Digitalization of Systems Engineering – Examples and Benefits for the Enterprise

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Increasing Need for Integrated Electric Power Systems

Burke Class Destroyer

By Petty Officer 1st Class RJ Stratchko

7.5 MW + Geared Propulsion

Zumwalt Class Destroyer

U.S. Navy photo courtesy of General Dynamics Bath Iron Works/Released

78 MW Integrated Electric Power

Future Surface Combatant

Power Requirements: TBD

Increased Demands for Electric Power:

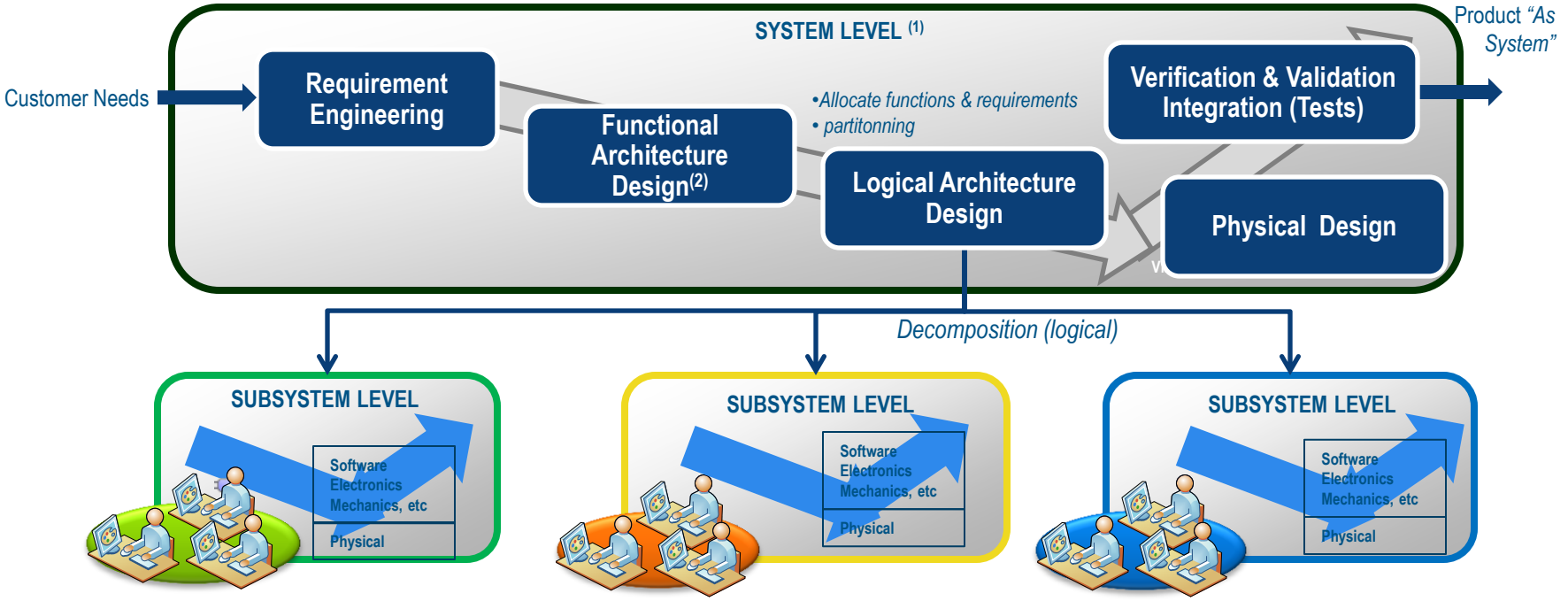
- Electromagnetic Railguns
- Laser Weapons
- SPY Radar
- Electronic Warfare
- BMD

What is the right combination of power generation and energy storage to meet future combat needs?

As Is Business Process

Governance (3)

