DASSAULT SYSTEMES

VIRTUAL TWIN EXPERIENCES

To understand and improve the real world

3DEXPERIENCE®

ABOUT THE PRESENTER


Rafale


OSF



SITAC


ATL2

DASSAULT AVIATION

Systems Engineer / Project Manager


Mirage F1CR


FLIR

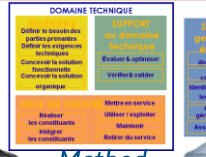

Mirage 2000-9


Method

STELLANTIS


Picasso


Partner



Method


C5


407

Compliance

Systems Engineering Deployment

adn


Energy


Pharmaceutical


Medical Devices


Aerospace


Automotive


Train / Signaling

System Engineering Business Unit Development & Consulting

INCOSE

AFIS

ISO

digital twin CONSORTIUM

OMG Object Management Group.

ISO/IEC29110

Gauthier Fanmuy

CATIA Industry Process Consultant Director

gauthier.fanmuy@3ds.com

Helping our Customers to understand the value of Virtual Twin Experiences and Model-Based Systems Engineering

ASC ARCHITECTURE DES SYSTÈMES COMPLEXES

CentraleSupélec

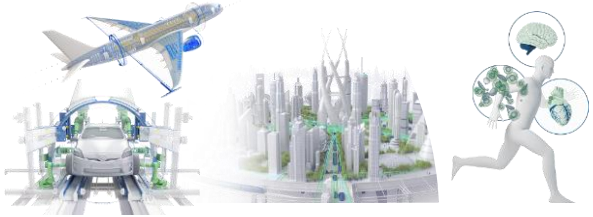
ARTS ET MÉTIERS

ENSTA ParisTech université PARIS-SACLAY

UNIVERSITÉ PARIS 1 PANTHÉON SORBONNE

DASSAULT SYSTEMES

Accelerate sustainable & generative economy with **Virtual Twin Experience**



- Solutions for Systems Engineering, 3D Modeling & Simulation, Product Lifecycle Management, Collaboration, Life sciences and data science
- Creation : 1981
- 5.95 b€ revenues (FY 2023, Non-IFRS)
- 23 800 Employees in 142+ countries
- 350 000+ Enterprise Customers
- 45,3 million Users
- 14 000+ Partners

Deliver **software solutions** for 12 **Industries**

Collaborate with Industry Leaders

DASSAULT AVIATION · KNDS · AIRBUS · BOEING · SAFRAN · NAVAL GROUP · DAMEN · LOCKHEED MARTIN · RENAULT · STELLANTIS · JAGUAR · LAND ROVER · BMW · TOYOTA · TESLA · FORVIA faurecia · BOSCH · CLAAS · ERICSSON · EDF · BOUYGUES

...

...and new "market shakers"

VERKOR · naarea · RIVIAN · VERTICAL · BOOM ...

3DEXPERIENCE® Lab

DASSAULT SYSTEMES

Participation in INDUSTRY STANDARDS Co-Creation & Adoption

Some Examples…

- Actively participate and lead the creation of **OMG Standards for MBSE**

- Engage with **Emerging Technology Ecosystem** for **Virtual Twin** and **Augmented Reality**

- Actively participate in **INCOSE** to support MBSE adoption
  - Corporate Advisory Board
  - Working Groups, MBSE INCOSE Certifications
  - Delivers papers, presentations, tutorials

