34th Annual INCOSE international symposium

hybrid event

Dublin, Ireland
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Accelerating Digital Transformation through MBSE, Multiphysics Simulation and Digital Twin in Aerospace Industry

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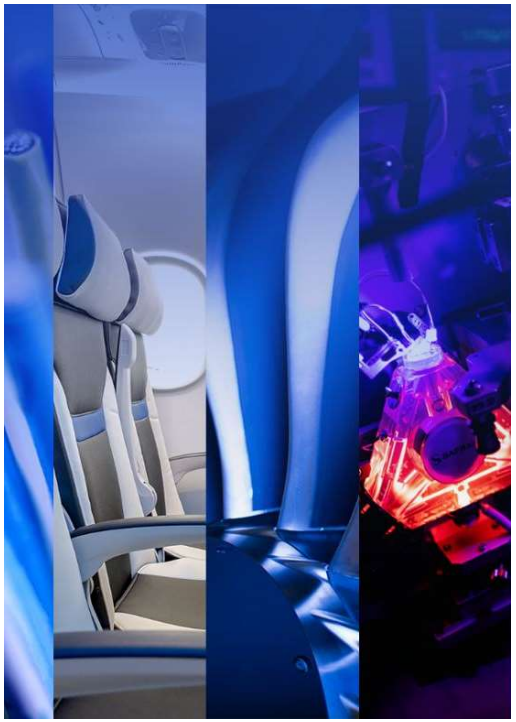
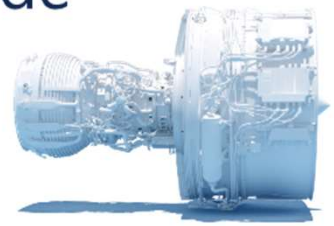
Safran at a glance



A world leader in our core markets

No.1 worldwide

- Narrowbody commercial jet engines (in partnership with GE)
- Helicopter turbine engines



No.1 worldwide

- Interiors for regional and business aircraft
- Aircraft water and waste management systems

No.1 worldwide

- Landing gear
- Wheels and carbon brakes (mainline commercial jets with more than 100 seats)
- Aircraft wiring
- Evacuation slides
- Oxygen systems

No.1 in Europe

- Tactical drones
- Inertial navigation systems
- Optronic (electro-optical) systems

No.1 worldwide

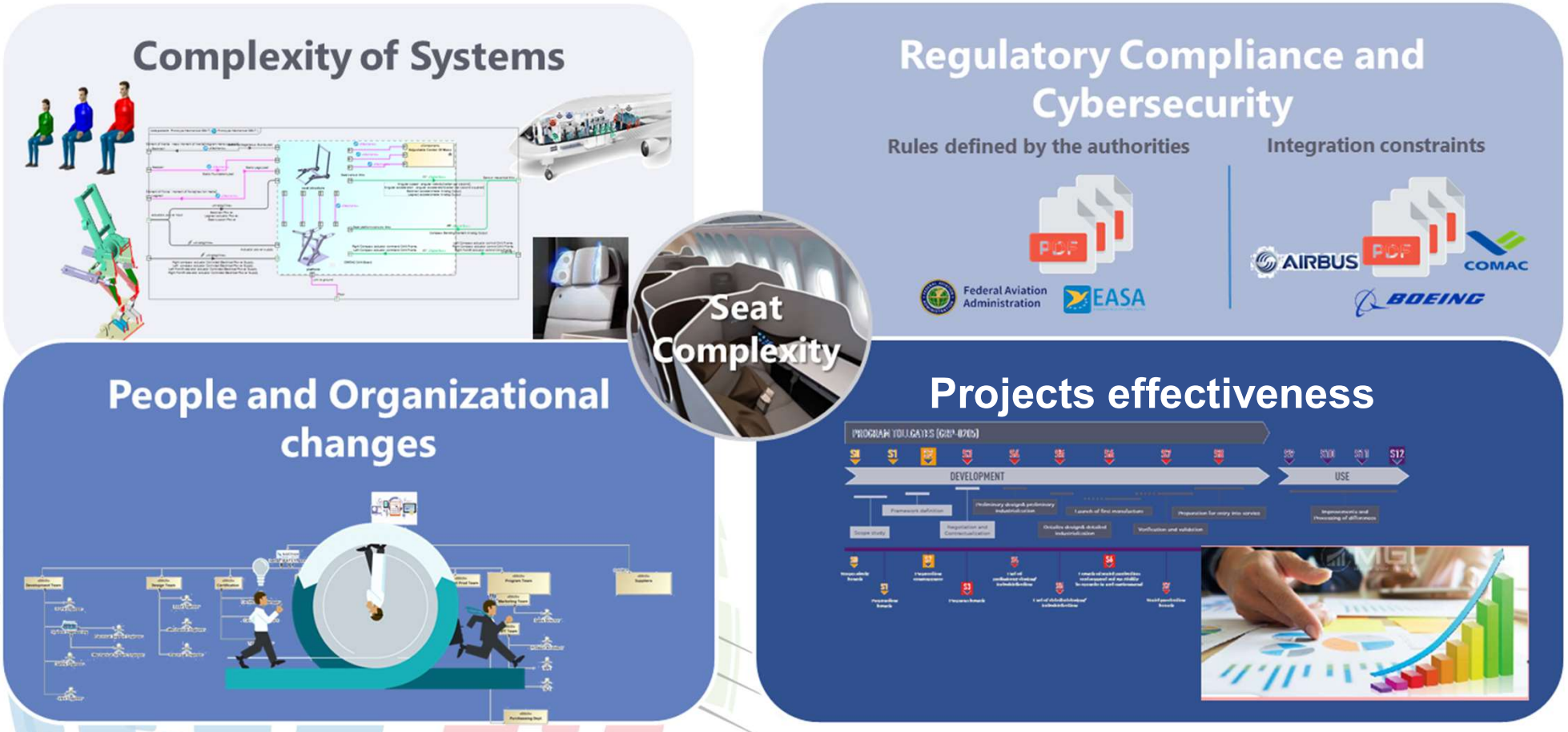
- Space surveillance via RF sensors
- Modems for satellite station keeping and space probe control
- High-performance space optics

