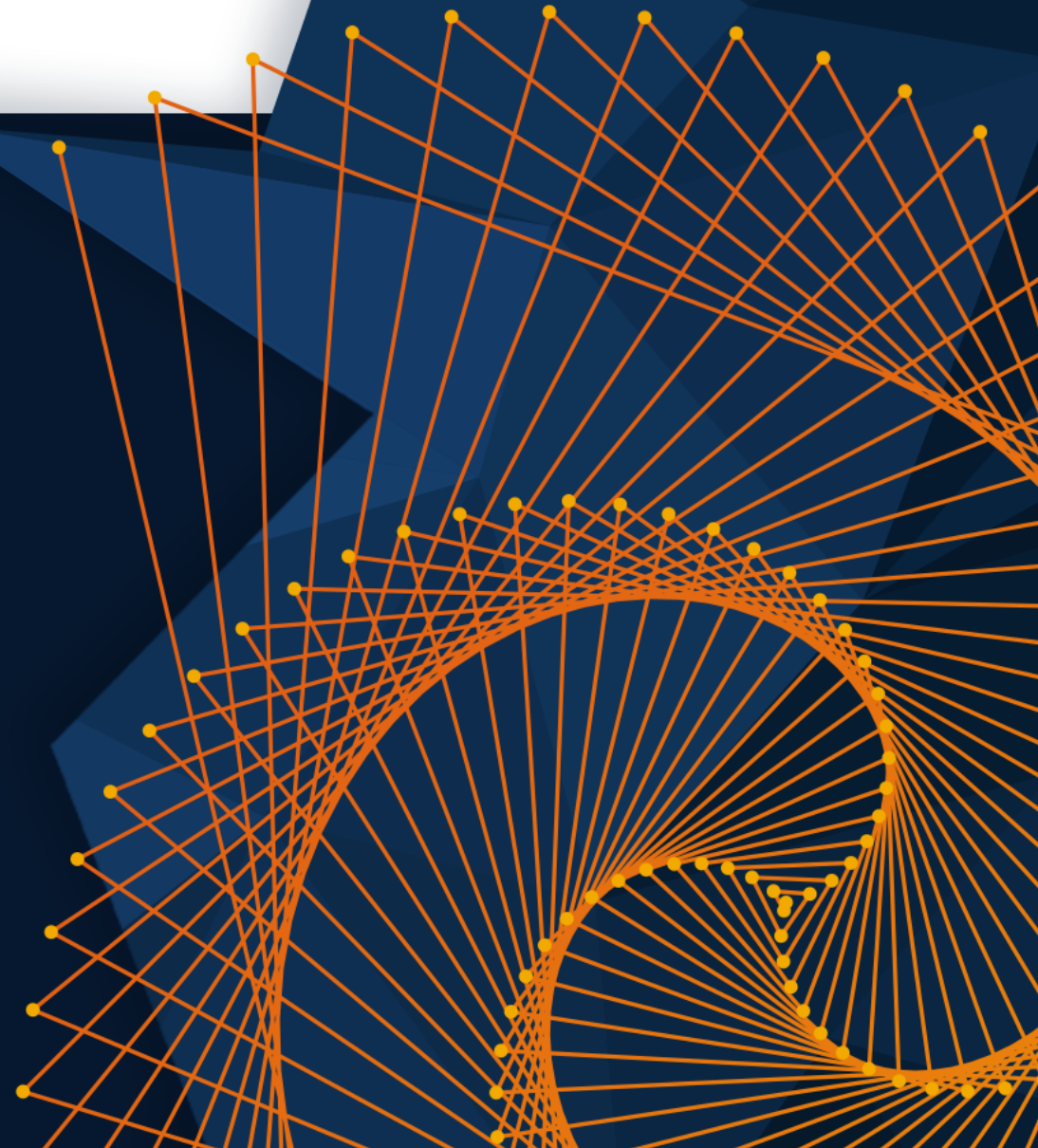
13th – 14th November 2024, Bilbao

Enhancing BMS Software Development with Model-Based-Design and IEC Certification Kit