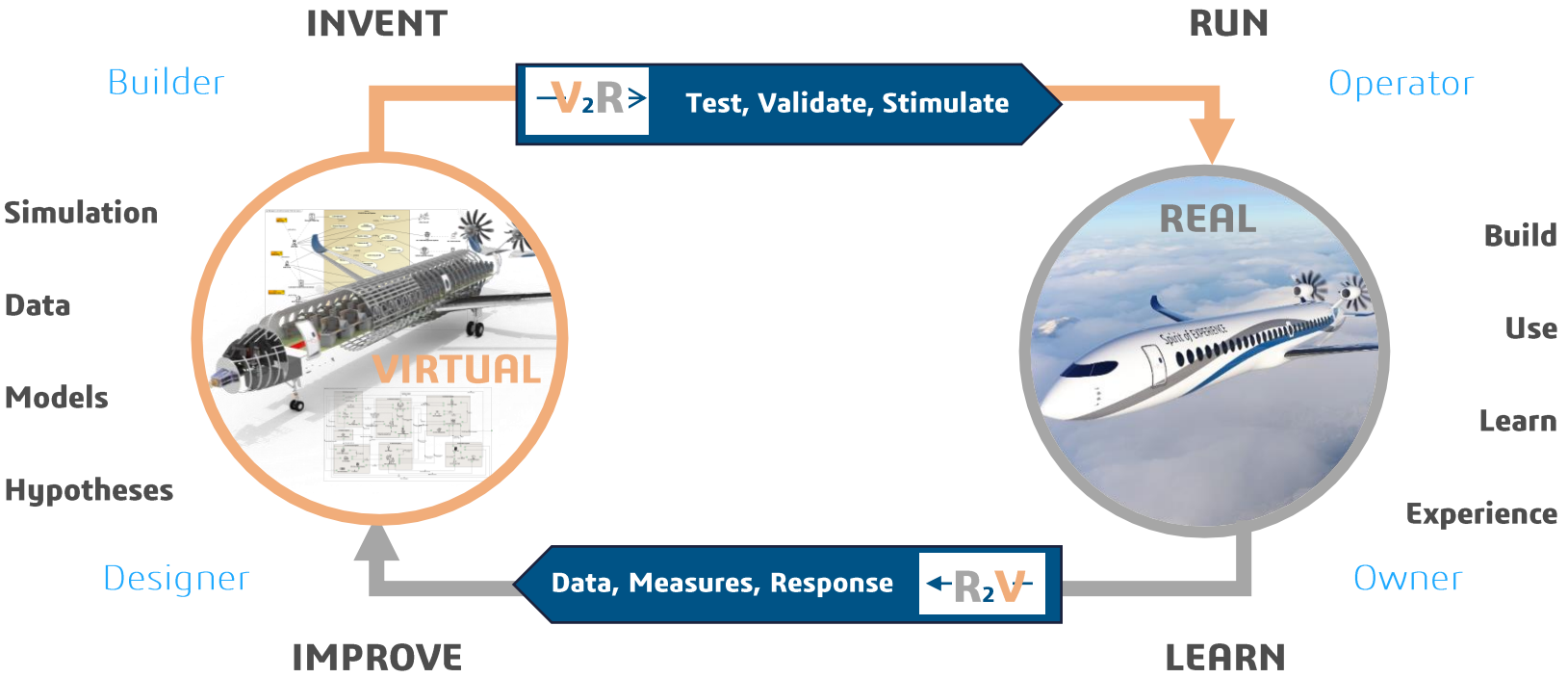
- Actively participate in **MODELICA Association Projects** for multidisciplinary simulation
  - **Modelica** Open Language
  - **Functional Mockup Interface** (FMI & eFMI for **Embedded Systems** & Software)
  - **System Structure and Parameterization** for co-simulation (SSP)

- Support of key **industry consortiums & standards**
  - **CONCERTO** **C**onstruction **O**f **N**ovel **CERT**ification meth**O**ds and means of compliance for disruptive technologies,
  - **AUTOSAR** **AUT**omotive **O**pen **S**ystem **Ar**chitecture
  - **Digital.auto** Software Defined Vehicle innovations
  - **OpenScaling** **Large scale cyber systems modeling & simulation** with Neural Networks

OUR BELIEF

Virtual worlds extend and improve the Real world

WHAT IS VIRTUAL TWIN?