Safran SEATS presentation

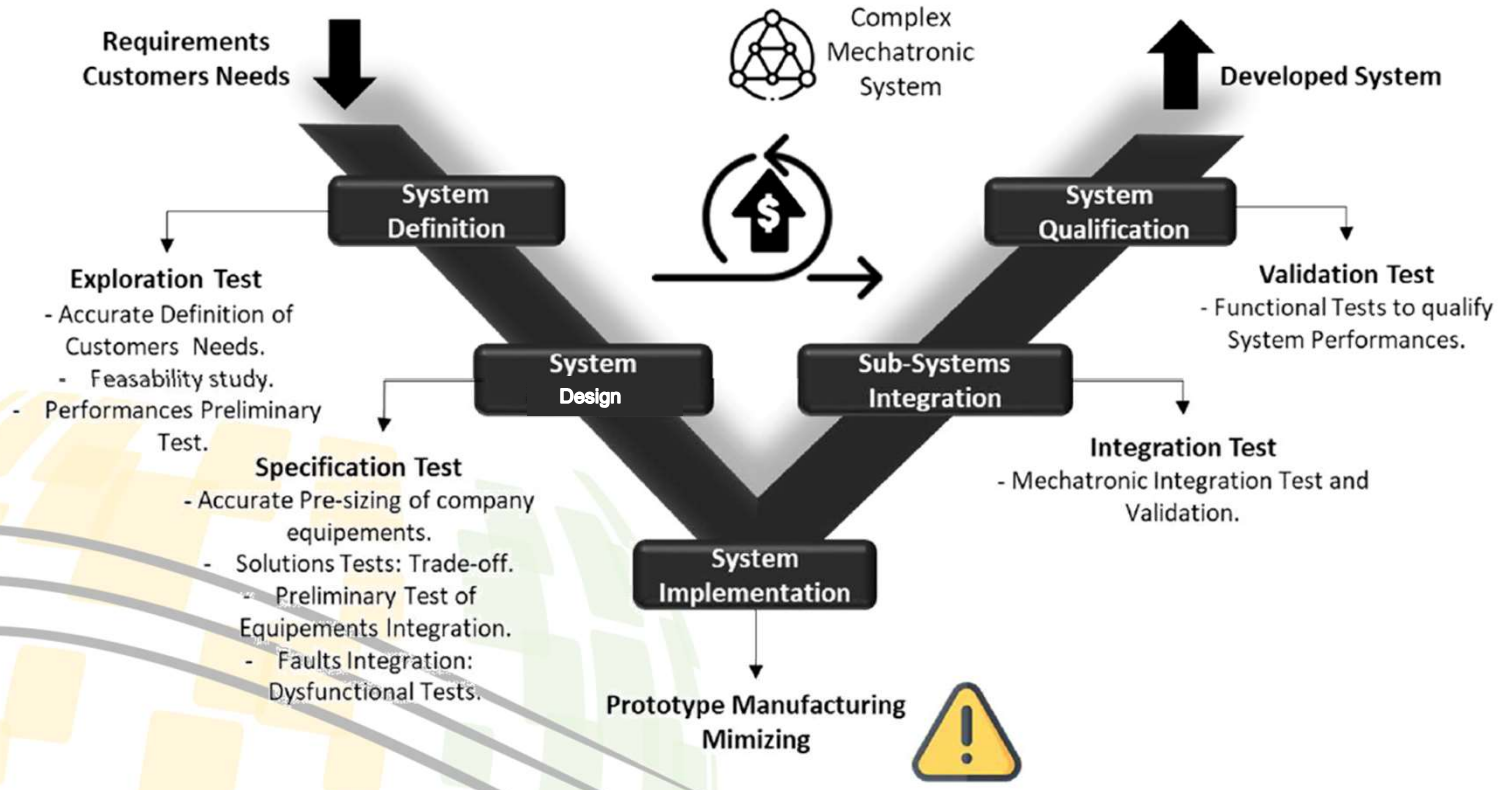
Safran Seats portfolio

Digital transformation challenges in the aerospace industry

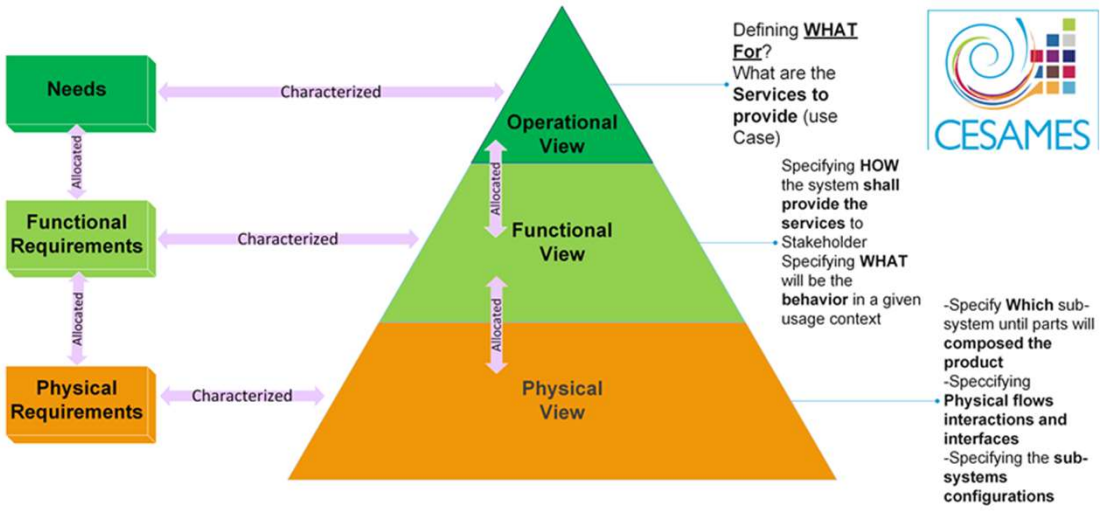
Aircraft SEATS Market complexity



Projects High Costs and Extended Lead Times

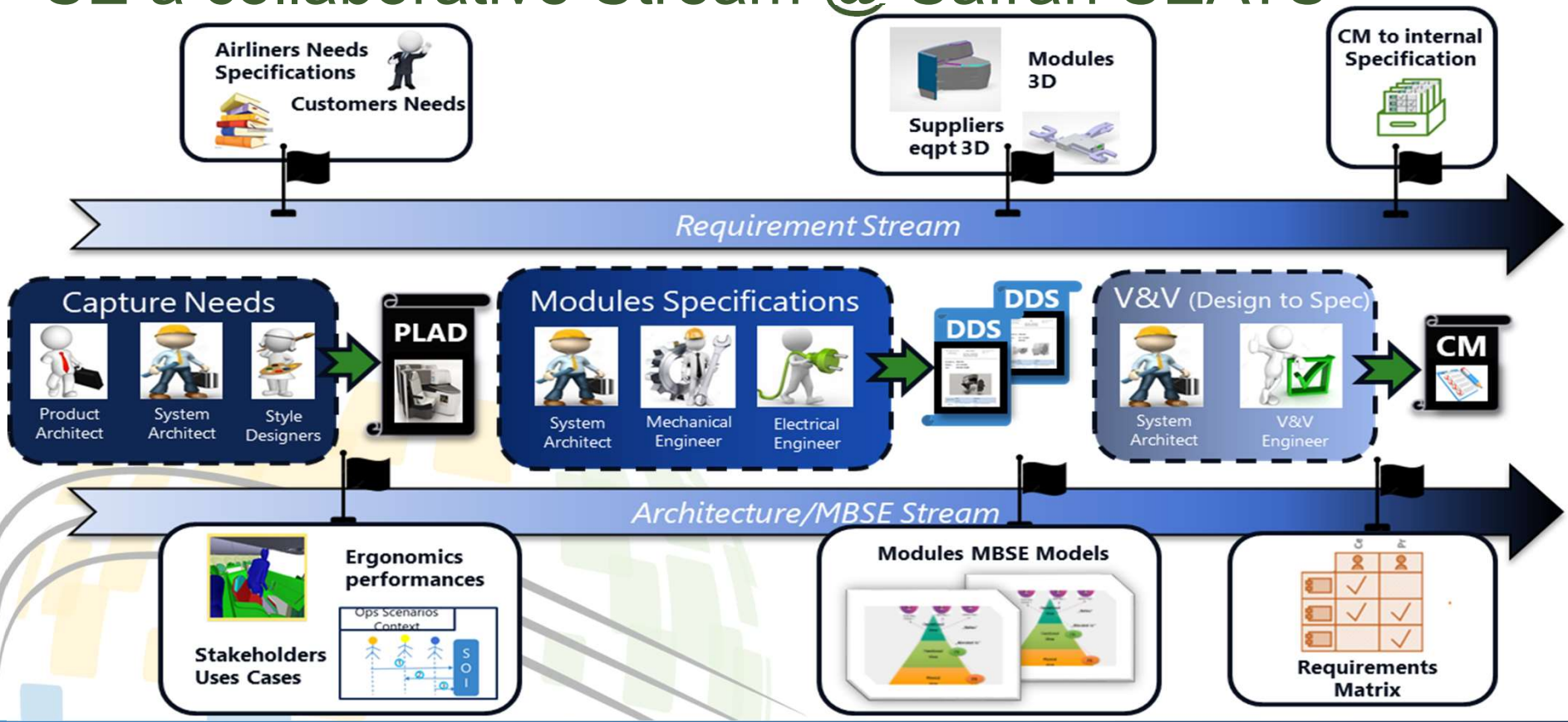