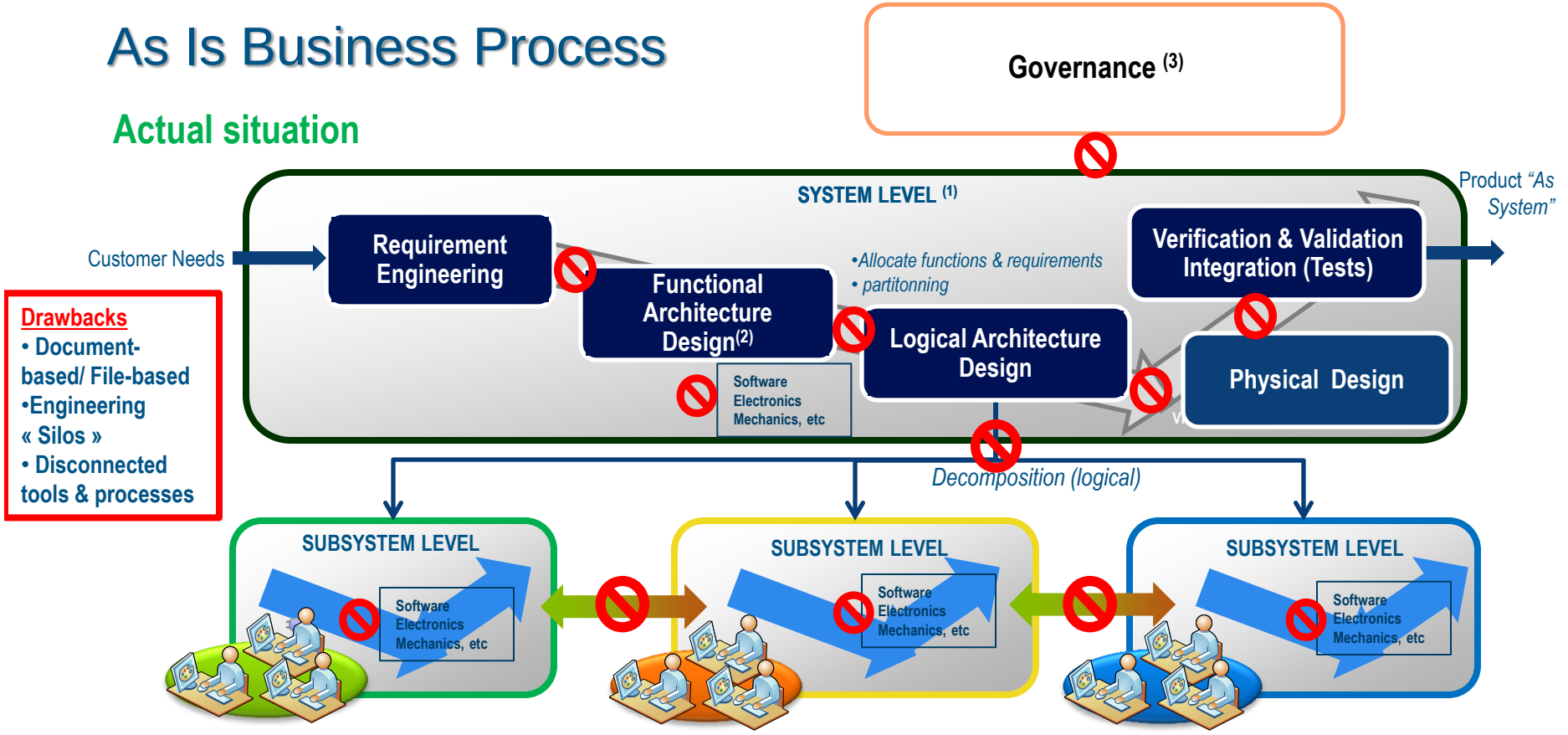
Overview



(1) Abstraction level (system decomposition by levels)
(2) Functional Analysis
(3) Configuration Management, Change Management, Portfolio Management, BOM Management, Decision Making, Issue & Defect , Project Management

As Is Business Process

Actual situation



(1) Abstraction level (system decomposition by levels)
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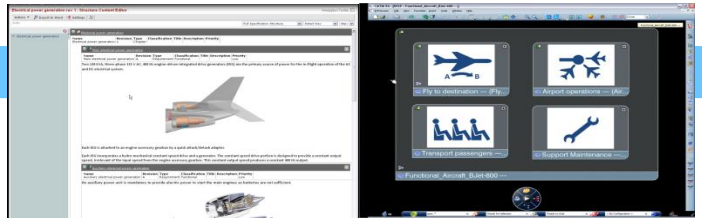
Example: Electrical Process Systems Engineering

Requirement, Functional

Requirements capture
Requirements management
Define functional architecture



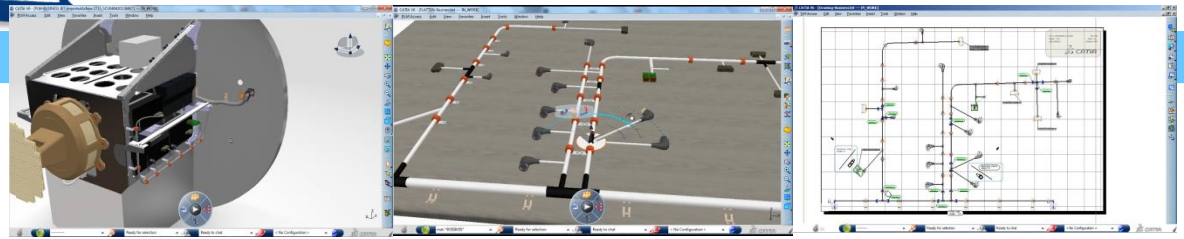
Logical

2D & 3D Logical architecture design
2D Wiring diagrams
Logical Wire routing in pathways
Wire dimensioning
Architecture validation