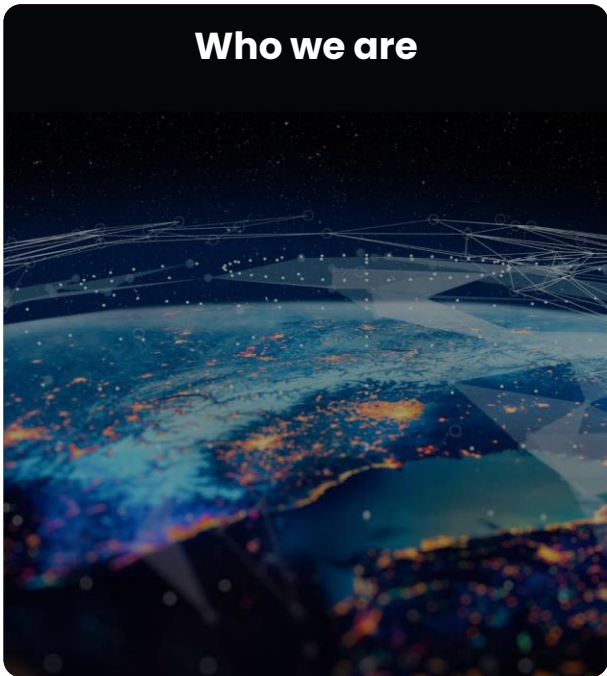
Giovanni Vagnoni, FEV Iberia SL



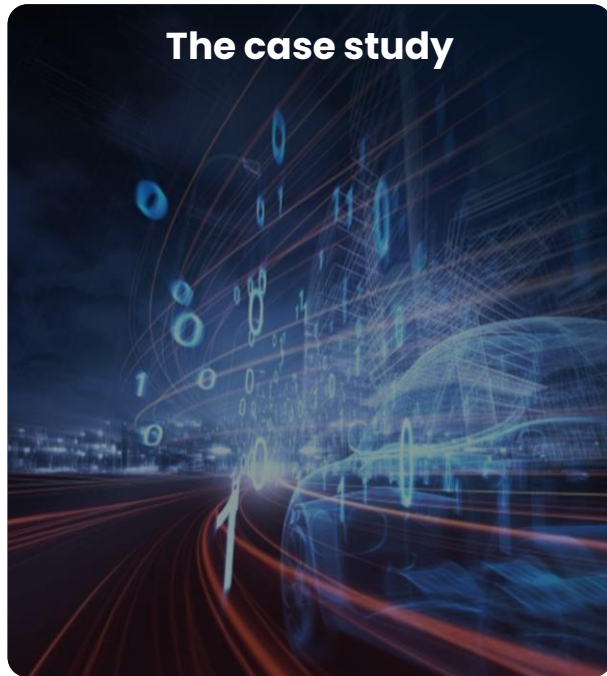
MATLAB EXPO



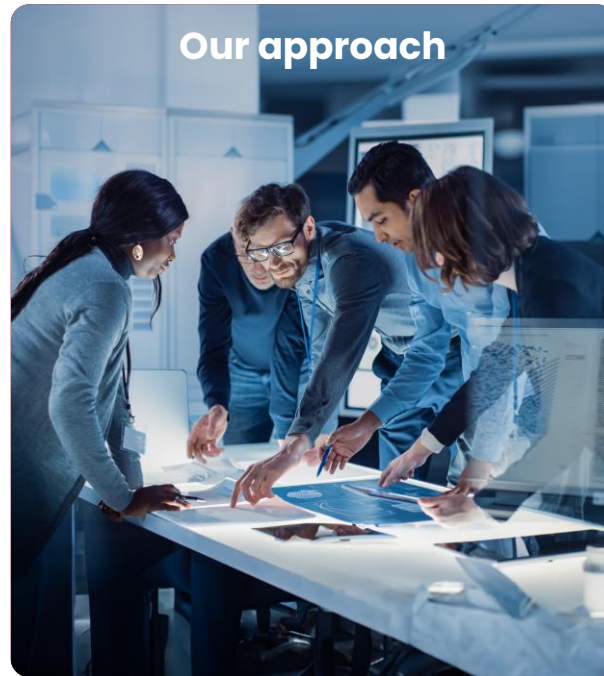
Who we are



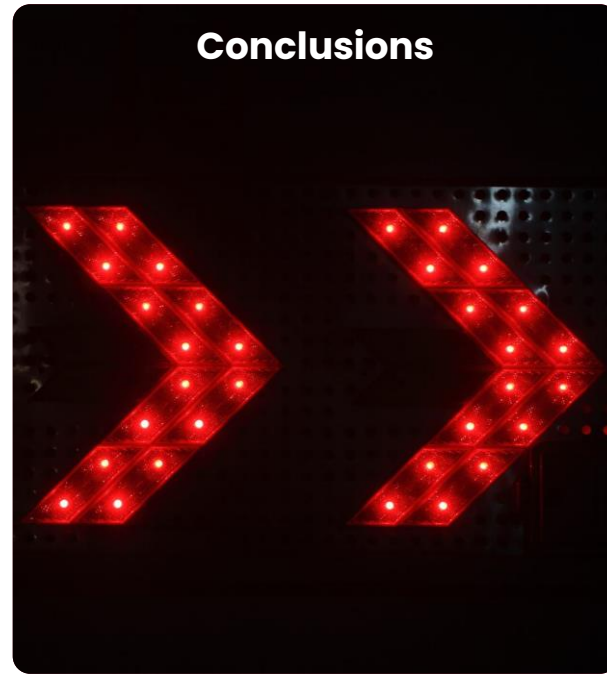
The case study



Our approach



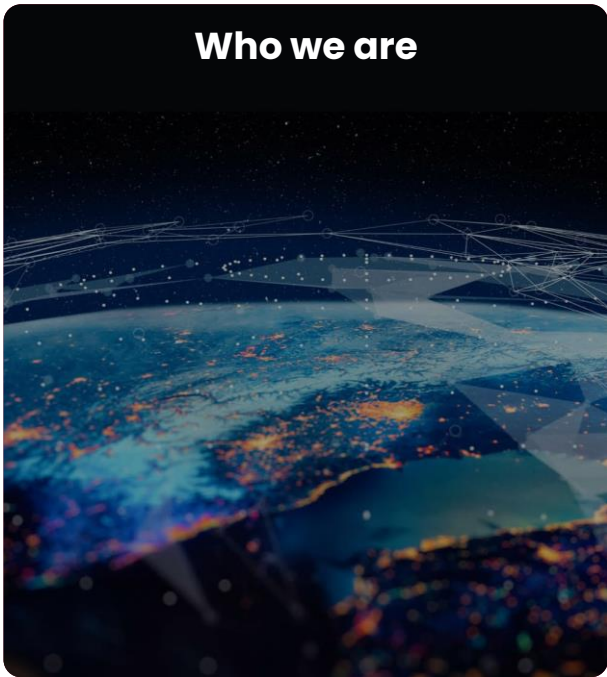
Conclusions



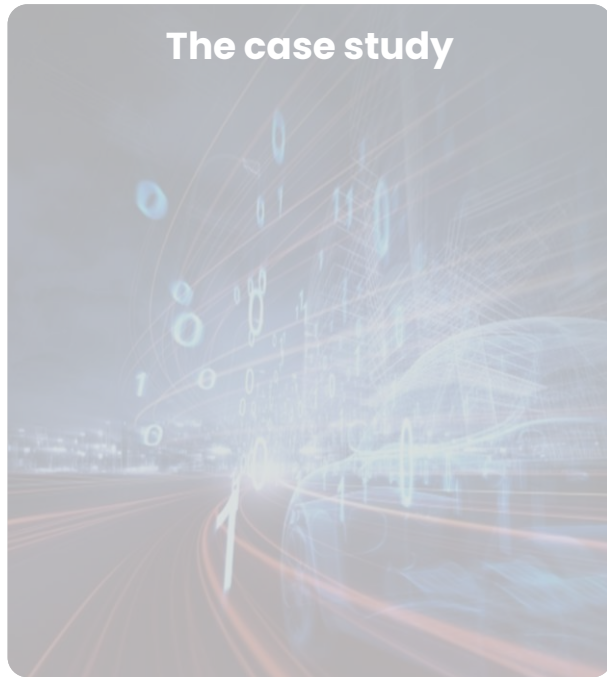
#FeeEVolution

FEV

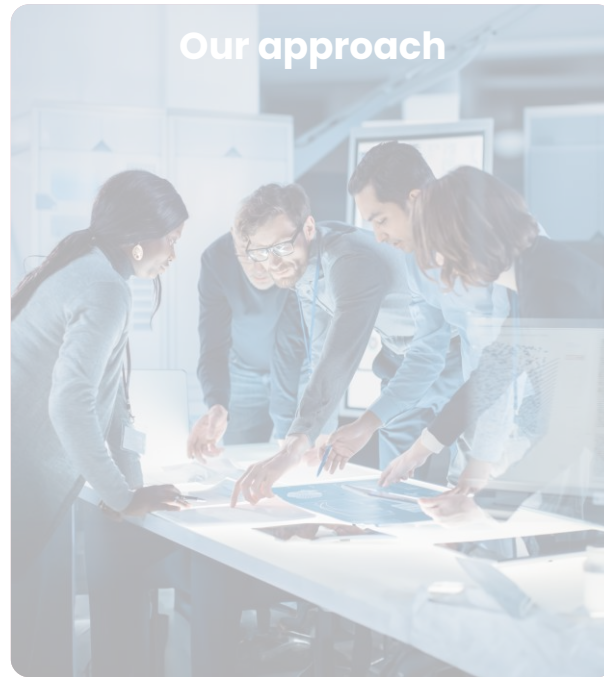
Who we are



The case study



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Conclusions



#FeeEVolution

FEV

Your engineering and consulting partner – strong, competent and reliable

GLOBAL REACH –
ONE FACE TO THE CUSTOMER

>7,100

Employees globally

>300

Test cells for engines, T/M, e-drives, fuel cells & batteries

200

Patent applications per year

>45

Years of experience

70%

Academics

>45

Subsidiaries on six continents

>50

Different nations



FEV

At FEV we are supporting our customers to keep the pace of the automotive transition process

THE AUTOMOTIVE TRANSITION PROCESS IS MOVING AHEAD VERY FAST



**New mobility concepts
e.g., car sharing**

FEV BEV vehicle:
SVEN



**Battery
electric drive**

FEV's battery
development center,
the largest worldwide



**Assisted, connected &
automated driving**

FEV ADAS vehicle
L3 capable
& SDV E/E structure