Usual V-Cycles **requires multiple physical prototypes** which **increases Development Lead TIMES** and **NRC's**



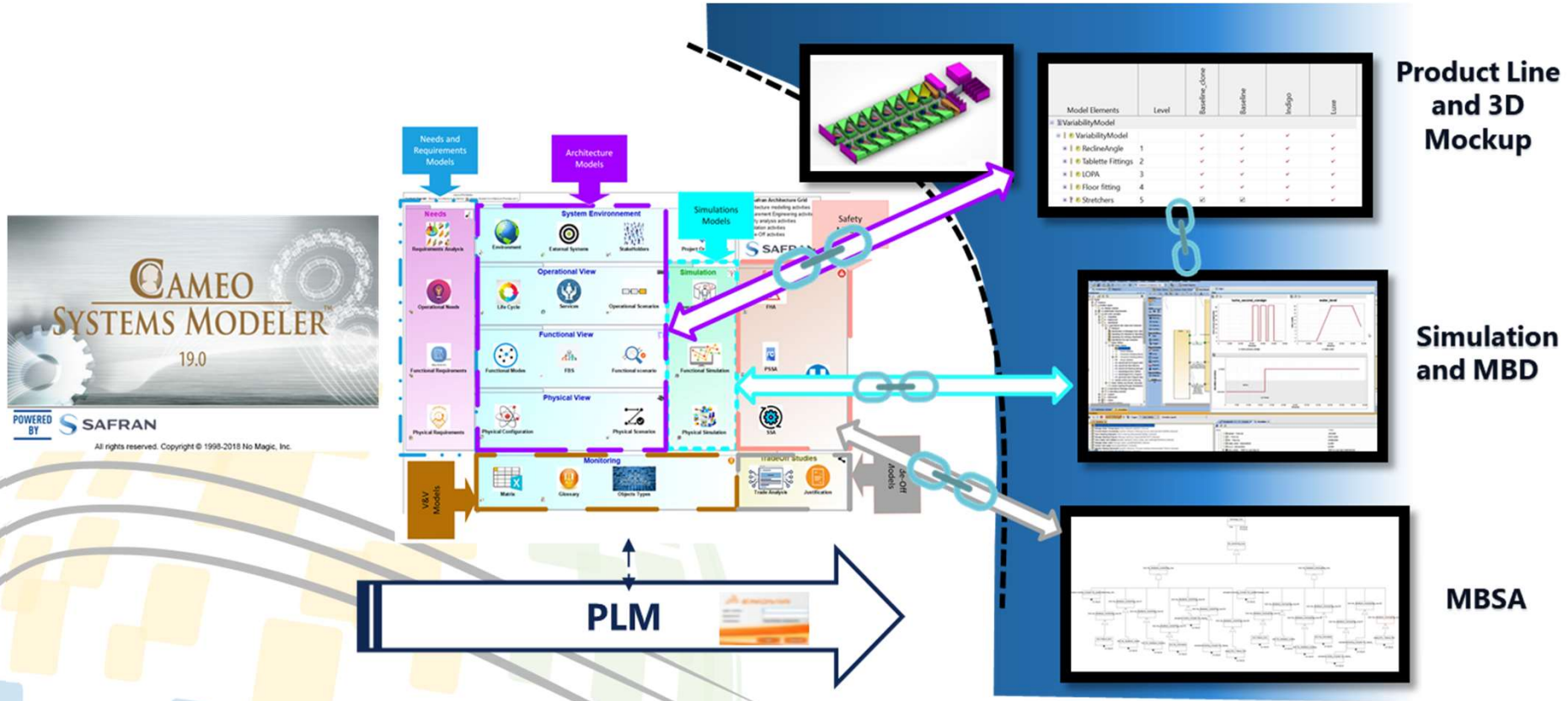
Deploying MBSE @Safran SEATS

SE a collaborative Stream @ Safran SEATS



A **collaborative multi-disciplinary engineering** process **from stakeholder requirements** definition **to detailed design**, validation, verification and certification phases.

