VIRTUAL ECU

ANSYS BEST PRACTICE SESSION:
„SIMULATION DRIVEN PRODUCT DEVELOPMENT FOR EVERYONE“

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FRIEDERIKE LOERKE

CASCON 2019

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Simulation Process Management: Virtual ECU
Motivation

Load derivation from a system perspective

Load profile

?

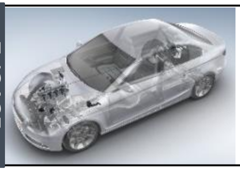
Cut out design element for product integration | load / load capacity level

Reliability Assessments

geometry-independent design rule, e.g. $\sigma \leq \sigma_{max}$ | stress / strength level

Level 0

System:
Vehicle

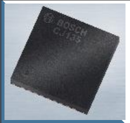
Level 1

Sub-System:
RB system
(e.g. injection system)

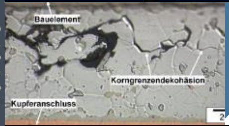
Level 2

Manufactured Item:
ECU

Level 3

Assembly

Level 4

Component

Level 5


Material, Interface

How to establish a robust data / information exchange between product-independent design element assessments & product-specific load derivation and load path design?

Motivation

- Only with standardized load path methods transparent requirements for design elements can be derived
- Standardized load path methods as enabler for tool based, automatized evaluation of design elements in mechanical architectures

Simulation Process Management: Virtual ECU
Motivation

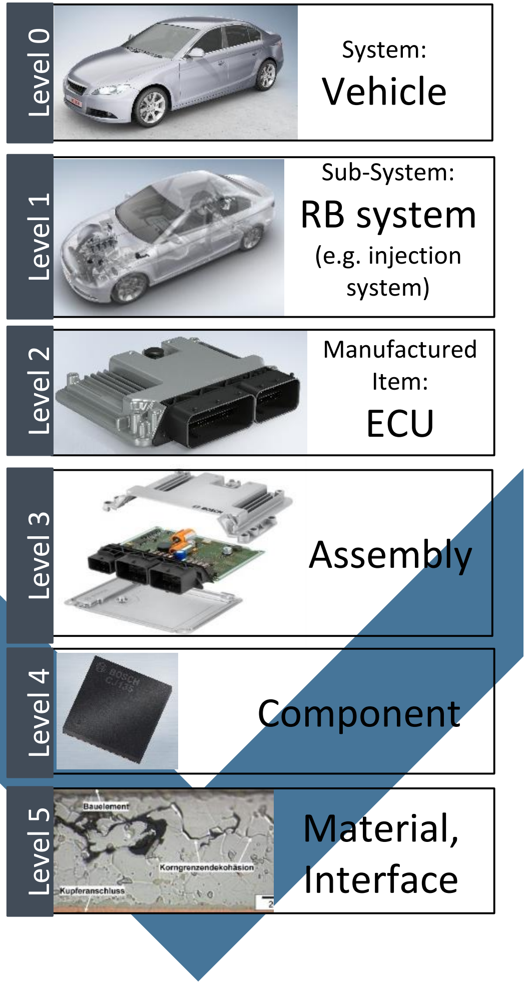
Load derivation from a system perspective

Automated setup of ECU models to feed reliability models with needed information

Cut out design element for product integration — load / load capacity level

Hosting of detailed reliability models

geometry-independent design rule, e.g. $\sigma \leq \sigma_{max}$ — stress / strength level



- Democratization in CAE-based product development means to empower non-experts to take advantage from simulation technology
- CAE experts could put the power of simulation <u>safely</u> into non-experts hands to overcome the general lack of CAE engineers

Democratization ?

Simulation Process Management: Virtual ECU
Outline

- Motivation
- Our journey to Simulation Process Management (SPM)
  - Drive ANSYS via Microsoft Excel / GUI
  - Process Automation & ANSYS WB Scripting by ACT
- Simulation Process Management
  - SPM Framework “Concert Hall” by Dynardo GmbH
- Virtual (Assembly of) ECU as automated solution for load derivation
  - “Deep-Dive” in customized workflow
- Outlook and Summary

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Simulation Process Management: Virtual ECU