**H2-ICE & e-fuel,
H2 Fuel cell propulsion tech.**

FEV engines
> 45% efficiency
in FEV hybrid-BEV

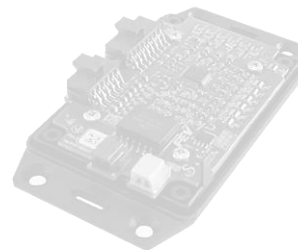
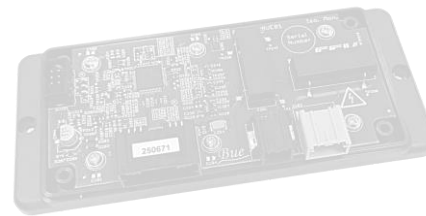
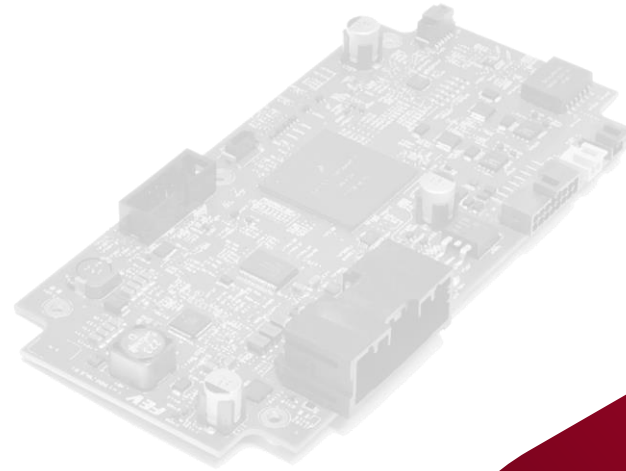
FEV's proprietary BMS

FEV

FEV's proprietary Battery Management System enables new players to quickly enter the xEV market

FEV offers

- ▶ BMS hardware and software solutions
- ▶ BMS solution for automotive and industrial applications
 - ▶ Different chemistries (NMC, LFP, LTO, SIB, etc.)
 - ▶ From 12 V up to 1000 V
 - ▶ A-SPIICE and ISO26262 certified
 - ▶ AUTOSAR and AUTOSAR-free variants
- ▶ Customization services for prototypes or series applications
- ▶ Additional services as modification/extension, integration, commissioning and calibration



- ▶ Proven solutions applied to various applications and continuously optimized since 2007
- ▶ White box option to enable customer to use FEV's solution as basis for its own development
- ▶ Customization by FEV to exactly address customers' needs
- ▶ Customer friendly license model, as one time license fee and tailored license scope

Who we are

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#FeeEVolution

FEV

At FEV we were responsible for developing the BMS-Application Software for an Asian OEM