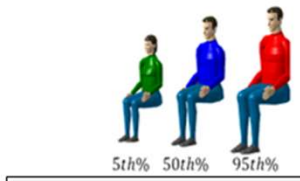
A tailored framework

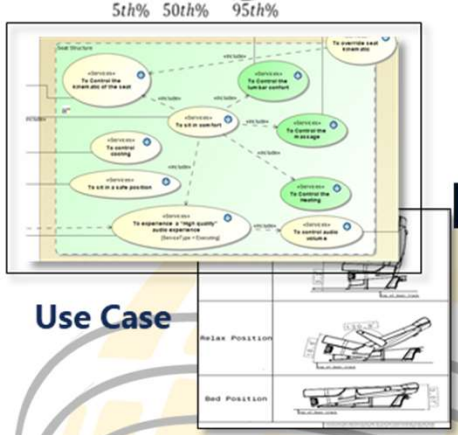


An **unified tools framework** enabling and supporting **System Engineering** activities and **linking Design Activities** (MBD).

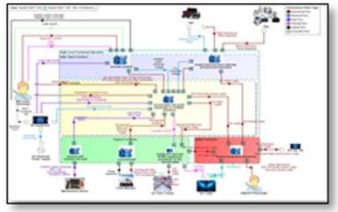
MBSE for B/C Seats : Trade-Off capabilities

FROM MBSE to MBD to early validate solutions

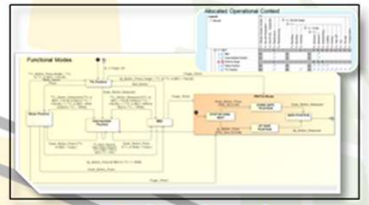




Use Case

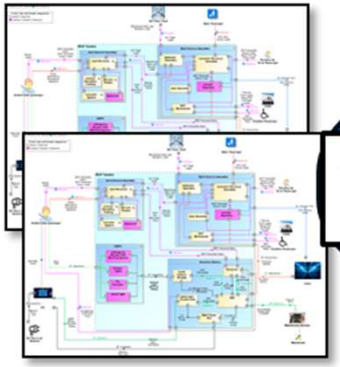


Functional interactions definition



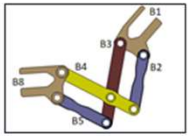
Behavioral definition

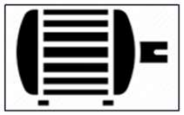
Pmax=xW



Fmax =yDaN

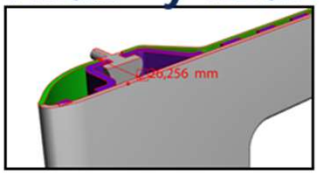
Architectures TRADE-OFF Process





Pm =x+iW

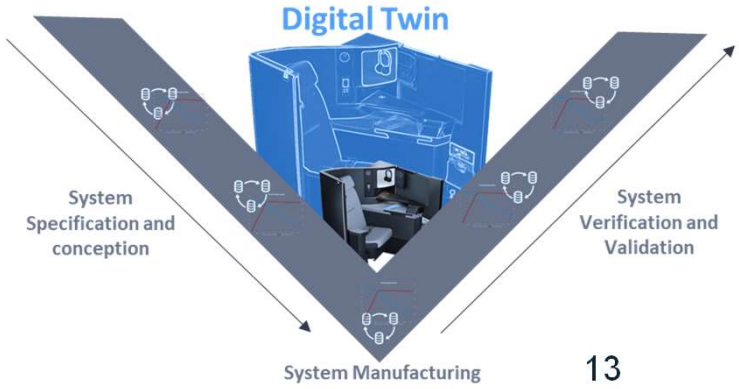
Fmax =y-nDaN



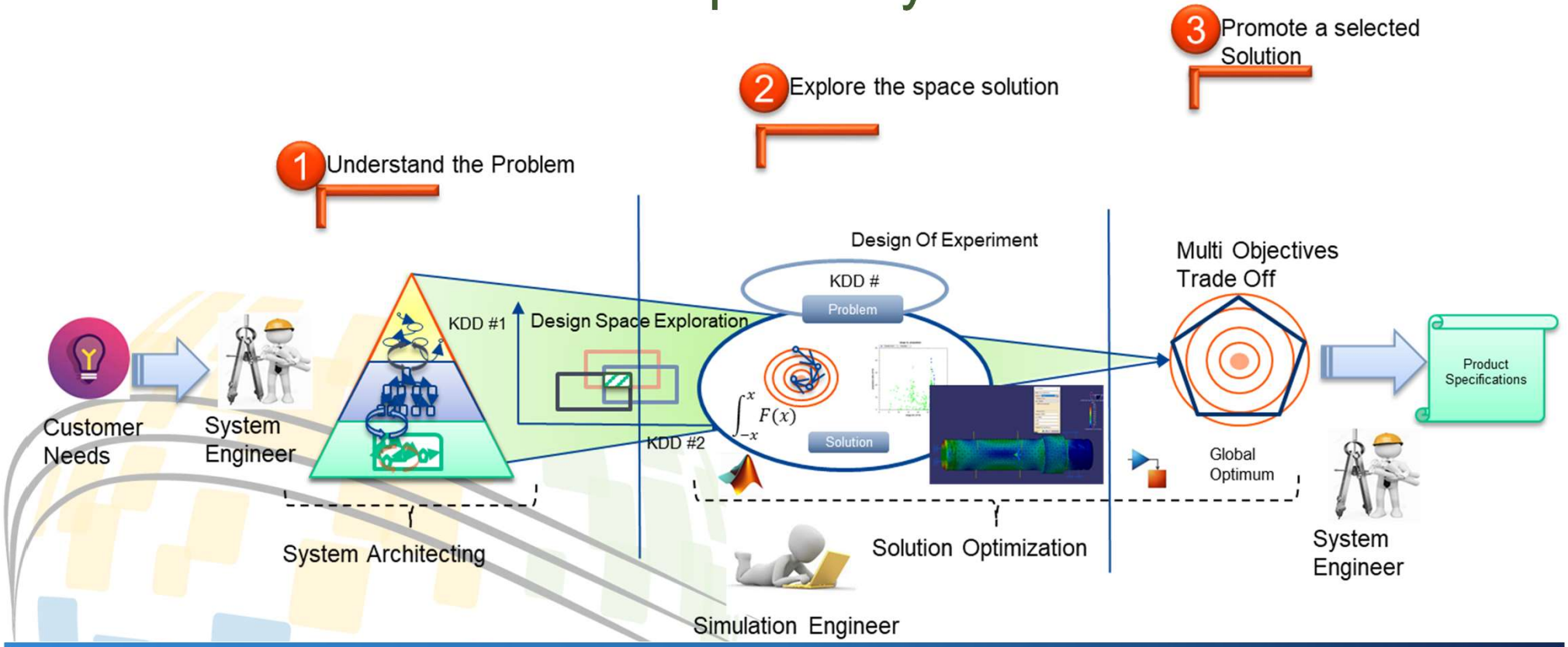
Mechanical Abuse Loads
Performance Characterization