CREATES THE “VIRTUAL TWIN EXPERIENCE”

Collaborative environment connecting the entire system **life cycle** with a continuous **digital thread**

A collaborative environment connecting virtual with real

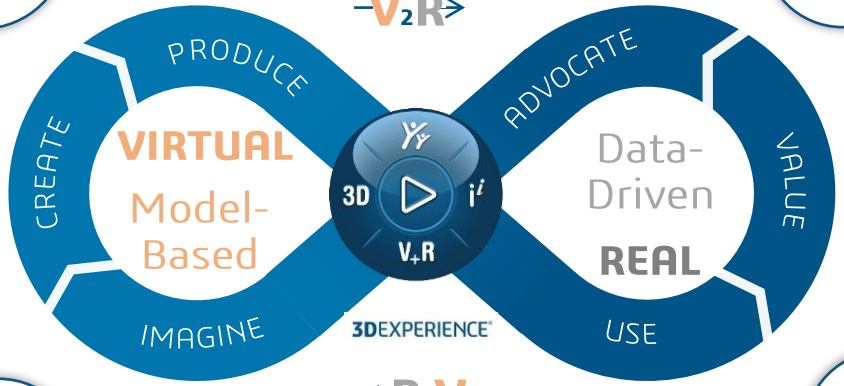
WHAT
Production Optimization

Execute transformation
From Virtual Experience

$-V_2R\rightarrow$

WHAT
Continuing Innovation

WHAT
Product Engineering



WHAT
Value Optimization

WHAT
Architectural CONOPS

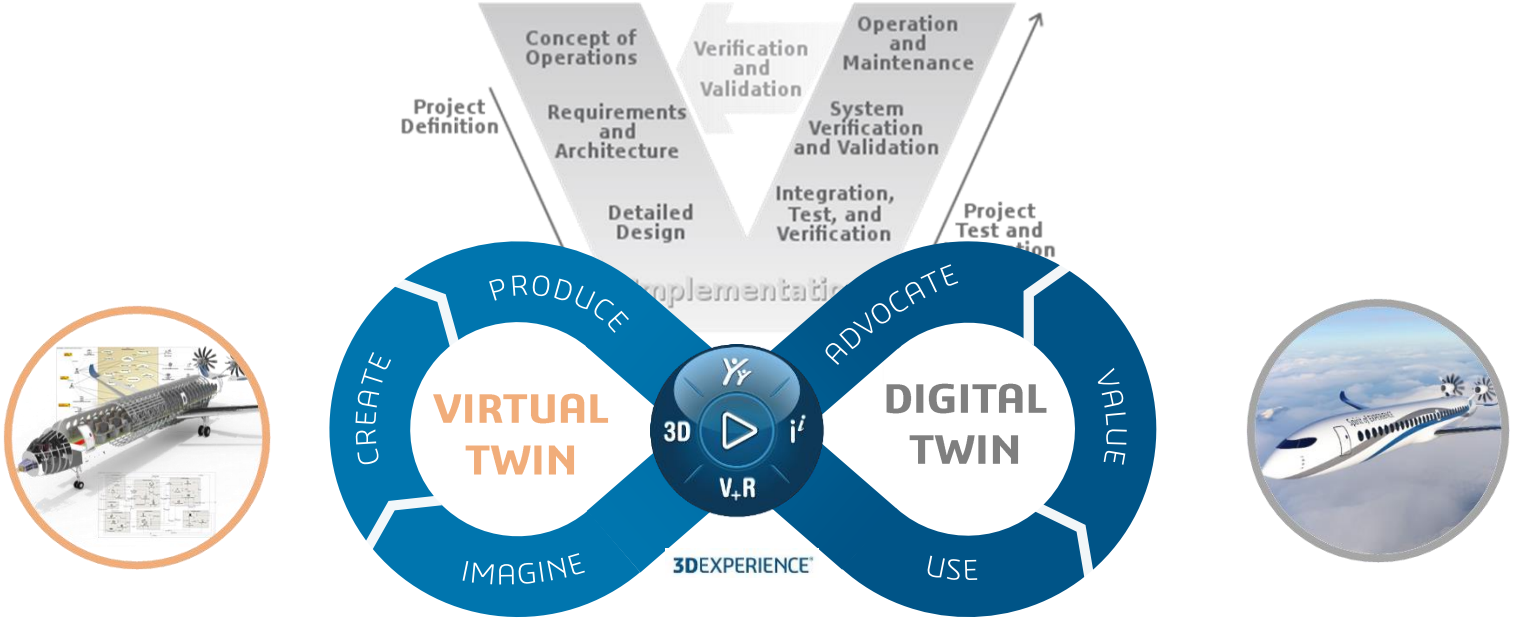
$\leftarrow R_2V-$

Improve virtual
From Real Experience

WHAT
Process Automation

Experiencing real-life, what-if scenarios or “what could be”

VIRTUAL TWIN VS DIGITAL TWIN



Virtual Twin is a **specialized** Digital Twin, that focusses on **early system life cycle** and **future capabilities**, before the physical system

ESSENTIAL CHARACTERISTICS OF VIRTUAL TWINS

Structure

- Data (real, synthetic)
- Models
- Simulation & analysis tools
- Application software
- IT & network infrastructure

Capabilities

- Concept exploration
- Modeling, simulation & analysis
- Design trades & optimization
- Planning & rehearsal
- Remote services & control
- Process automation
- Training & instruction

Functional Features

- Data collection & processing
- Synchronization (V2R, R2V)
- Analysis & synthesis
- Simulation
- Visualization & presentation
- Sensing, monitoring & control
- Optimization & decision support

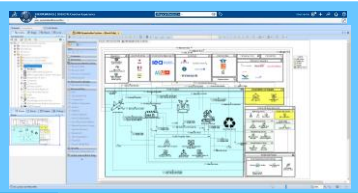
Domains of Applications

- Mission planning & rehearsal
- Product & service design
- Manufacturing planning & layout
- Supply chain planning
- Predictive maintenance
- Infrastructure planning
- Operations and execution

MANY VIRTUAL TWINS… FOR SYSTEM LIFE CYCLE

Enterprise Twin

- Transformation strategy
- Process referential & applicative Programs
- Organization, posts & resources