BEV

Passenger car application

LFP

Cell chemistry



>20

ASW features

>50

Software components

>350

Software Units

>1500

I/Os

>4000

Tunable parameters

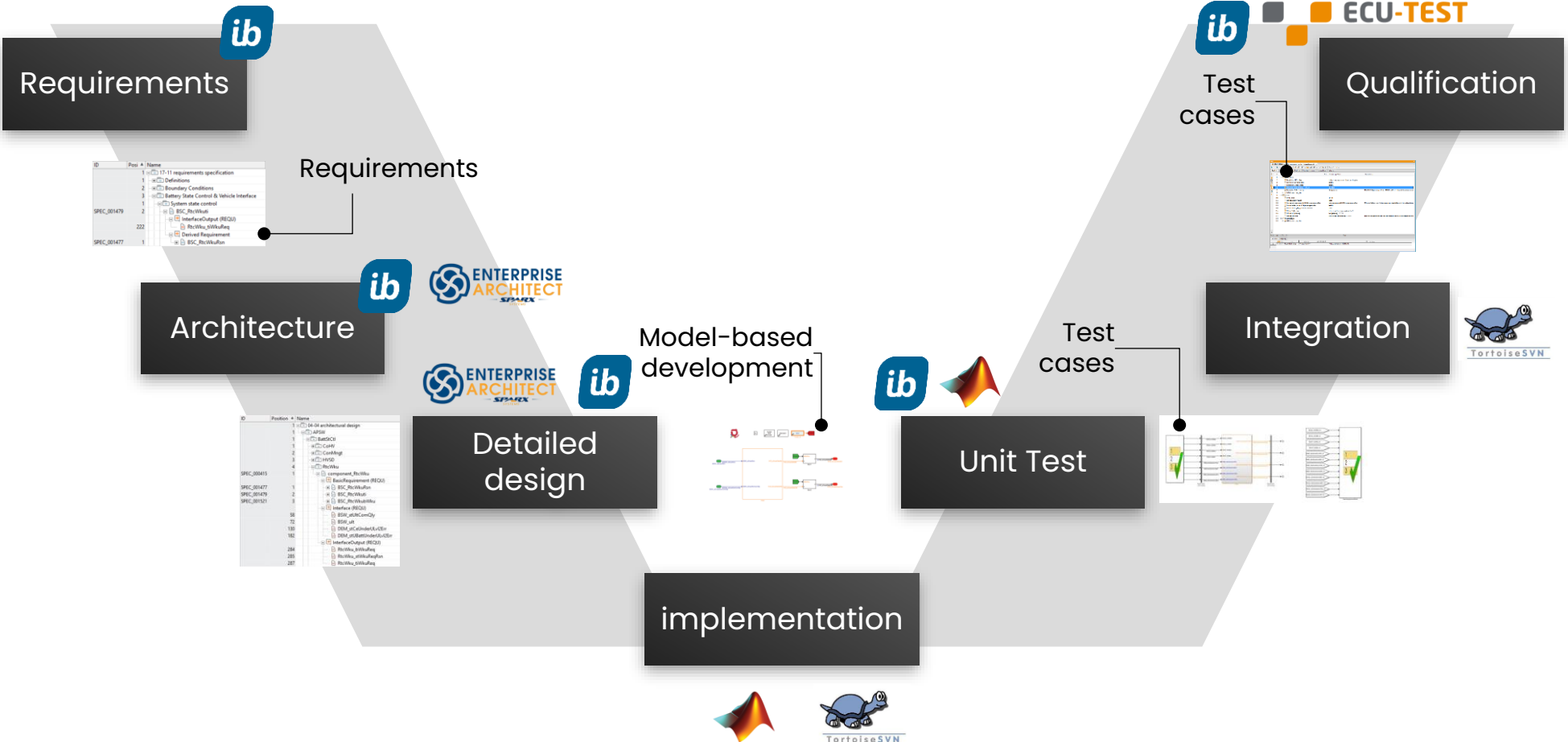
>500

Software requirements

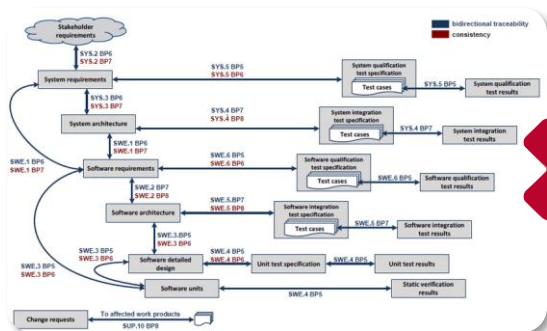


FEV

FEV's toolchain for ASW development was based on different tools and several scripts to bridge them



Using disconnected best-in-class tools does not always result in the best process since integrating tools can be challenging!



