Siemens’ Strategy for Digitalization of the Ideation and Engineering Process

Transform Product Development with “Digital Twins” for Closed Loop Performance Engineering

Jan Leuridan
Senior Vice-President, Simcenter Portfolio, Siemens PLM Software
The world is evolving …
… challenging the engineering of tomorrow’s products

- Smart systems integrating mechanical, electrical, controls
- Interconnected Systems of Systems
- New materials …
- New manufacturing methods …
- Continuous Development

Siemens PLM Software
Siemens PLM Software Digital Innovation Platform
Digitalization of the future… available today

With the Digital Innovation Platform, you can digitalize your entire innovation process, from the Idea through Production to Operation — and back.

Simcenter™
Simcenter Portfolio
Frontloading Verification and Validation (V&V)

Enabling “Digital Twin” for Closed Loop Performance Engineering

Design

Simcenter™ Portfolio

System Simulation  |  CAE Simulation  |  Physical Testing

Design space exploration

Teamcenter - Digital Continuity for Multi-Domain Traceability, Change and Configuration
Simcenter Portfolio
Aligning our priorities to advance “Digital Twin” maturity

Increasing scope
- Multi domain & Multiphysics
- Multifidelity
- Industry experience

Delivering insight
- Intelligent Design Exploration
- Simulation-Test
- V.R. & A.R.

Enabling enterprise collaboration
- Openness
- Cloud
- Deployment flexibility
- Data & Process Mgmt

Saving engineering time & accelerating ROI
- Workflow & User Experience
- Services & Support
- Engineering
Increasing scope
Battery design: STAR-CCM+, Battery Design Studio and Amesim

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**CELL DESIGN**

**PRESIZING**

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**BATTERY PACK**

**CELL INTEGRATION**

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**BATTERY COOLING SYSTEM**

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**FRONTLOAD**

**CONTROLS DEV.**

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**INTEGRATED PERFORMANCE**

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**SAMSUNG**

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**Improving the cooling system for jelly roll batteries**

“Using the CFD-based Thermal Management System functional model created with Simcenter STAR-CCM+ and Battery Design Studio, a close agreement between simulations and experimental measurements was achieved, validating the model against experiment with greater than 90 percent accuracy”

Dr Suman Basu – Senior Chief Engineer
Increasing scope
Expanding into Electromagnetics - Low Frequency

Electromagnetics: Torque, Power, Loss, …

Thermal  Structural  NVH  Durability  …

Simcenter 3D

Solution Time 0.0005 (s)

Particle Velocity: Magnitude (m/s)

Simcenter STAR-CCM+
Increasing scope
Expanding into Electromagnetics - High Frequency

Engineering for EMC / EMI

Example: Antenna (Radar) Design and Integration
Delivering insights
Model Based System Testing

Embed Simcenter Amesim into Simcenter Testlab

Model validation using Test results
Virtual channels to complement testing

Embedded simulation models in Test processing

to extend Testing scope

Real-Time Models

Towards unified platform for XiL Testing
Delivering insights
Integrating Virtual Reality (VR) – Towards Augmented Reality (AR)

Simcenter STAR-CCM+

Simcenter 3D*

* AR in cooperation with Siemens Corporate Technologies and Inpro
Simcenter Webapp Server

Empower extended enterprise with system simulation capabilities

Model author:
Prepare & share Simcenter Amesim models

Model consumers:
Parametrize, run, process results …

Client-Server Architecture
On-Premise & Cloud
Web-client
Any device
“We need simulation-based design validation combined with coupon level testing to establish a reliable verification process for all the material and design choices at hand.”

Dr. Yuta Urushiyama, Chief Engineer, Technology Research Division, Honda
Simcenter Portfolio – Key Enabler for Generative Engineering
Engineer innovation with intelligent exploration

<table>
<thead>
<tr>
<th>Component</th>
<th>System</th>
<th>Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking beyond the usual&lt;br&gt;Explore and optimize</td>
<td>Function drives design&lt;br&gt;Exploit knowledge</td>
<td>Exploring design space&lt;br&gt;Widen frontiers</td>
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</tbody>
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Siemens PLM Software
Generative Engineering
Enabling integrated component design for Additive Manufacturing

Performance driven design generation
50% Weight reduction
Reduced aerodynamic drag

“We have found a new way with our partners in Siemens to accelerate our innovation process”

Frank Götzke, Head of New Technologies, Bugatti

Generate component designs that “anticipate” deformations of the Additive Manufacturing (AM) process