Our journey to Simulation Process Management

Drive ANSYS via Excel / GUI

- APDL Scripting
  - Excel-Front-End
  - MATLAB & python GUI

2012

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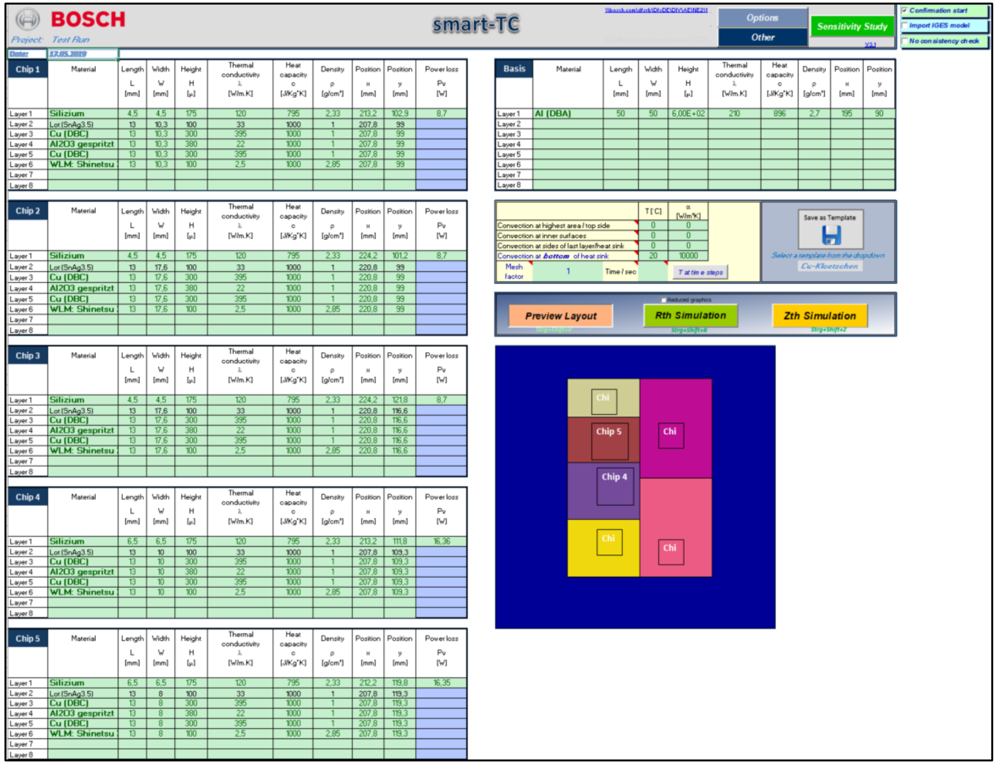
Simulation Process Management: Virtual ECU