System of Systems, System Product Twins

- Mission engineering
- Systems Engineering
- Product Design

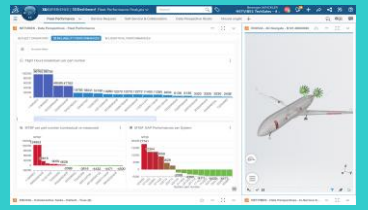
Industrial Network Twin

- Design for production
- Supply chain planning
- First article

Manufacturing Twin

- Design for manufacturing
- Supply chain planning
- Manufacturing execution

Service Twin



- Service design
- Service execution
- Logistic support for operations

AS NEEDED — Conceptual Operations & Studies

AS SPECIFIED — Preliminary Design & Joint Definition

AS DESIGNED — Detailed Design

AS PLANNED — Manufacturing & Assembly

AS BUILT

AS CERTIFIED — Ground & Flight Tests

AS MAINTAINED — In-Services Operators & Support

DASSAULT SYSTEMES

MODELING AND SIMULATION AS ENABLER FOR DIGITAL TRANSFORMATION…

40 years ago… for Mechanical Engineering

STEP

MODELING AND SIMULATION AS ENABLER FOR DIGITAL TRANSFORMATION…

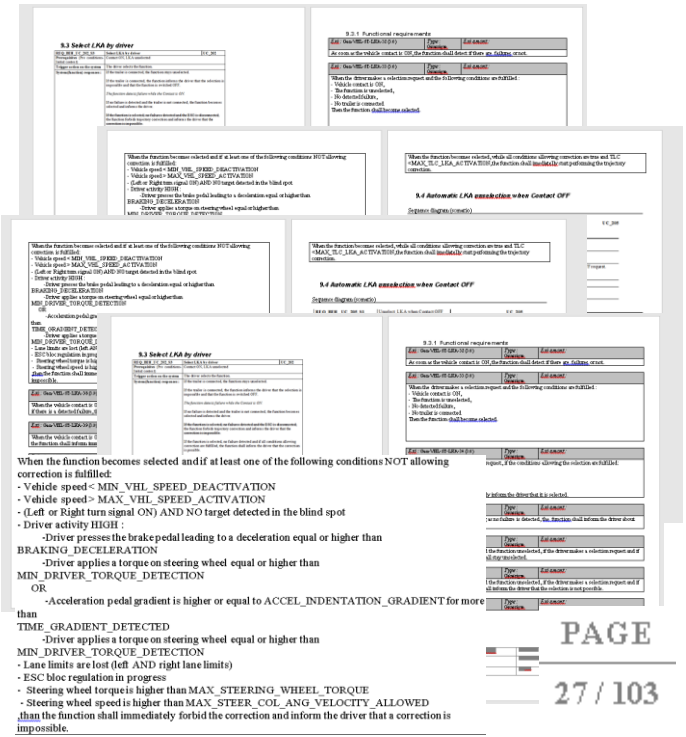
MODel & **SIM**ulate to improve **collaboration**, evaluate **"what-if" scenarios** and support informed **decision-making**

40 years ago… for Mechanical Engineering

STEP fmi FUNCTIONAL MOCK-UP INTERFACE DASSAULT SYSTEMES

MODELING AND SIMULATION AS ENABLER FOR DIGITAL TRANSFORMATION…

…for multi-disciplinary & software-intensive systems



When the function becomes selected and if at least one of the following conditions NOT allowing correction is fulfilled:
- Vehicle speed < MIN_VHL_SPEED_DEACTIVATION
- Vehicle speed > MAX_VHL_SPEED_ACTIVATION
- (Left or Right turn signal ON) AND NO target detected in the blind spot
- Driver activity HIGH :
  - Driver presses the brake pedal leading to a deceleration equal or higher than BRAKING_DECELERATION
  - Driver applies a torque on steering wheel equal or higher than MIN_DRIVER_TORQUE_DETECTION

  OR
  - Acceleration pedal gradient is higher or equal to ACCEL_INDENTATION_GRADIENT for more than TIME_GRADIENT_DETECTED
  - Driver applies a torque on steering wheel equal or higher than MIN_DRIVER_TORQUE_DETECTION
- Lane limits are lost (left AND right lane limits)
- ESC bloc regulation in progress
- Steering wheel torque is higher than MAX_STEERING_WHEEL_TORQUE
- Steering wheel speed is higher than MAX_STEER_COL_ANG_VELOCITY_ALLOWED

than the function shall immediately forbid the correction and inform the driver that a correction is impossible.