GENERATIVE

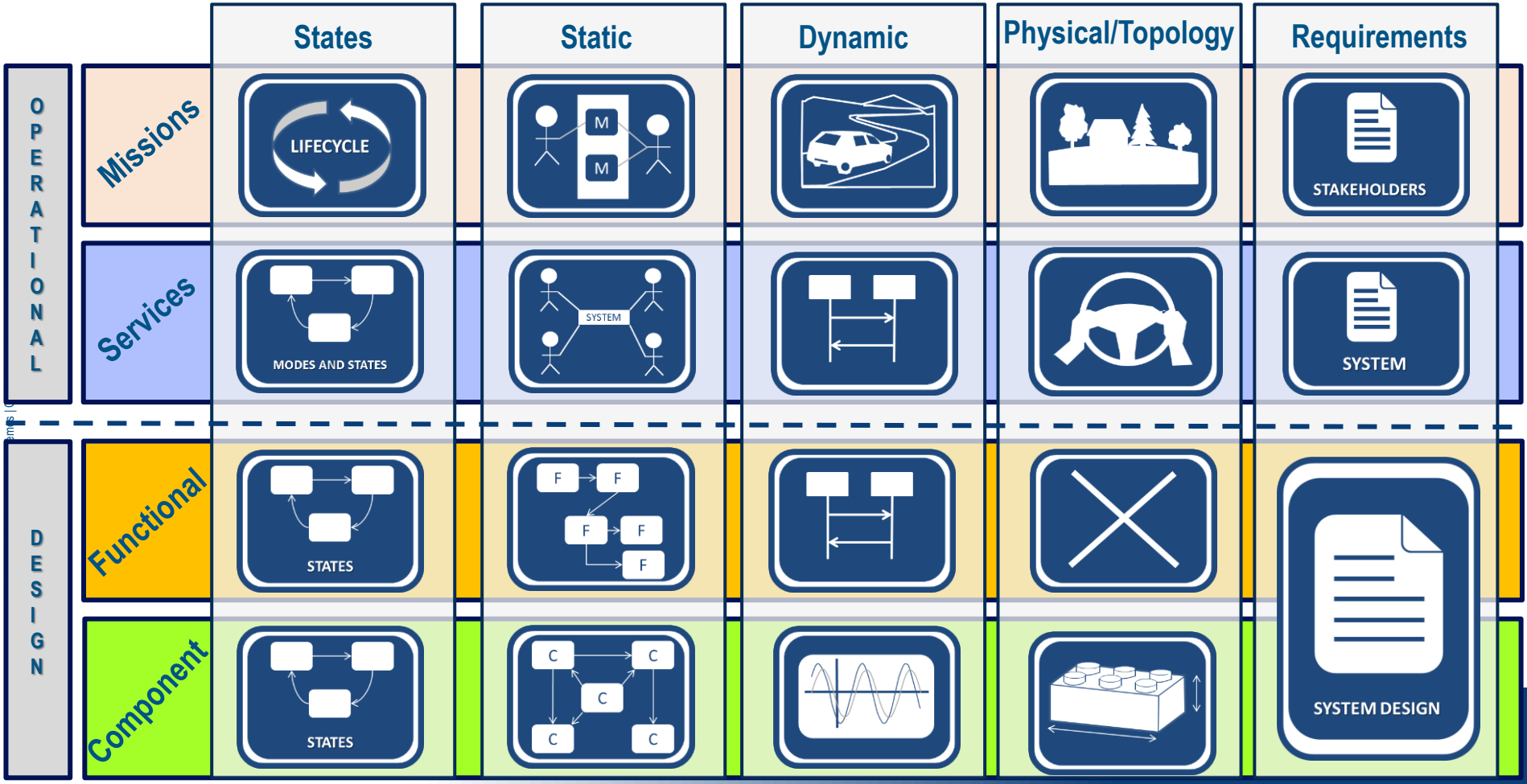
Physical

3D harness design in context
Equipment installation
Physical Wire routing
Harness validation
Harness flattening/documentation