Drive ANSYS via Microsoft Excel: smart-TC

VBA-Driven MS Excel-Frontend

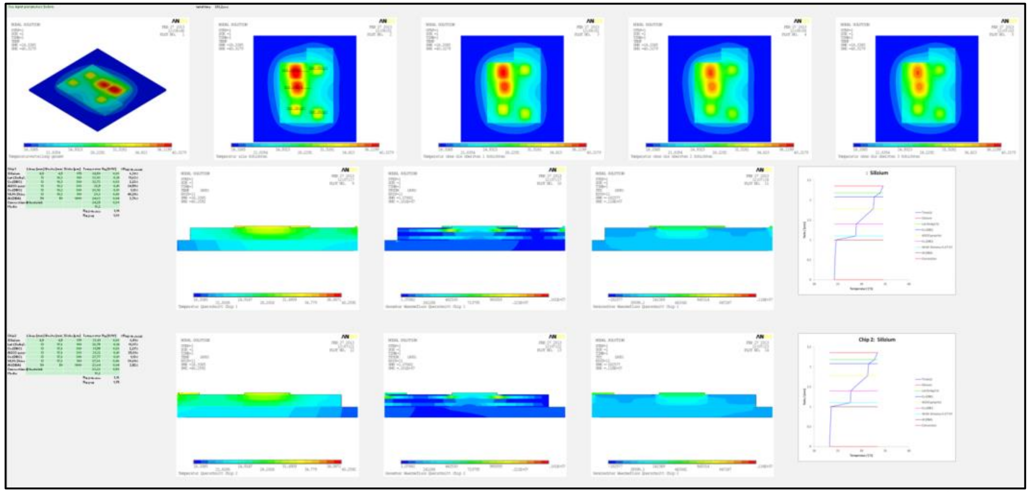


Excel-based user interface

APDL-Driven ANSYS Backend

```
*dim,n_s,array,n_c
*dim,n_s1,array,n_c
*dim,a_s,array,n_c,num_comm+n_ctot
*dim,b_s,array,n_c,num_comm+n_ctot
*dim,d_s,array,n_c,num_comm+n_ctot
*dim,d_tot,array,n_c
*dim,nc_h,array,n_c
*dim,dtot_h,array,n_c

*dim,mpformtrx,array,n_c,n_ctot
*dim,rtt,array,1,1
n_num=0

*do,i,1,n_c
    start=start%i%
    *if,Cylndr_%start%,eq,1,then
        p_wq(i)=1e6*max(K%start%,1e-20)/(3.141592654*0.25*C%start%*C%start%)
    *else
        p_wq(i)=1e6*max(K%start%,1e-20)/(C%start%*D%start%)
    *endif

    p_min(i)=1e6*1e-16/(C%start%*D%start%)*(1+1e-8)
    nc_h(i)=n_c%i%
    start=start%i%+n_c%i%-1
    *do,k,1,n_c%i%
        *if,n_c%i%,gt,k,then
            *if,K%start%,gt,0,then
                *if,Cylndr_%start%,eq,1,then
                p_wq(i)=1e6*max(K%start%,1e-20)/(3.141592654*0.25*C%start%*C%start%)
                *else
                p_wq(i)=1e6*max(K%start%,1e-20)/(C%start%*D%start%)
                *endif
                nc_h(i)=k

            *endif
        *endif
```