Burner Head
AM Induced Deformation
Generative Engineering
Driving system concept innovation with design exploration

Generate Innovative system concepts through design space exploration

Initial System Generated System

75% Reduction in Power Consumption
While maintaining mixing quality and time
Generative Engineering
Architecture Exploration with Functional System Modeling

Architecture
Configuration & Parameters

Product use
Driving Cycles

Fuel Consumption

System evaluation
Analytics

Driving Pleasure
Drive Comfort

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Page 19
2018-10-15
Generative Engineering
Architecture Exploration with Functional System Modeling

System Definition

System Components
Constraints

System Architecture Generation

Including component variability...
1000’s

Generated System Architecture

Combinatorial Optimization - AI

KPI’s
Pareto Front Analysis

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Siemens PLM Software
“Digital Twin” of the Product – Multiple domains

“Digital Thread”
“Virtual” Validation of Systems for Autonomous Driving
Requiring Integrated Model Based Systems Engineering (MBSE)

Simcenter Prescan

Orchestration of Verification and Validation (e.g. HEEDS)

- Traceability
- Functional safety
- Architecture management
- Requirement management
- Application lifecycle management

Massive HPC

Real Time

Vehicle Configurations

Controls & Sensors Configurations

Traffic Scenario’s

10,000’s …
Sensor modeling – “Digital Twins”
… Critical enabler for “Virtual” Validation

### Simcenter Prescan
Physics Based Modeling of Sensors

<table>
<thead>
<tr>
<th>Camera</th>
<th>LiDAR</th>
<th>V2X</th>
<th>Radar</th>
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Simcenter Prescan

Physics Based Modeling of Sensors

Camera | LiDAR | V2X | Radar |
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Simcenter Portfolio – Towards continuous development
... Realizing the full value of digitalization

Enabling “Digital Twin” for Closed Loop Performance Engineering

Utilization

Teamcenter - Digital Continuity for Multi-Domain Traceability, Change and Configuration
Towards continuous development
Drive closed loop innovation leveraging IoT and Cloud

Field Data Collection
(Simcenter SCADAS XS)

“Model-in-the-Loop”
Virtual Sensors
(Simcenter Amesim)

Remote Monitoring
(Simcenter Testlab)

Ref.: Demonstrated at Hannover Messe, 2016
Simcenter Portfolio
... “Digital Twins” for “In-Product” application

Increasing In-product Compute Power …

Opportunity
For Real-Time “Digital Twins”

To Increase Product Performance and Lower Cost
DRS360 – A Real-Time Development Platform
Sensor Fusion and Object Classification

A Low Latency (LoLa) implementation enabling raw sensor data fusion
Application of AI to optimize processing by focus on in-field information
“Digital Twin” on the Edge

… Distributed data analytics

Real-Time Simulation
Industrial Edge
Run-time

“Digital Twin” on the Edge
Rule based data analytics

Edge App Mgmt

PLM Core Services
MindSphere

Mind App
Mind App

IoT Hardware
Simcenter Portfolio … Forward Strategy

Generative Engineering

Model Based Systems Engineering

Enabling “Digital Twin” for Closed Loop Performance Engineering

System Simulation | CAE Simulation | Physical Testing

Design space exploration

Frontload Verification and Validation

“In product” Application

Engineer innovations that deliver business impact

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Simcenter Conference Europe
December 3-5, @Hilton Prague

**Speakers**

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- Access
- ACT
- ADG Mobility
- Airbus
- Aker Solutions
- Apex Group
- Atlanting
- AVL Qpunkt
- AZL
- BAE Systems
- BASF
- B&B-AGEMA
- BMW
- Continental
- Daimler
- Danfoss
- Dipolo
- E-cooling
- Faurecia Clean Mobility
- FORD
- Gustomsc
- Honeywell
- Hoval
- Hyundai
- Iceotope
- IFP
- Imamoter
- InDesA
- Irkut
- Jaguar Landrover
- JCB
- JSC NPO Energomash
- Mahle
- Mitsubishi
- NRG
- Opel
- Poclain Hydraulics
- Qinetiq
- Renault
- Ricardo
- Rolla SP Propellers
- SACE
- SAIC Motor
- Skolkovo Institute
- Stadlerrail
- Tetrapack
- Unilever
- Valeo
- VDL
- Voith Turbo
- Volvo Truck
- Vyaire Medical
- Wartsila
- ZF
- ZFW
- …
THANK YOU

Jan Leuridan
Senior Vice-President, Simcenter Portfolio, Siemens PLM Software