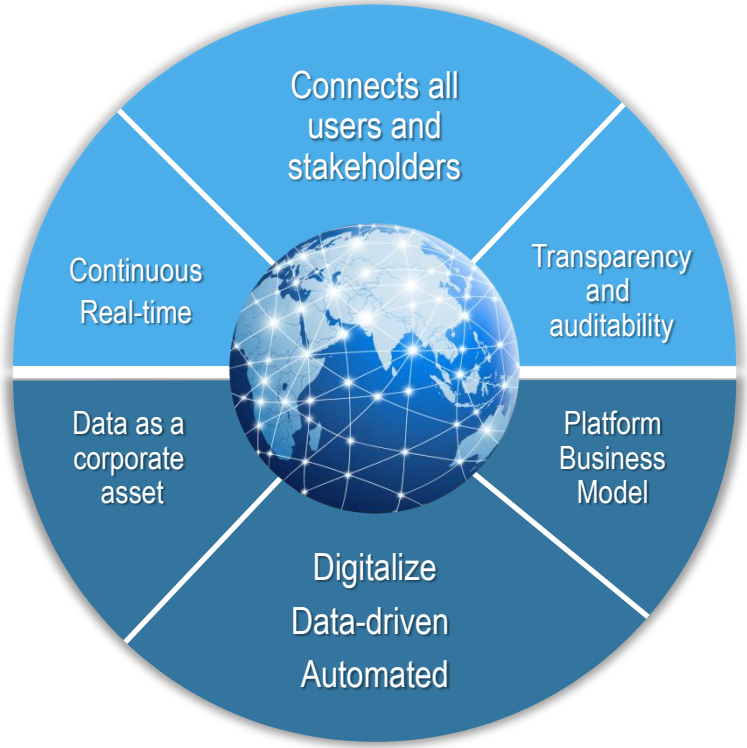


COLLABORATIVE PLATFORM

Modeling Methodology for Systems (M&MS)