User Input defines APDL Code definition



Post processed Results visualized in Excel

Simulation Process Management: Virtual ECU

Our journey to Simulation Process Management

Drive ANSYS via Excel / GUI

- APDL Scripting
  - Excel-Front-End
  - MATLAB & python GUI

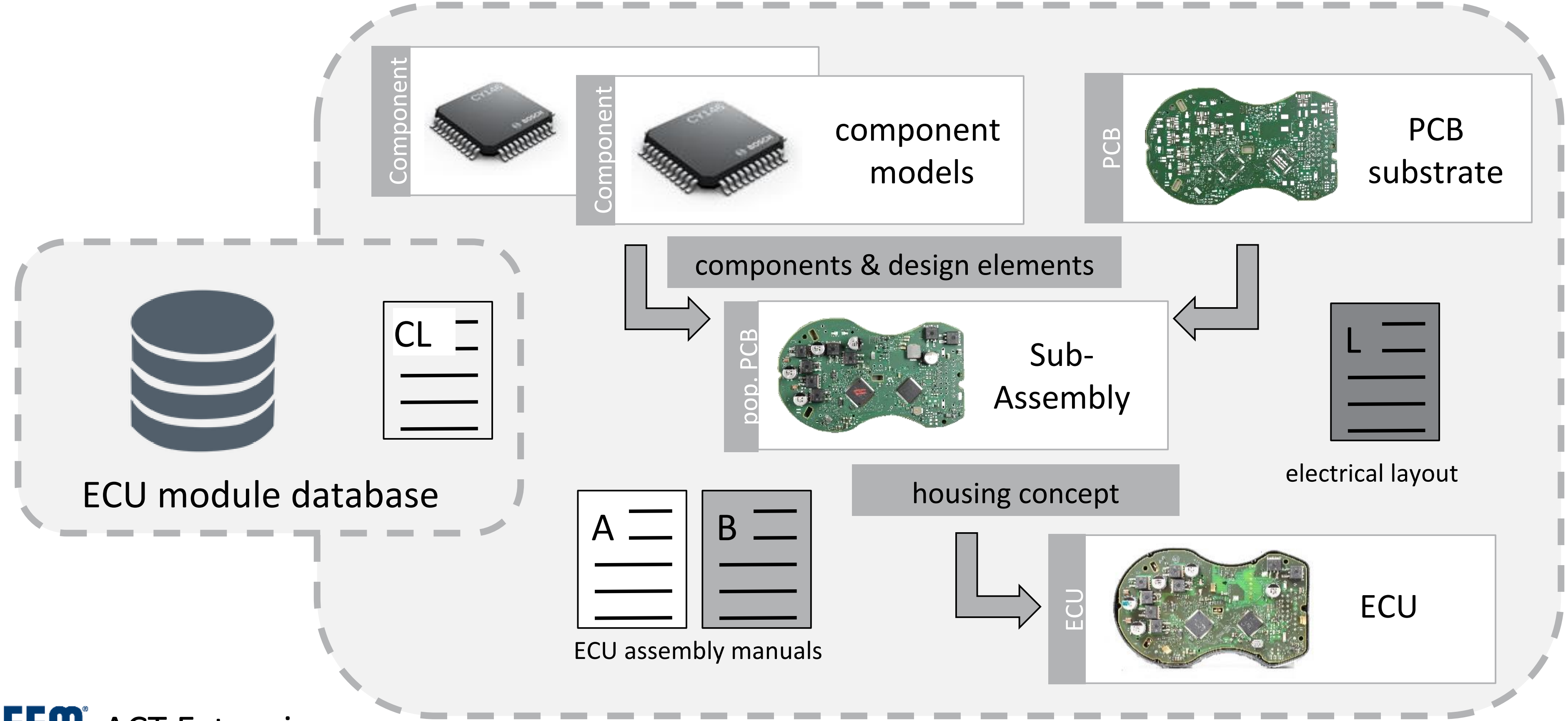
2012

Automation & WB Scripting

- Drive ANSYS via **ACT** (Application Customization Toolkit) wizards

2016

Simulation Process Management: Virtual ECU
Virtual Assembly of PCB/ECU



CADFEM ACT Extension

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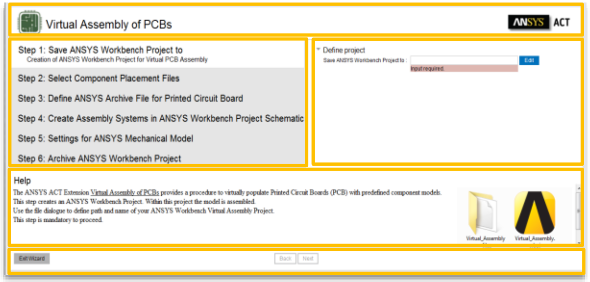
Simulation Process Management: Virtual ECU

Virtual Assembly of PCBs / ECUs-ACT

CADFEM ANSYS

ACT Wizard Programmierung: XML + Python + HTML

- XML: Konfiguration + GUI-Definition
- Python: Implementierung
- HTML (optional): Benutzerhilfe



Python-Datei

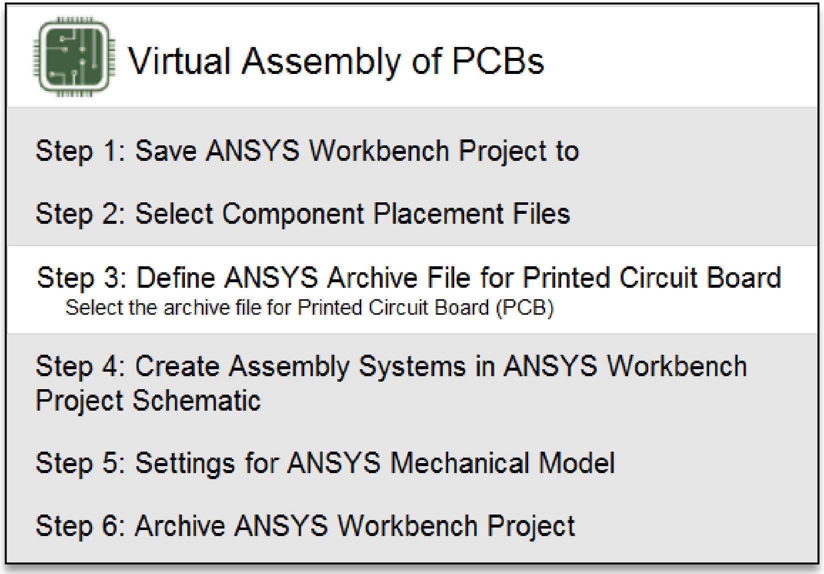
```python
#==========================================================
# step 1
#==========================================================
def oninit(step):
    global _controller
    if _controller == None:
        _controller = controller.Controller(ExtAPI, step, globals())

def save_project_to(step):
    return _controller.save_project_to(step)

def reset_step1(step):
    return _controller.reset_step1(step)
```

XML-Datei

```xml
<wizard name="Virtual Assembly of PCBs" version="1" context="Project" icon="wizard_icon">
    <description>Project schematic wizard for virtual assembly of PCBs.</description>

    <!-- step 1 -->
    <step name="WorkbenchProjectCreation" caption="Step 1: Save ANSYS Workbench Project to" context="Project" version="1" HelpFile="help/project_save_as.html">
        <description>Creation of ANSYS Workbench Project for Virtual PCB Assembly</description>

        <callbacks>
            <oninit>oninit</oninit>
            <onupdate>save_project_to</onupdate>
            <onreset>reset_step1</onreset>
        </callbacks>

        <propertygroup name="step_1" display="caption" caption="Define project">
            <property name="save_project_to" caption="Save ANSYS Workbench Project to :" control="custom" class="src.templates.file.FileSaveObj">
                <attributes filters="Workbench Project Files (*.wbpj)|*.wbpj" buttonLabel="Browse"/>
            </property>
        </propertygroup>
    </step>
```