Traceability between tools requires ad-hoc plug-ins



Ad-hoc plug-ins require **maintenance**



Maintenance requires **time**



Time is **money**

Who we are

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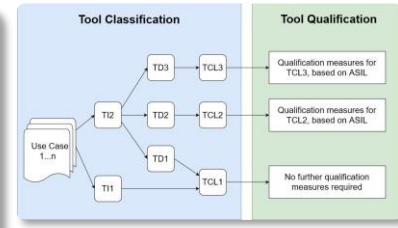
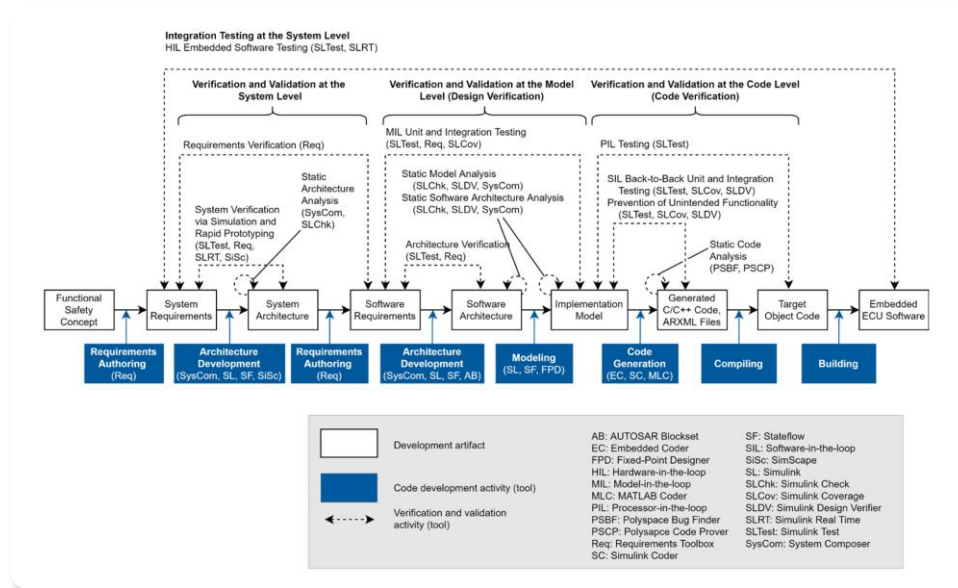
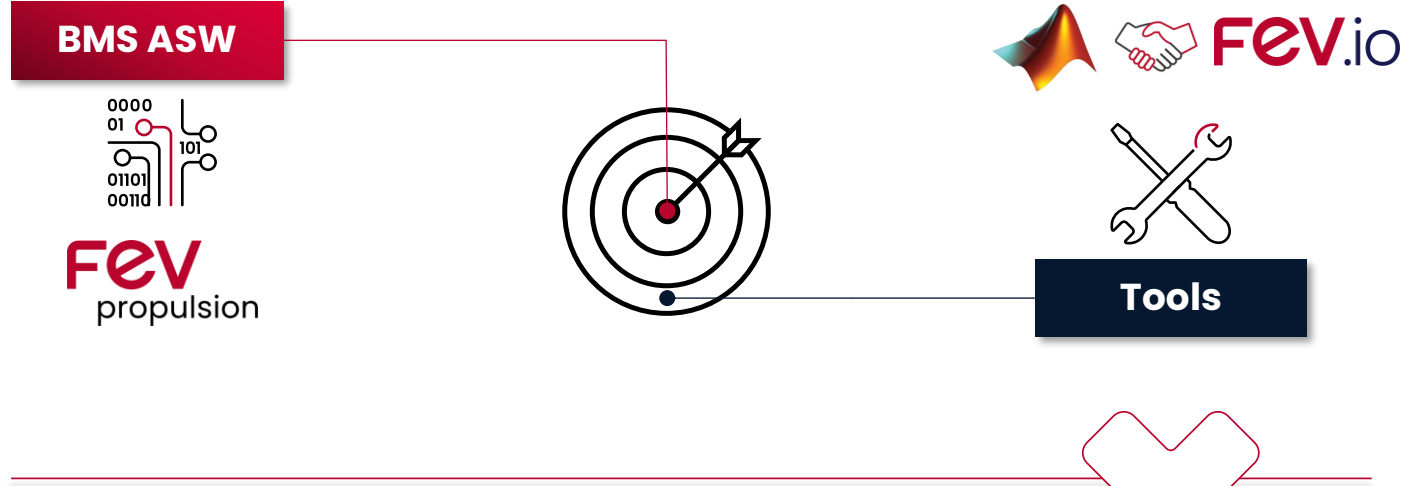
Conclusions

#FeeEVolution

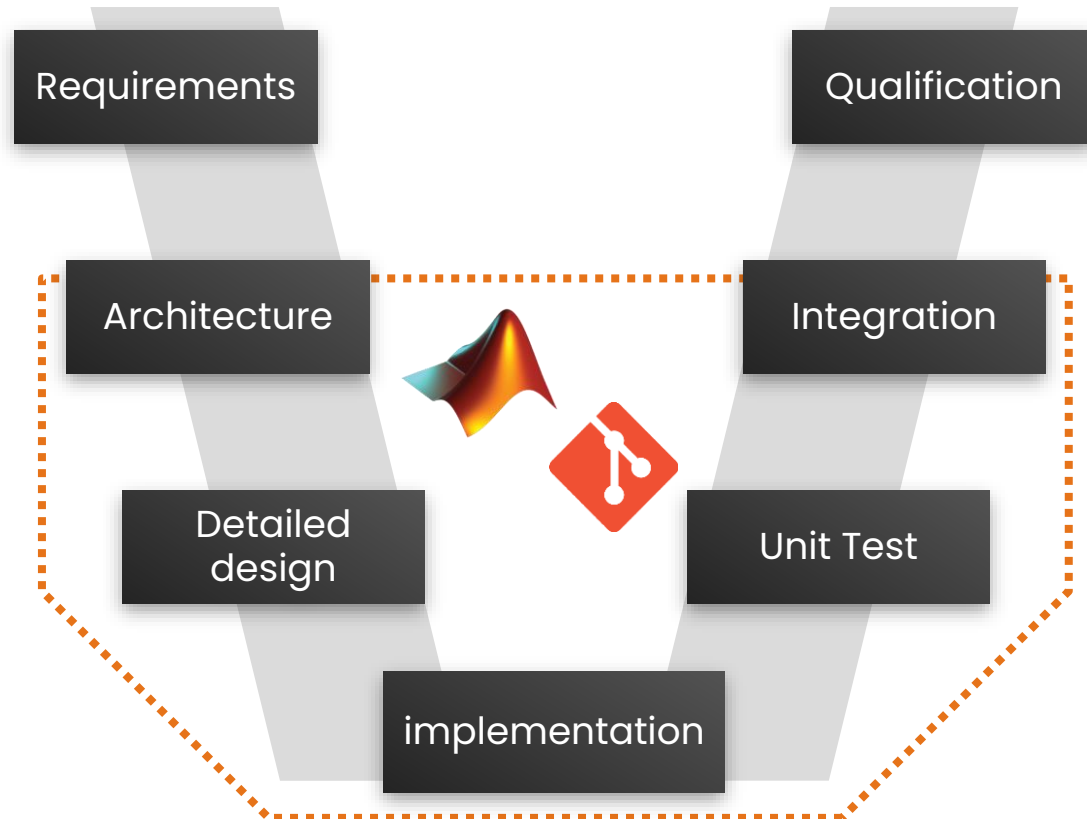
FEV

THE APPROACH

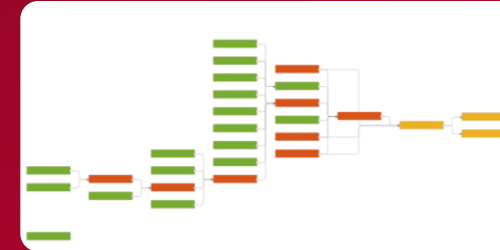
The MathWorks' IEC Certification Kit enabled us to focus on the project core business



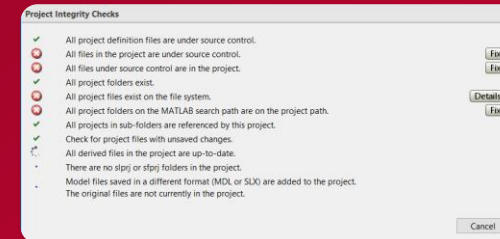
As fewer working environments as possible...