Platforms – Business framework for sustainable growth



Digital Velocity

User Experience

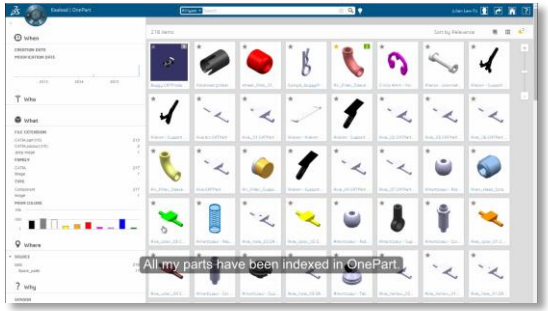
Data as an Asset

Become **data-driven** leveraging existing data

Sourcing & Standardization Intelligence

OnePart

Part Supply

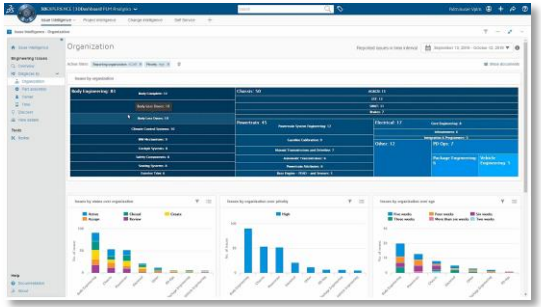


PLM Analytics Intelligence

Issue Intelligence

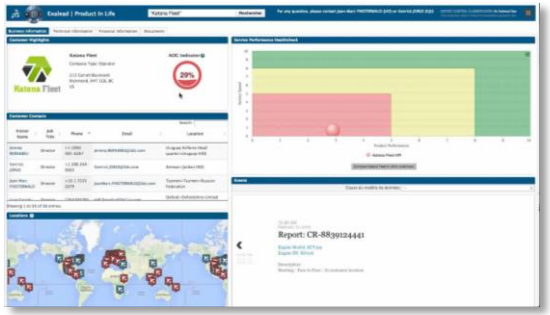
Change Intelligence

Project Intelligence



Digital Experience Intelligence

Business Analytics

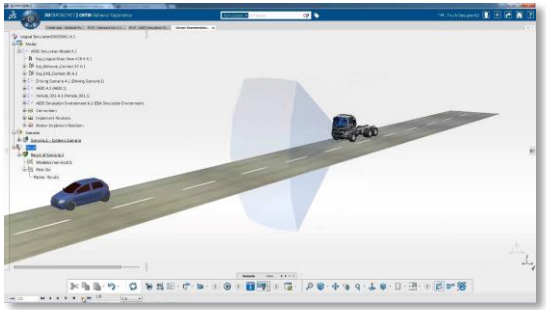


Do a lot more with a lot less

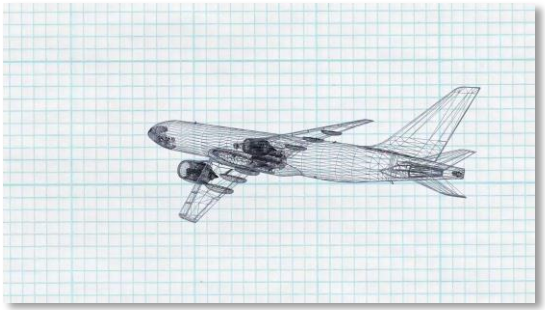
Model-based / V+R enterprise

Model based configuration management

Model based systems engineering



Model based optimization



Model based manufacturing and service

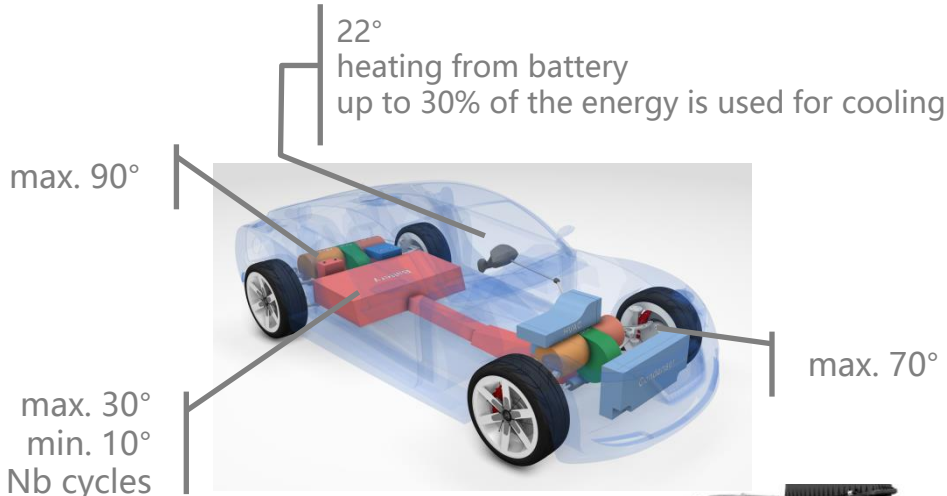
Sustainable innovation through virtualization

Example:

An automotive trend…

Automotive | Hybrid & Electric Car Challenges

- Need for re-inventing overall architecture
- Components undergoing massive evolution
- Hard to find the optimal solution combining multi-discipline area
- Vulnerable components require maximum attention
- Driving and passengers experiences: safety and comfort



Mechatronics Engineering | Process Challenges

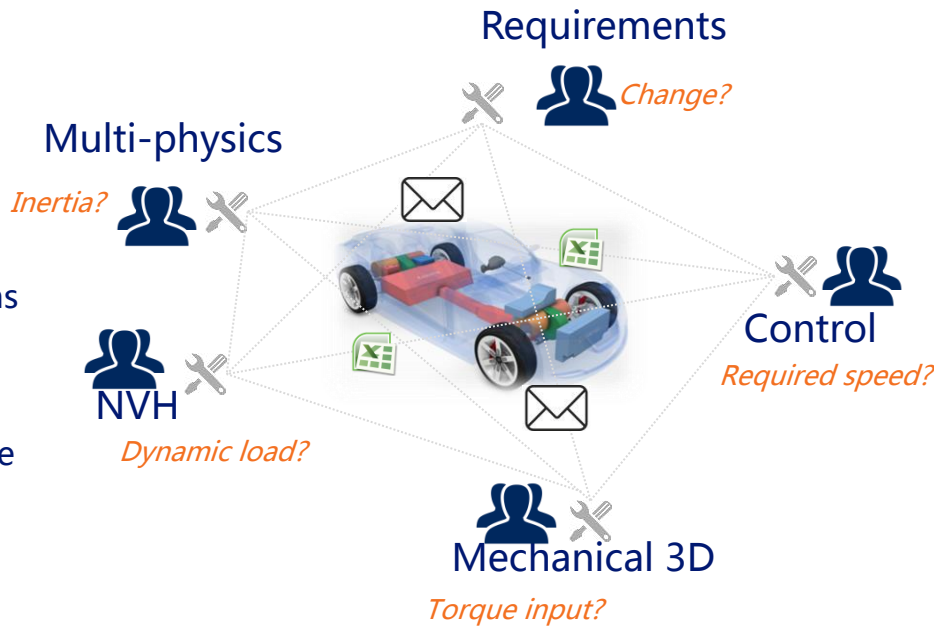
- Multidiscipline & Multi Organization
- Several standalone, **not integrated** tools used
- Technological Parameters **manually** shared throughout simulations

Limited multi-physics simulations covering complex systems

Misalignment of Product Releases between Process Stakeholders

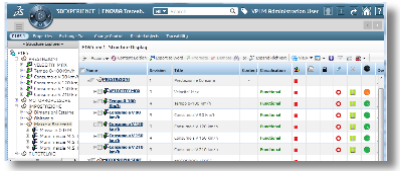
Late awareness of errors cause project delays and introduce high costs for physical prototype.