© CADFEM 2017 CADFEM ANSYS Simulation Conference 2017 am 15.-17. November 2017 in Koblenz 13

ANSYS ACT-Driven ANSYS-Frontend



Krätschmer, D., Zhang, Y.: "Automatisierter Workflow zur modellbasierten Bauelementbestückung von Leiterplatten elektronischer Steuergeräte", CADFEM ANSYS Simulation Conference 2017

Simulation Process Management: Virtual ECU

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2016

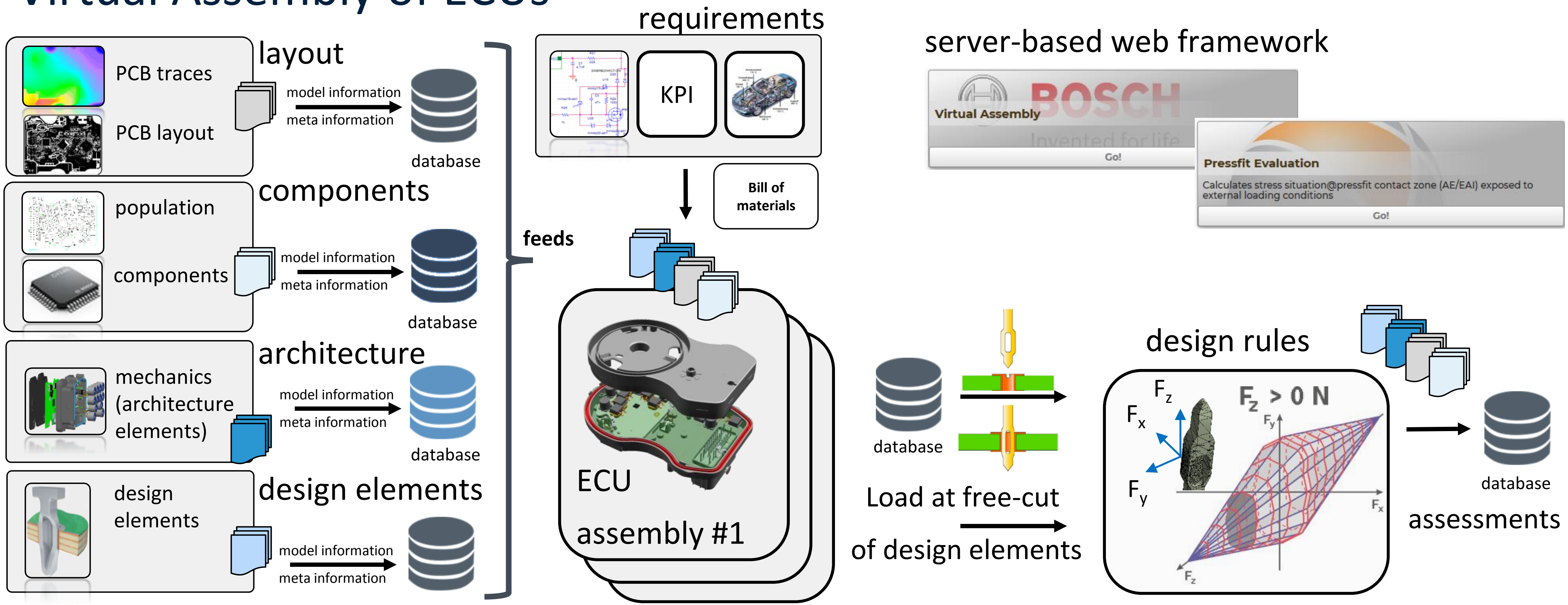
Simulation Process Management

- Simulation Process Management based on Dynardo‘s optiSLang and Concert Hall
- Web Applications

2019

Simulation Process Management: Virtual ECU

Virtual Assembly of ECUs



Various information sources → Databases → Automated Virtual ECU assembly → Standardized Load Derivation → Standardized Design Element Assessment → Lessons learned