FROM MBD to MBSE to assess architecture requirements specifications

Introducing a new early validation methodology with a Business Class SEAT study case



The Nexus Between System Architecture and Digital Transformation in Aerospace Systems



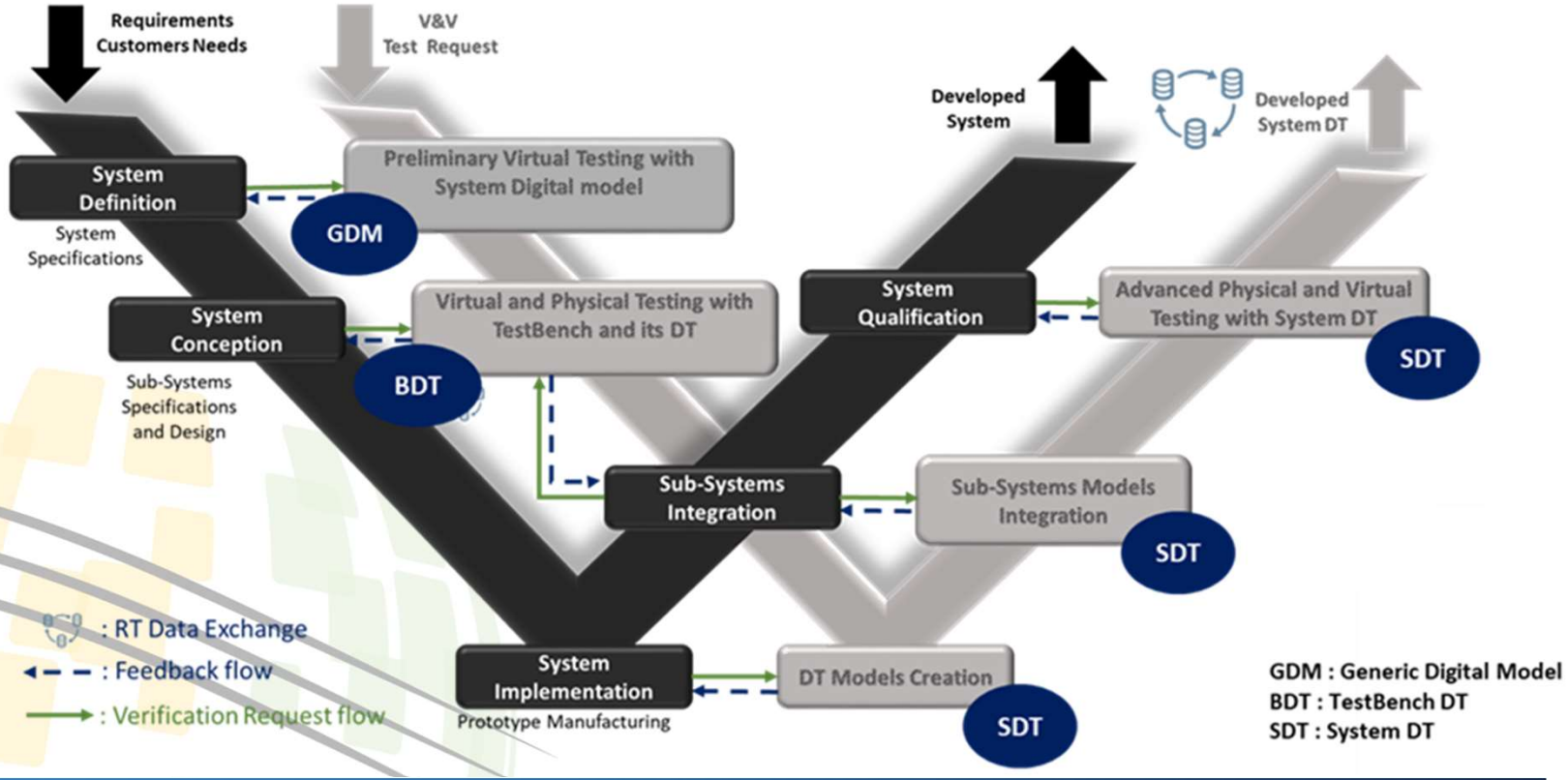
Early validation means are mandatory to **assess multiple architectures solutions**, before manufacturing mature prototype.

Our Approach : DT with HIL-Test Bench 2 Parallel V-cycles handling 3 Main Uses Cases

UC1: To support systems engineers for assessing seats product kinematics and trajectories

UC2: To support systems engineers for verifying seats statics and dynamics key performances (forces, torques, speed, angular speeds,…)

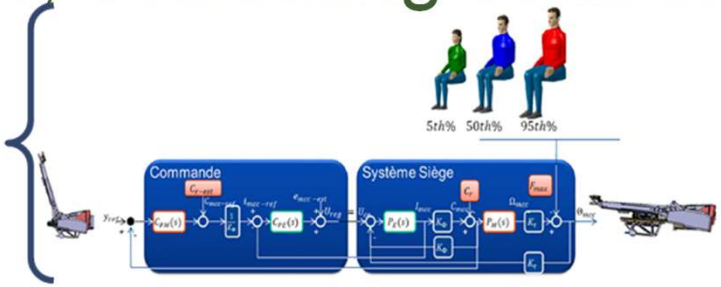
UC3: To support Design teams on pre-validating subassemblies desing, being compliant to functional requirements.