Very hard to find solutions when the system behavior has not been completely simulated

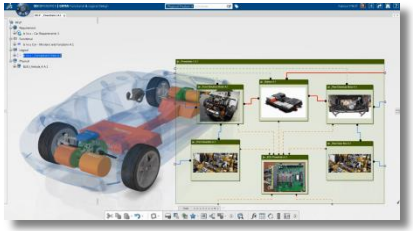


MBE/Platform-based Mechatronics Process

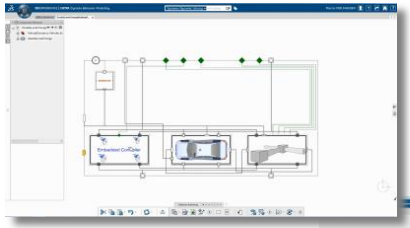
Requirements Engineering



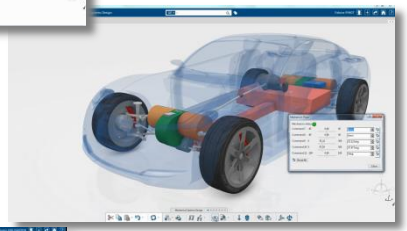
System Architecture Design

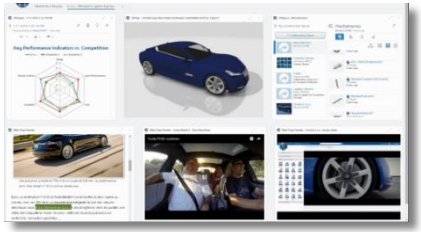


Behavior Modeling



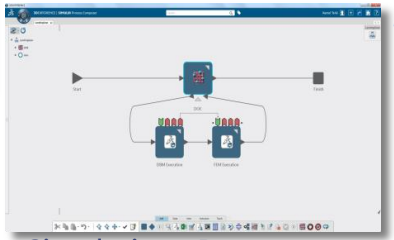
3D Modeling



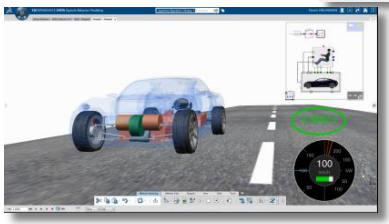


KPIs Validation

3DEXPERIENCE®



Simulations Processes Optimization and DOE

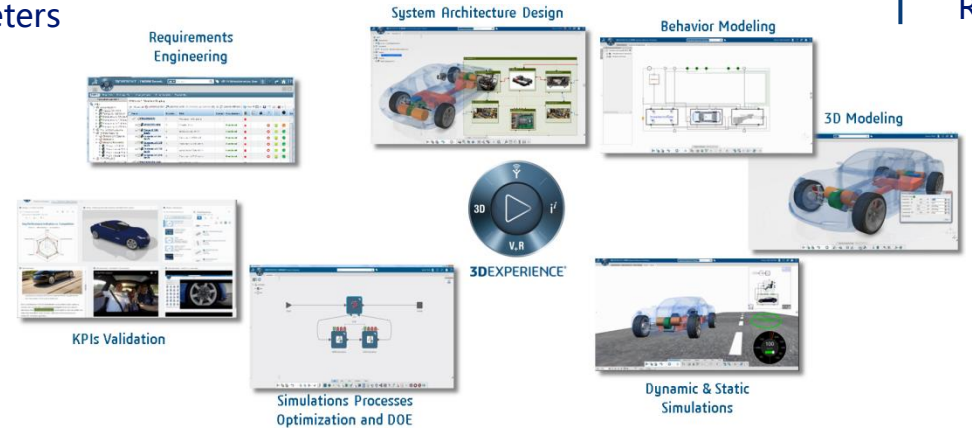


Dynamic & Static Simulations

MBE/Platform- Based Mechatronics Engineering Values

System Engineering collaboration
- Single Source of Truth
- Shared Models
- Shared Parameters

KPI verification/validation
- Any action is verified versus targets
- Real-time management decision