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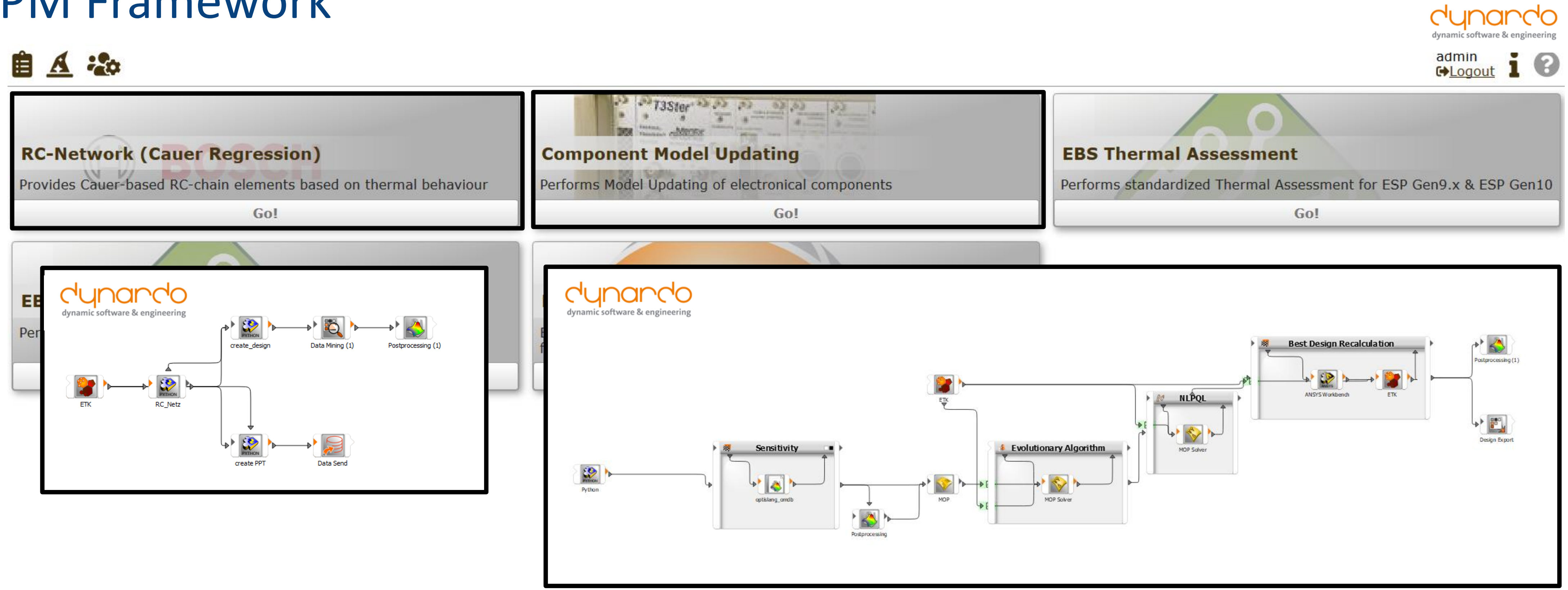
Simulation Process Management: Virtual ECU

SPM Framework



Dynardo’s web framework hosts optiSLang projects offering user input and upload opportunities

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Simulation Process Management: Virtual ECU
Embedding and extension of ACT solution

Web-based provision of “**Virtual Assembly of ECUs**”

Step by step approach

Filter	Prepare PCB	Populate PCB	Assembly	Physics	Solve	Postprocessing	dDOE	pDOE	Run

Prepare PCB

Substrate

ESP_Gen9_3_EV7140_C1

pcb - ESP_Gen9_3_46pol_16HC1221C00000005
ecad - 16HC1221C00000005_1030L06568_v01
cpreport - CPR_1030L06568_v01