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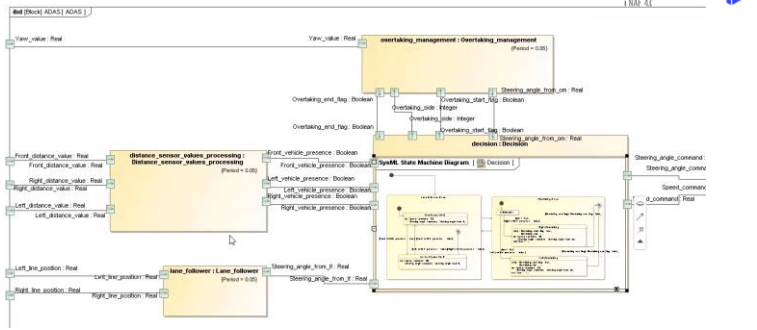
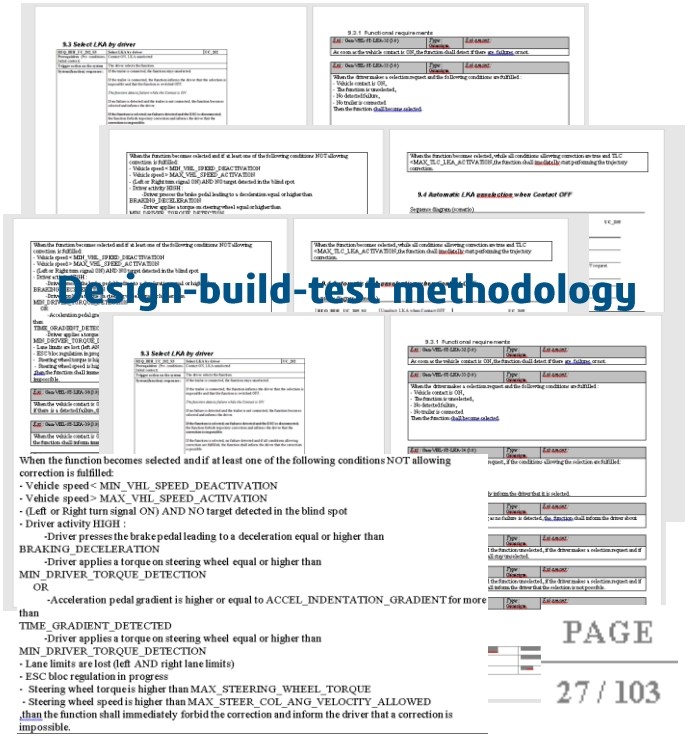


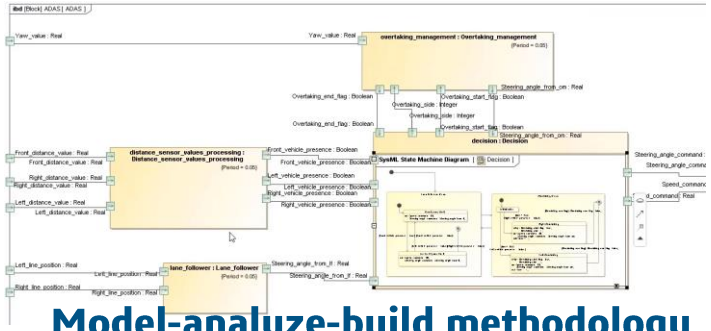
MODELING AND SIMULATION AS ENABLER FOR DIGITAL TRANSFORMATION…

MODel & **SIM**ulate to improve **collaboration**, evaluate **"what-if" scenarios** and support informed **decision-making**

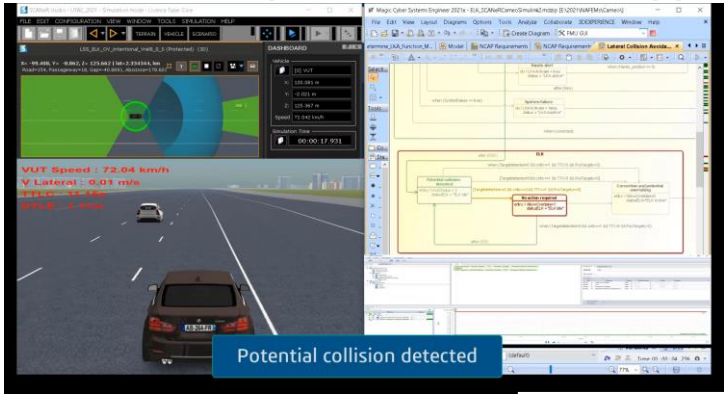
…for multi-disciplinary & software-intensive systems