Introducing a new **early validation methodology**

1) Step MBSE Modelling : Understanding the problem, evaluating solutions

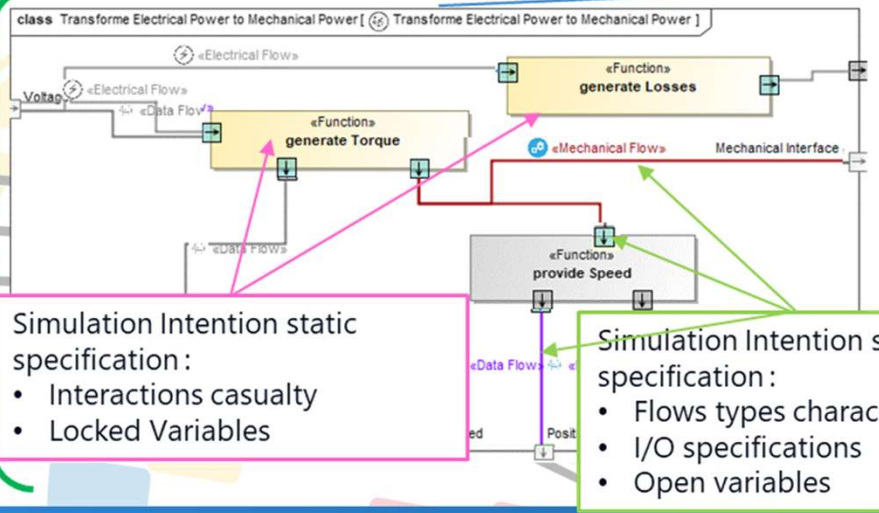
The Problem

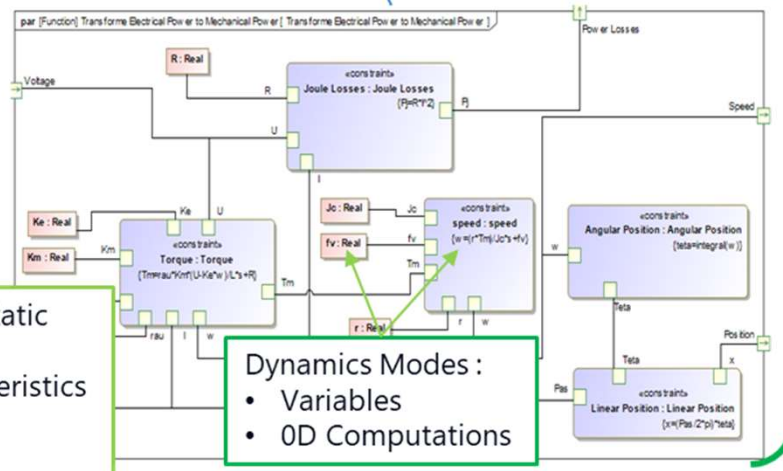


#	Nom
1	1 The system must be actuated with translation and rotation
2	1.1 The system Backrest must be able to rotate around z-axis
3	1.2 The system Seatpan must be able to translate in x-axis
4	1.2.1 The Seatpan actuator must be controlled in position
5	1.2.1.1 The Movement TTL--> BED must not exceed 22s
6	1.2.2 The Seatpan actuator must support passenger load (50, 75,
7	5 The system height must be adjustable
8	6 The actuation system must be controlled and powered

The Solution

"Satisfies"





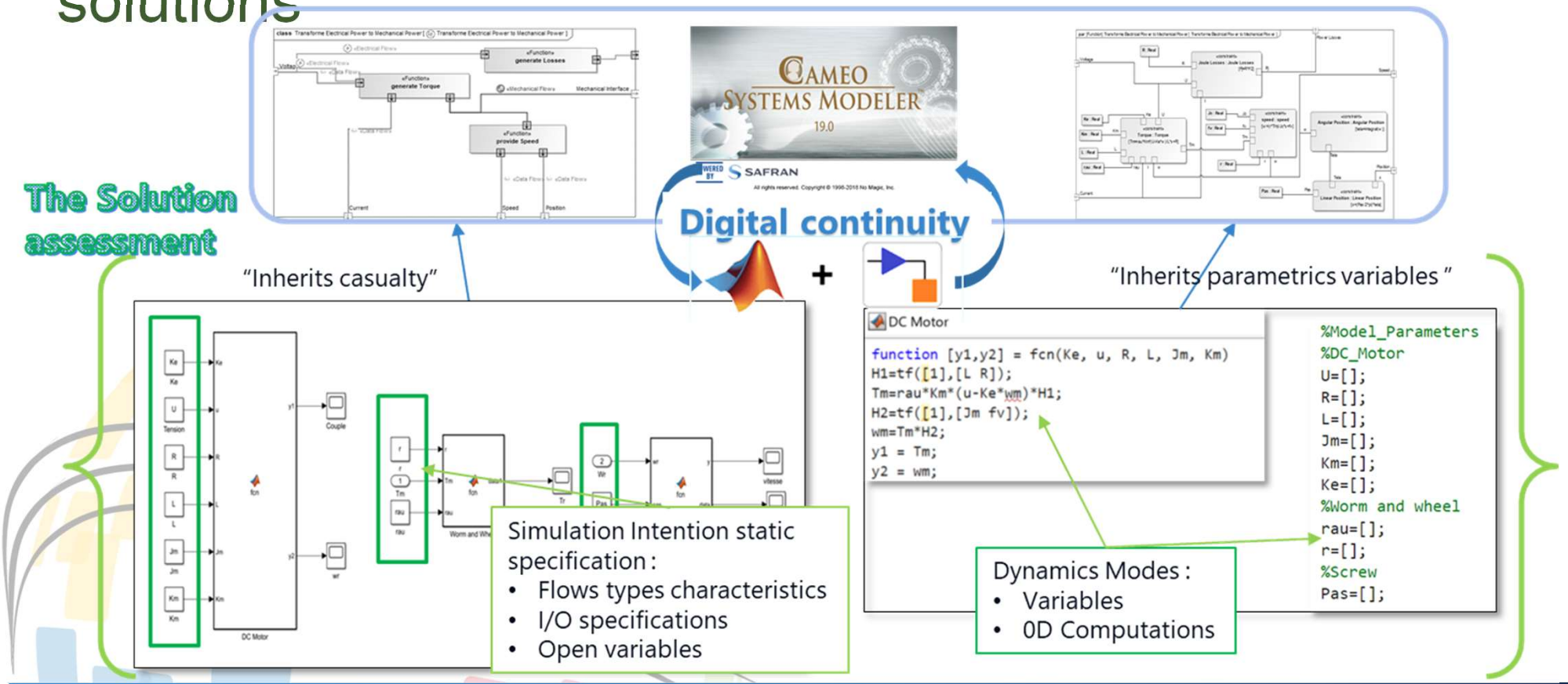
Simulation Intention static specification :
- Interactions casualty
- Locked Variables

Simulation Intention static specification :
- Flows types characteristics
- I/O specifications
- Open variables