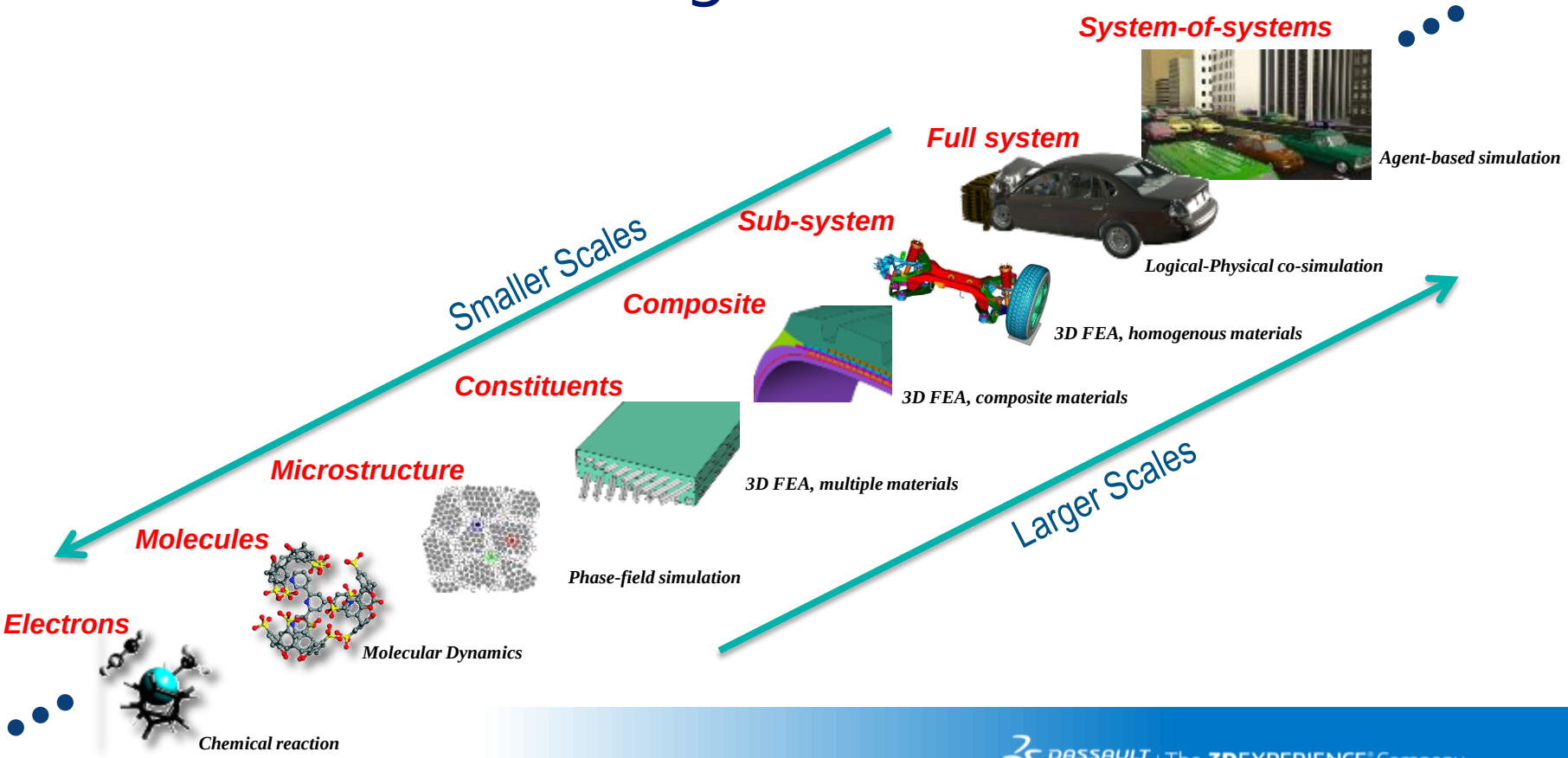


System Engineering Re-use
- At any level
- From parameters to processes

System optimization within openness
- Multi-physics & Multi-scale Simulations
- Simulation workflows and optimization
- Open to standards

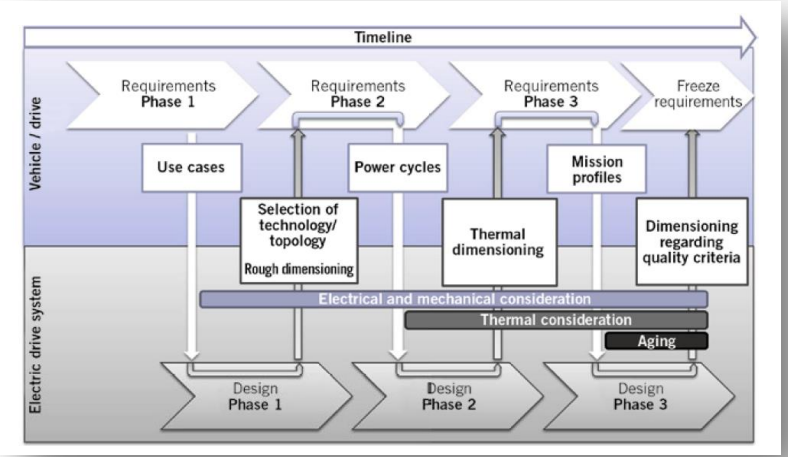
System definition unicity
- One single definition for all systems roles
- Consistent Systems Engineering Methods
- Unified lifecycle for any object in the Platform

Multi-scale Modeling and Simulation



Example: BMW X5 eDrive - Process

- DEDRIS (dimensioning of electric drive system) Process is used to build the electric drive system.
- Our team at 3DS GmbH was significantly involved in defining & establishing the process, building the system & components models and designing test cycles