... MATLAB Project made consistency checks easy



Dependency Analyzer



Project Integrity Checks



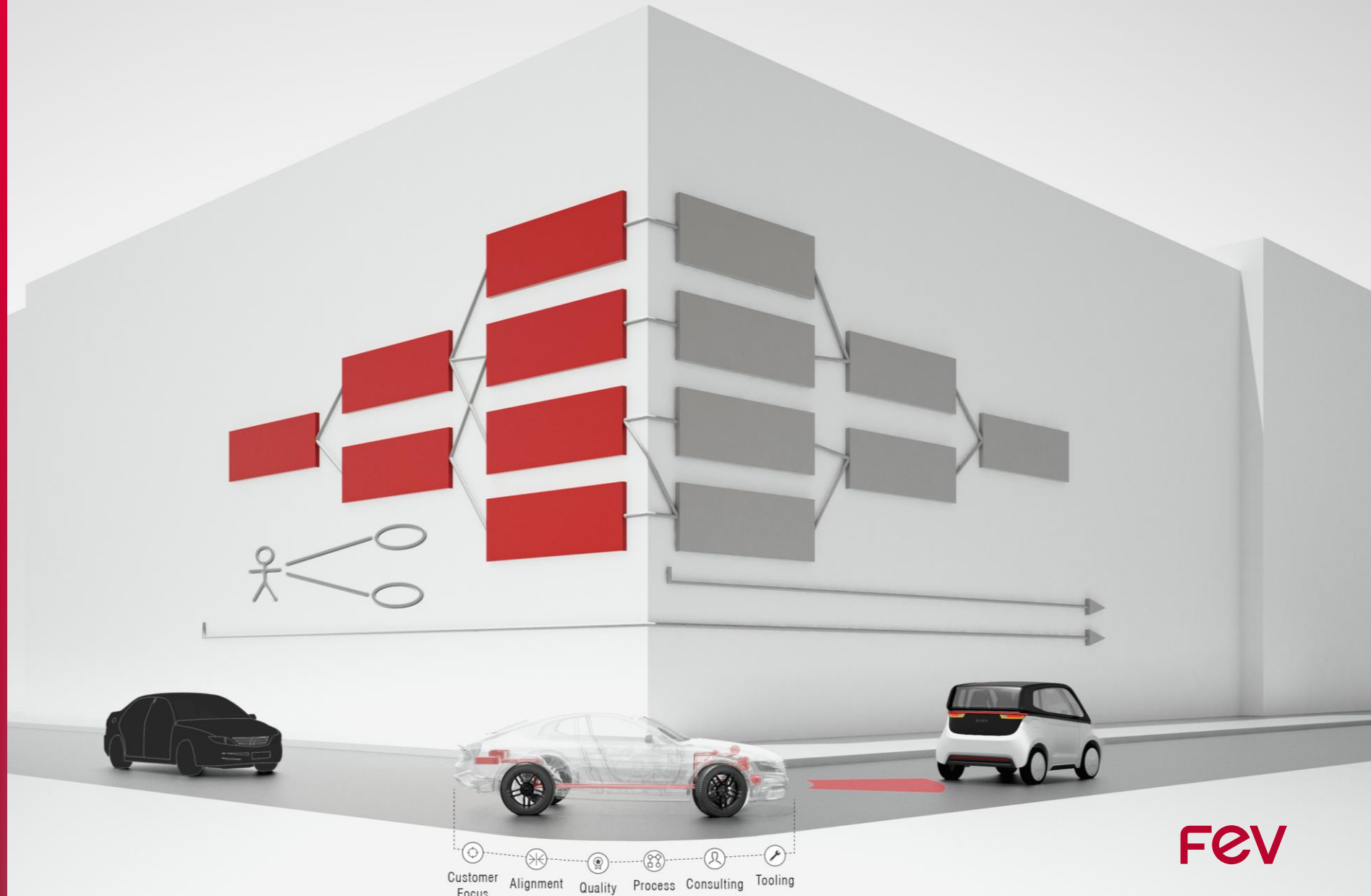
Model Dashboards

Consistency and Quality checks in 1 place

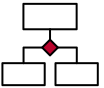


ARCHITECTURE

A strong architecture provides a solid foundation for building software that meets the needs of users and stakeholders



System Composer proved to be an excellent tool for modelling of AUTOSAR software architectures



Architecture Design in **System Composer** – AUTOSAR SW Architecture



Global data & configuration



Improved consistency with detailed design



Model Centric Approach: models are the single source of truth, supported by notes, requirements and interfaces specification

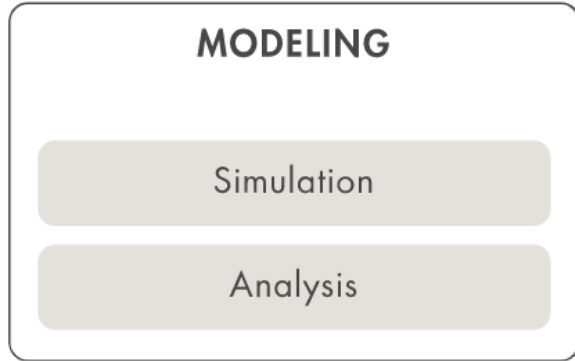
The image displays a software development environment with several tool windows:

- Block diagram:** A graphical representation of a system architecture with interconnected components.
- Code Mapping:** A window showing the mapping between model elements and code, including a table of model parameters and their corresponding code attributes.
- Model Notes:** A window containing text describing the component's functionality: "The component is responsible for enabling cell balancing functionality. Balancing is carried out with respect to the SOC difference at TOC."
- Requirements Manager:** A window displaying a list of requirements, including their IDs (e.g., R20, R21) and descriptions.
- Local Interfaces Specification:** A window showing a list of local interfaces, each associated with a database icon.