Dynamics Modes :
- Variables
- 0D Computations

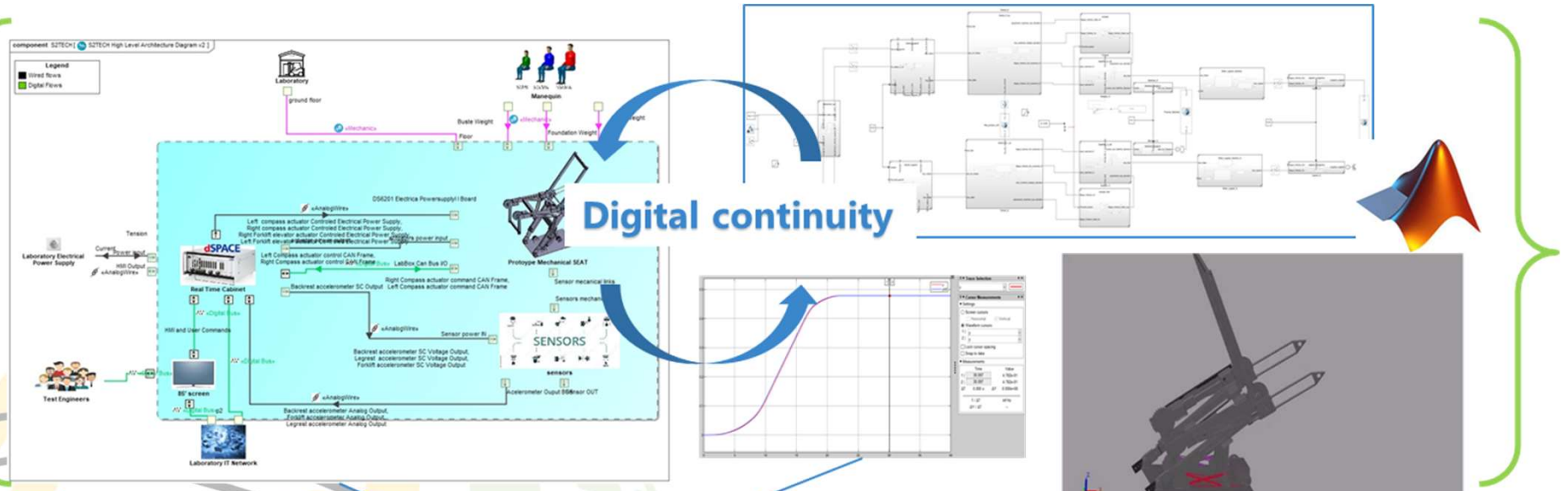
Creating the **System Functional Architecture**, with **simulation intention** specifications

2) Step Digital Twins models : Exploring space solutions



Generating automatically the **Functional Simulation System Architecture**, with **simulation variables**

3) Step Digital Bench Twins models : Achieving early validation



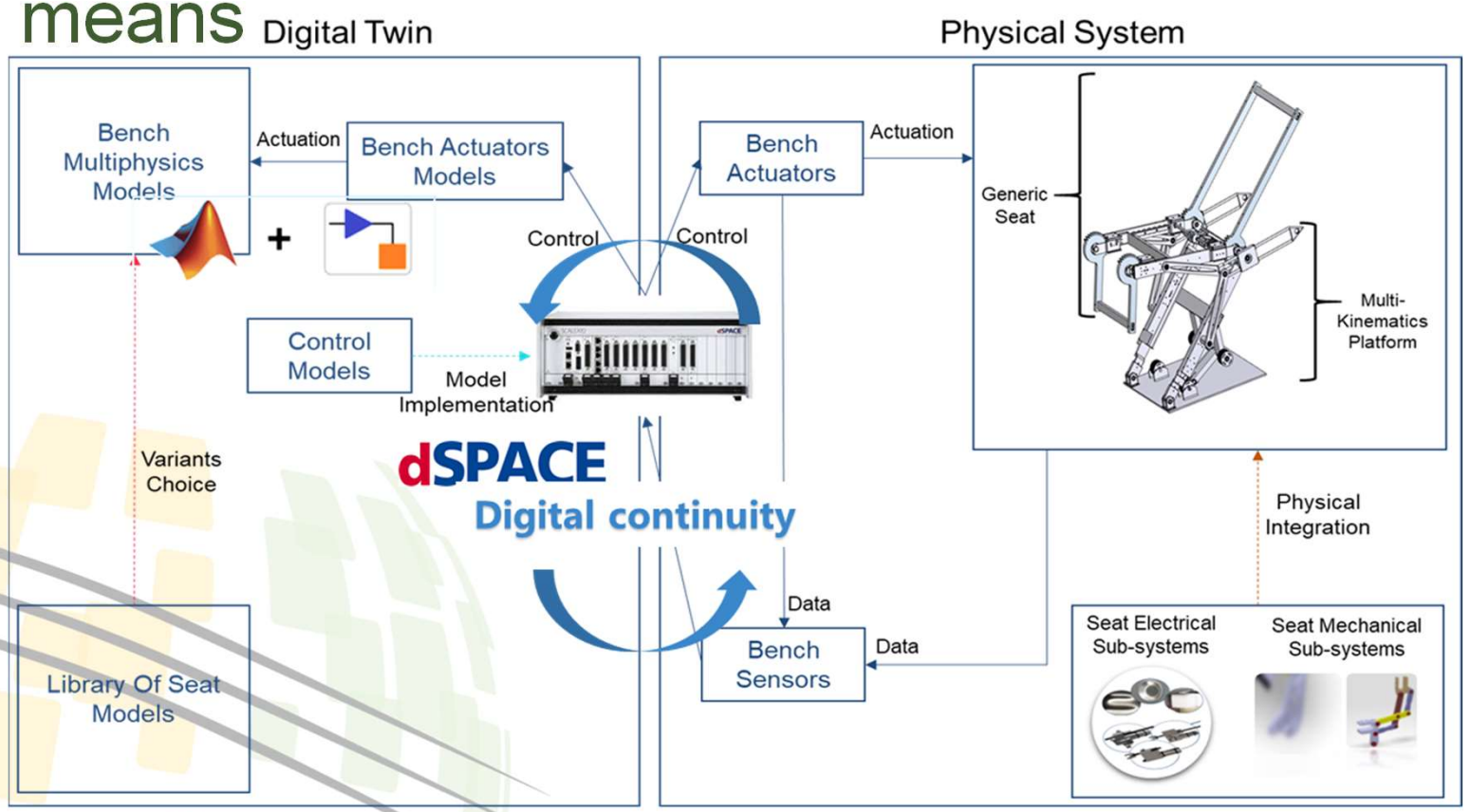
The Solution validation

"Validates"

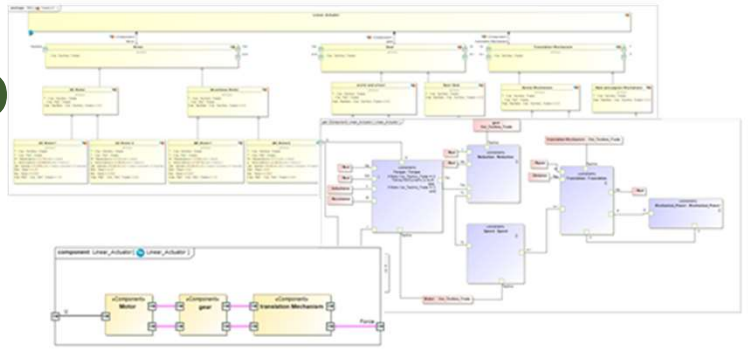
4	R	1.2.1 The Seatpan actuator must be controlled in position
5	R	1.2.1.1 The Movement TTL--> BED must not exceed 22s
6	R	1.2.2 The Seatpan actuator must support passenger load (50, 75,