Design-build-test methodology

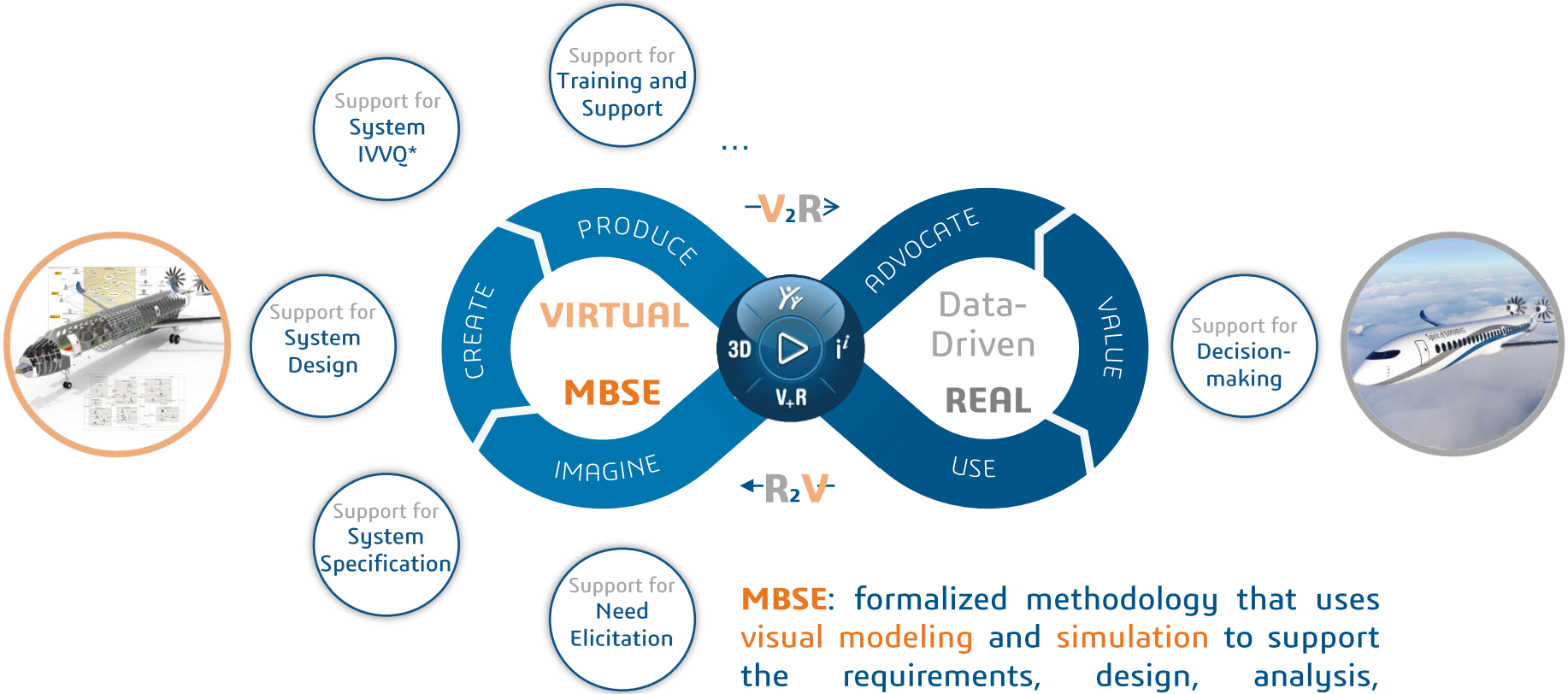


Model-analyze-build methodology



UAF OMG UNIFIED ARCHITECTURE FRAMEWORK · NAF 4.0 · fmi FUNCTIONAL MOCK-UP INTERFACE · efmi · SSP

VIRTUAL TWIN EXPERIENCES | MODEL-BASED SYSTEMS ENGINEERING



MBSE: formalized methodology that uses visual modeling and simulation to support the requirements, design, analysis, verification, and validation associated with the development of complex systems.