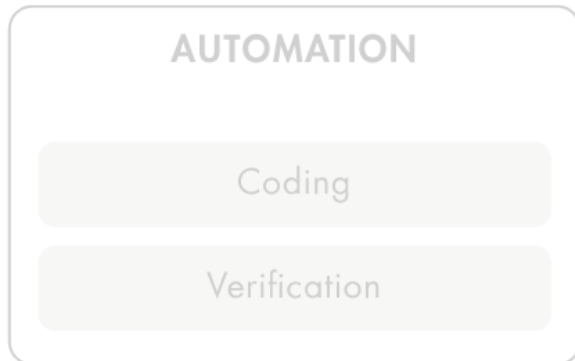
➤ Improved model quality



Following Model Based Design guidelines ...

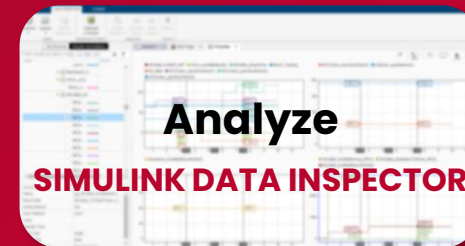


Try out **new** ideas.
Fast **repeatable** tests.



Eliminate **manual** steps
and reduce **human** error.

... We simulated models already during design phase



Pre-validated models for earlier integration



“Premature optimization is the root of all evil”

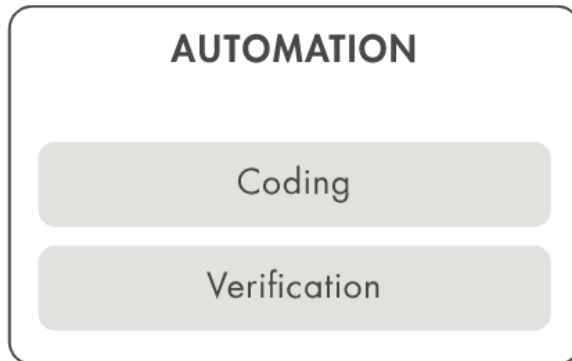
Donald Knuth - “The Art of Computer Programming”

Once team's know-how about the processes and tools was established...

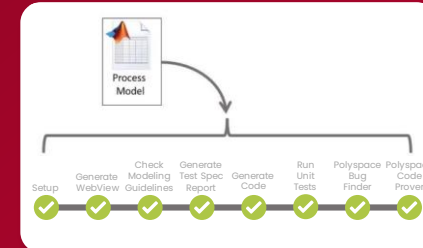
... We started the automation with Process Advisor



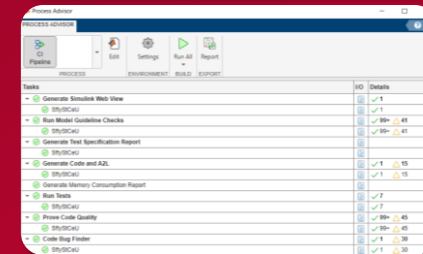
Try out **new** ideas.
Fast **repeatable** tests.



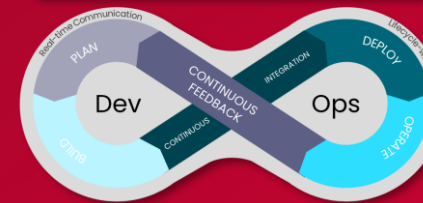
Eliminate **manual** steps
and reduce **human** error.



Customizable Process



Process Advisor App

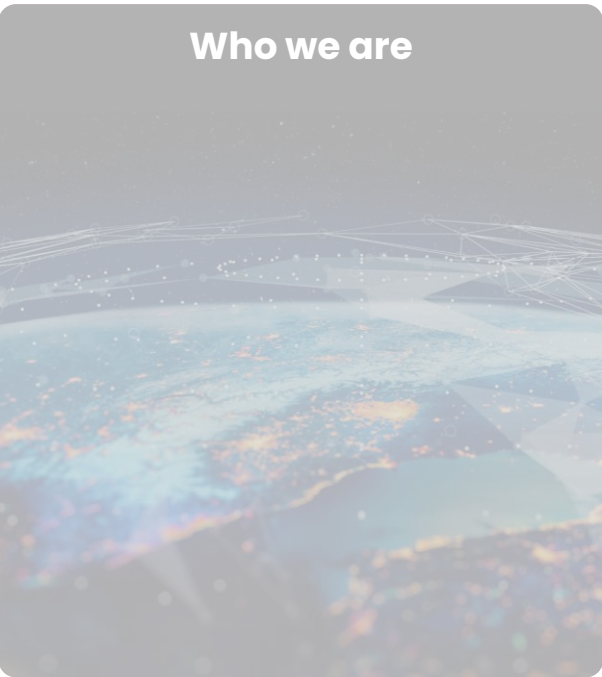


Integration in CI system

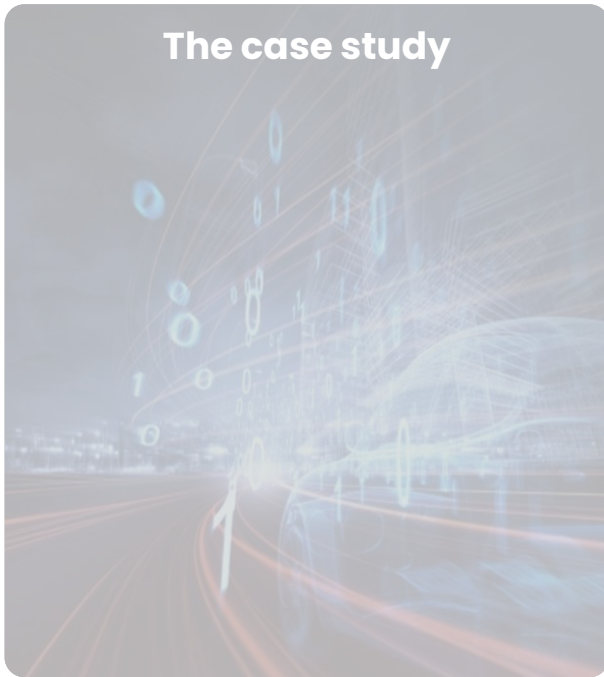
➤ **Easy and quick automation of the build process**