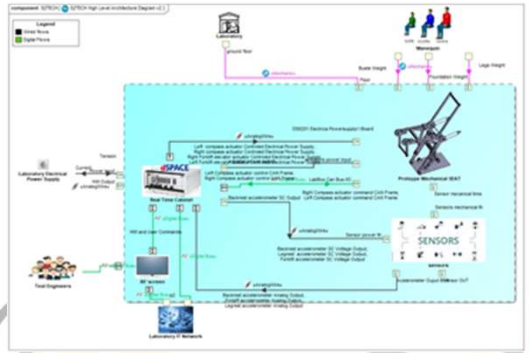
Assessing System **Functional Architectures assumptions**, with **DT Model in The Loop means**

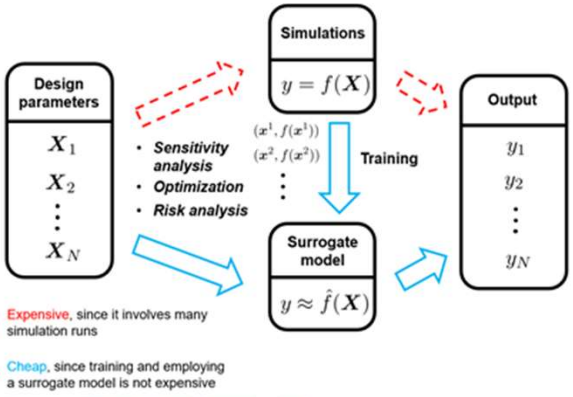
4) Completing Early validation with Hardware-in The-Loop means

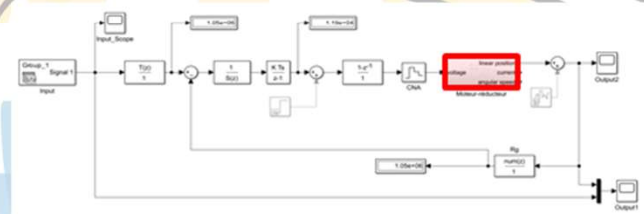


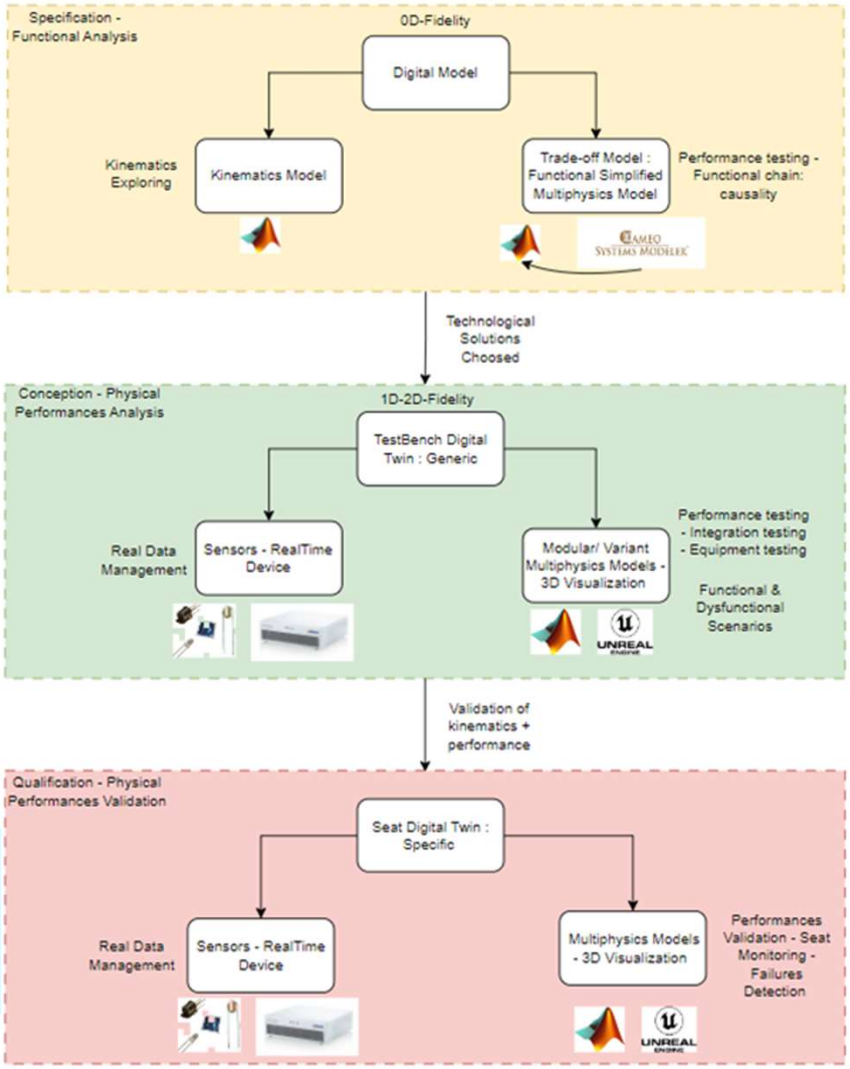
To sum up






Design parameters
X_1
X_2
X_N
Simulations
$y = f(X)$
$(x^1, f(x^1))$
$(x^2, f(x^2))$
Training
Surrogate model
$y \approx \hat{f}(X)$
Output
y_1
y_2
y_N
• Sensitivity analysis
• Optimization
• Risk analysis
Expensive, since it involves many simulation runs
Cheap, since training and employing a surrogate model is not expensive




Specification - Functional Analysis
0D-Fidelity
Digital Model
Kinematics Exploring
Kinematics Model
Trade-off Model : Functional Simplified Multiphysics Model
Performance testing - Functional chain: causality
Technological Solutions Choosed
Conception - Physical Performances Analysis
1D-2D-Fidelity
TestBench Digital Twin : Generic
Real Data Management
Sensors - RealTime Device
Modular/ Variant Multiphysics Models - 3D Visualization
Performance testing - Integration testing - Equipment testing
Functional & Dysfunctional Scenarios
Validation of kinematics + performance
Qualification - Physical Performances Validation
Seat Digital Twin : Specific
Real Data Management
Sensors - RealTime Device
Multiphysics Models - 3D Visualization
Performances Validation - Seat Monitoring - Failures Detection

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www.incose.org/symp2024
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