choose substrate

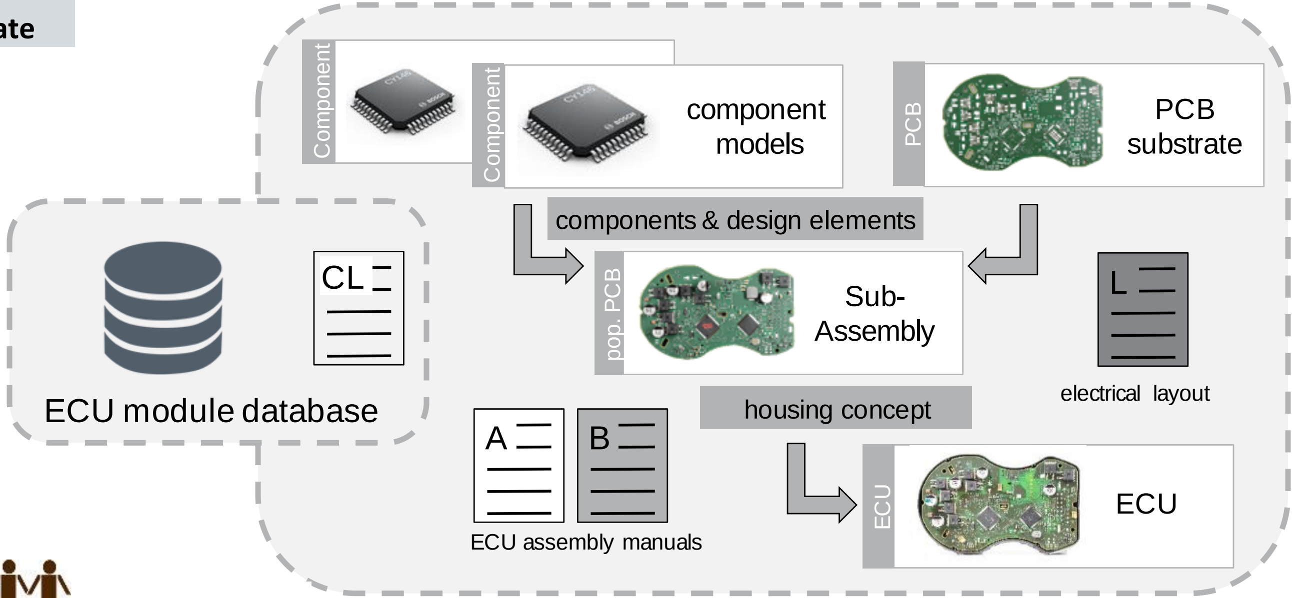
Components

ESP_Gen9_Gen10_Components

components - Thermal_270248002
components - Thermal_270248006
components - Thermal_0272240286AA
components - Thermal_2261098422T
components - Thermal_2261098423T
components - Thermal_2261098507T
components - Thermal_8909002288
components - Thermal_8909003608
components - Thermal_8909003680
components - Thermal_8909003704
components - Thermal_8909004443
components - Thermal_8909004600
components - Thermal_8909005344
components - Thermal_8909006289
components - Thermal_8909008656
components - Thermal_1267375118
components - Thermal_1267375119
components - Thermal_8909004442
components - Thermal_1267375251
components - Thermal_8909005638
components - Thermal_8909006290
components - Thermal_8909003190
components - Thermal_8909B01907
components - Thermal_1270E3546601T
components - Thermal_1270E3546501
components - Thermal_1270E3558301T
components - Thermal_8909006510

choose components

ready to use for
everyone



knowledge provided by
experts

Prepare PCB
Populate PCB
Assembly
Load Case
Solve
Post-processing

Mission: CAE workflows are fully covered by SPM based on standardized database-hosted modules

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Simulation Process Management: Virtual ECU

Automotive Electronics | AE/EBS | 2019-08-07
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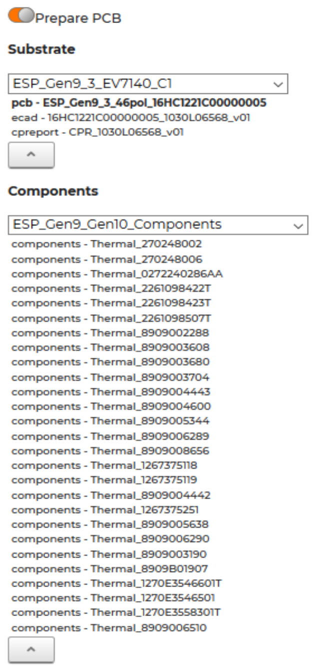
Simulation Process Management: Virtual ECU
Embedding and extension of ACT solution

Web-based provision of “**Virtual Assembly of ECUs**”



- Approach to host CAE engineering workflows by central web-service ready to use for AE associates
- CAE Apps serve as baseline for highly standardized design element reliability assessments in ECU architectures
- CADFEM-provided CAE workflow for general ECU-related simulations embedded in Simulation Process Management (SPM)-Framework
- ACT-programming as a software project (architecture, documentation, testing,…)
- Scalable framework solution ready to be extended by additional ANSYS modules

Relevant CAE workflows are fully covered by SPM based on standardized database-hosted modules