Who we are



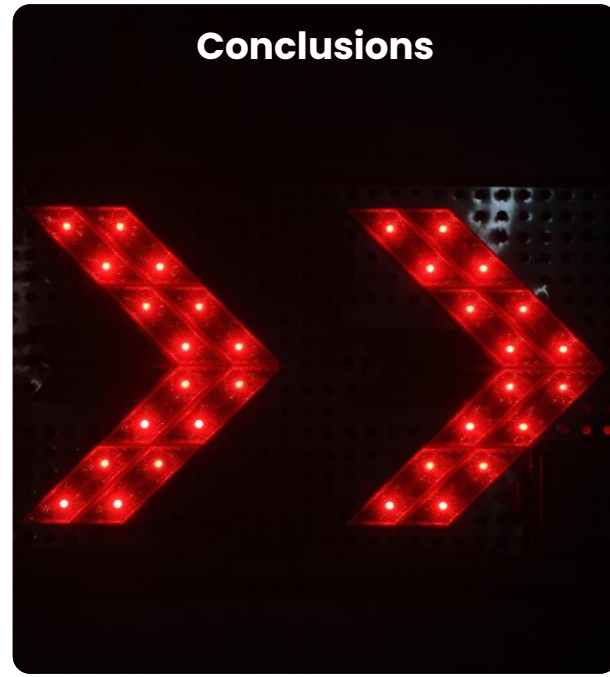
The case study



Our approach



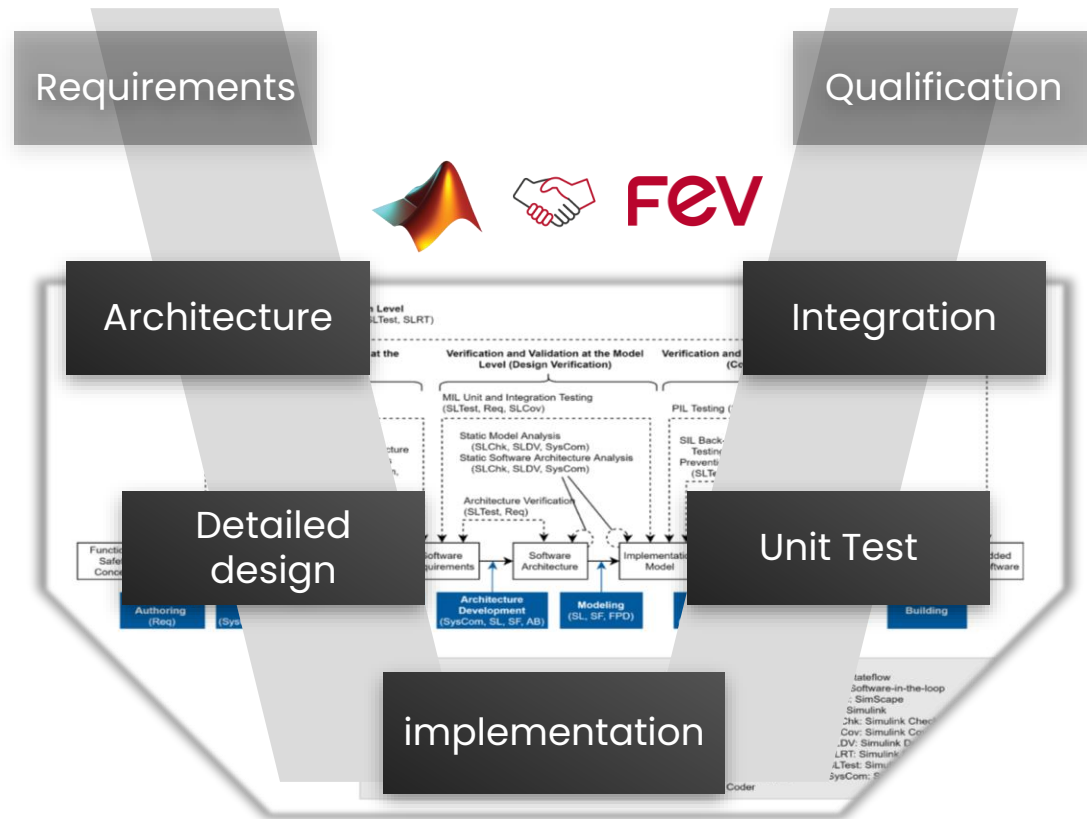
Conclusions



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FEV

With the help of the IEC certification kit and MathWorks tools we could seamlessly achieve project targets and process compliance



- ▶ Successfully **upscaled** the MathWorks IEC Certification kit to a series development project
- ▶ Improved **traceability** and **consistency** between development artifacts
- ▶ **Reduced** overall **toolchain costs** and **reduced** overall **development time**¹

Our plan...

- ▶ Continuously **upgrade** tools to benefit from the latest features
- ▶ **Tailor** the MBD process to **AI** development needs
- ▶ **Apply** the BMS software case study to other ECUs
- ▶ **Upscale** the software process to system level

Interested? Get in touch with us!



Dr. Ing. Giovanni Vagnoni

FEV Iberia SL

Department Manager for
Electric Powertrains

+34 615 397 624
vagnoni_gi@FEV.com



Mohammad Abu-Alqumsan

MathWorks

IEC Certification Kit
Product Marketing

+49 89 45235 6801
mabualqu@mathworks.com

feel evolution