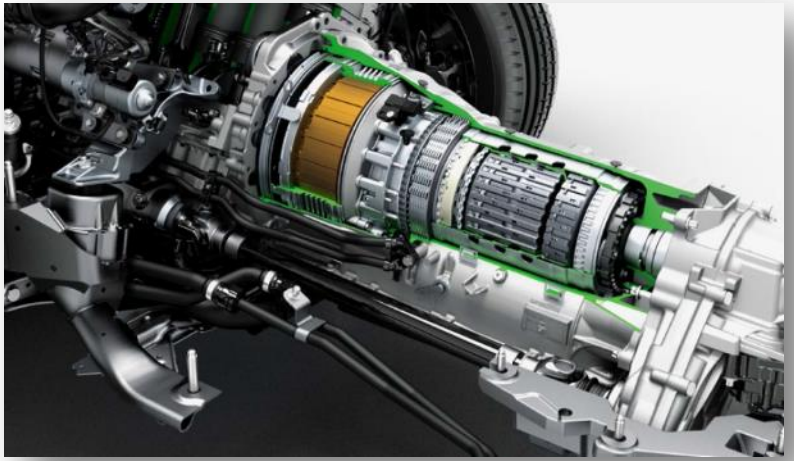


"During the whole Dedris process the simulation of the electric drive system plays an essential role for the evaluation of system behaviour."

REFERENCE Meinert, Senger, Wiebking, Diegelmann | The Plug-in Hybrid Technology of the New BMW X5 eDrive | MTZ - Motortechnische Zeitschrift 05-2015

BMW X5 eDrive - Simulation

- The simulation is based on multi-physics Modelica models of the components which are connected to a corresponding system in Dymola.
- Based on these cycles the temperature profiles within the components are calculated, the cooling requirements are derived and appropriate degradation concepts are developed.



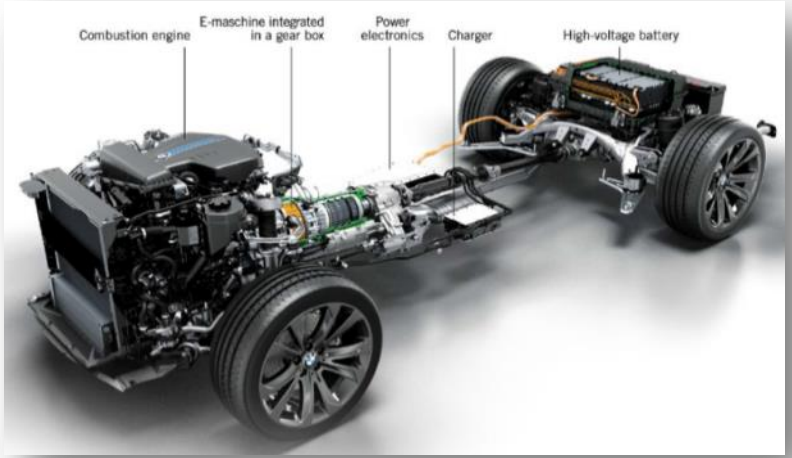
"By integrating this model into the BMW vehicle simulation very precise statements relating to driving performance and efficiency of the final vehicle can be generated."

REFERENCE Meinert, Senger, Wiebking, Diegelmann | The Plug-in Hybrid Technology of the New BMW X5 eDrive | MTZ - Motortechnische Zeitschrift 05-2015

BMW X5 eDrive - System

- System Architecture PHEV with FWD
  - 6,8 kWh High Voltage Battery,
  - 70 kW / 250 Nm Electric Motor
  - Four Cylinder ICE

- Characteristics:
  - Electric Range (NEDC): 30 km
  - Maximum Electric Speed: 120 km/h
  - Maximum Electric Power: 83 kW



"Optimum performance means to achieve outstanding driving dynamics with special attention on a comprehensible behaviour of the electric Drive […]."

REFERENCE Meinert, Senger, Wiebking, Diegelmann | The Plug-in Hybrid Technology of the New BMW X5 eDrive | MTZ - Motortechnische Zeitschrift 05-2015

BMW X5 PHEV

Platform-based Project at Exotic Car-maker: Proof of Value

Project

- 'confidential' – hybrid-related
- One year project, involving
  - Mechanical Designers
  - System Modeling Specialists
  - Structural Analysts
- Platform-based execution

Benefits

- 3 real prototypes built instead of 4
- Development time reduced: 6 months saving estimated
- € 2M savings on the complete project
- Higher innovation capacity

Next Steps

- Develop new innovative car architecture
- Deploy to other organization
- New complete car targeted 2018

Conclusions

- Enabling RFLP Systems Engineering Process with integrated Simulation and Requirements management capabilities is critical to solving today's complex system design challenges
- Key Capabilities include:
  - Requirements traceability
  - Multi-scale and 1D simulation for physics-based behavior modeling
  - Cross-discipline real-time collaboration
  - Single source of truth
- Digitalization accelerates the development process – saving time and money.
- Defense and Industry can now look to platform-based solutions for engineering of complex systems.