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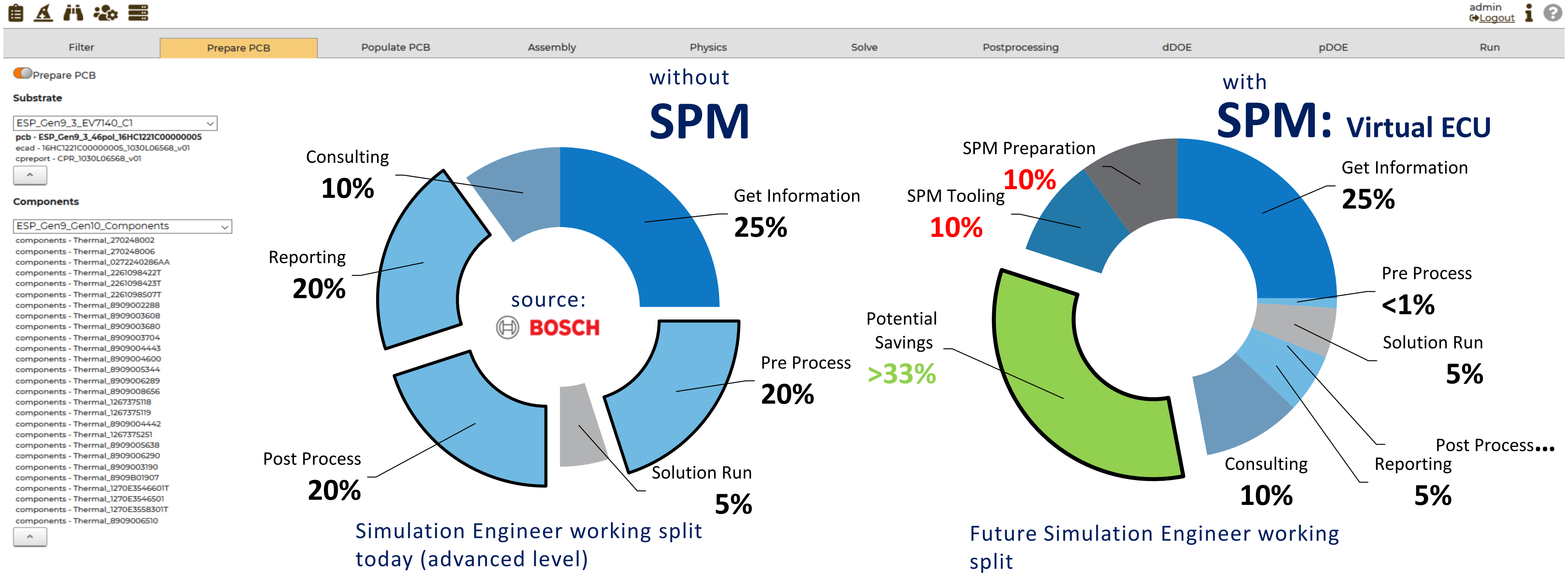
Simulation Process Management: Virtual ECU
Effect of Digital Transformation in CAE Engineering

Web-based provision of CAE Engineering workflows



Automation of time-consuming tedious tasks promises efficiency gains of 33% (mid-term perspective)

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Simulation Process Management: Virtual ECU

Outlook

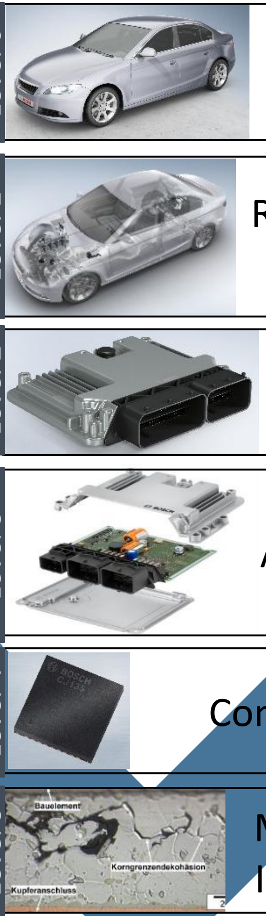
Load derivation from a system perspective

Automated setup of ECU models to feed reliability models with needed information ✓

Cut out design element for product integration — load / load capacity level

Hosting of detailed reliability models ✓

geometry-independent design rule, e.g. $\sigma \leq \sigma_{max}$ — stress / strength level



Level 0	System: Vehicle
Level 1	Sub-System: RB system (e.g. injection system)
Level 2	Manufactured Item: ECU
Level 3	Assembly
Level 4	Component
Level 5	Material, Interface

- Democratization in CAE-based product development means to empower non-experts to take advantage from simulation technology ✓
- CAE experts could put the power of simulation <u>safely</u> into non-experts hands to overcome the general lack of CAE engineers ✓

Democratization !

Simulation Process Management: Virtual ECU

Outlook & Summary

Any Questions?

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