**IVVQ: Integration Verification Validation Qualification*

IN-SERVICES - OPERATIONS & SUPPORT CHALLENGES

High Cost related to Maintenance, Repair, and Overhaul (MRO)

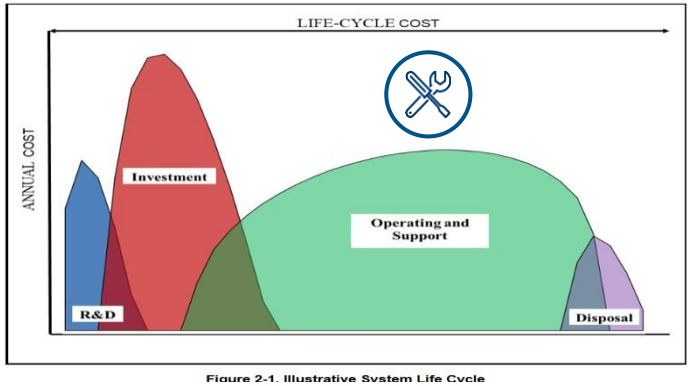


Figure 2-1. Illustrative System Life Cycle

Source: US DoD Cost Assessment and Program Evaluation, 09/2020

Sustainment cost constitutes 70% of a weapon system's total ownership cost.

Source: U.S. Government Accountability Office (GAO)

Difficulty to predict sustainment & operational availability in complex ecosystem

- **System of Systems Interdependencies**
  - ✓ Coordinating across **multiple state & industrial stakeholders and systems** (acquisition agency, armed forces, defense contractors, maintenance crews, and logistical supply chains, …)
- **Missions Variability & Unpredictability**
  - ✓ Mission intensities (reconnaissance, air-to-air combat, etc.)
  - ✓ Multiple combat systems configuration
  - ✓ Environmental conditions, Equipment failures
- **Limitation with traditional deterministic approach**
  - ✓ Need for **stochastics** simulation to account for **uncertainties** and **non-deterministic** behaviors
- **Availability of "easy to use" decision-support tools for "non-MBSE Specialist" Users**

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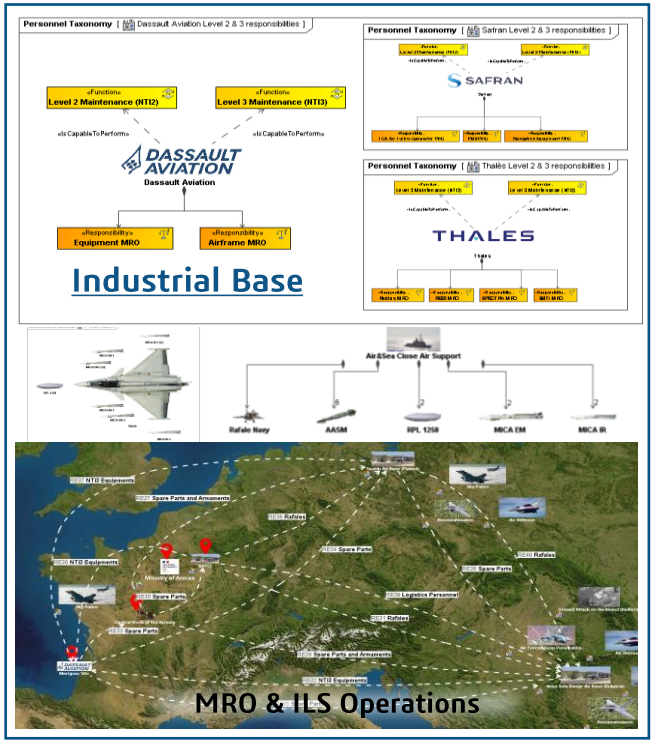
USE CASE | AIRCRAFT FLEET Logistics & Sustainment – Spare Parts Management

- **Industrial consortium** delivering **"Full in Service Support"** solutions (ex. "Rafale Care" program)
- **Key objectives to achieve high level of Operational Availability (Ao)**
  - **Enhance MRO** Operations (Maintenance, Repair & Overhaul)
  - **Optimize ILS** (Integrated Logistics Support)
- **Use Case Example**
  - **Spare Parts Management**, from **production** to **stock inventory** to **bases delivery**



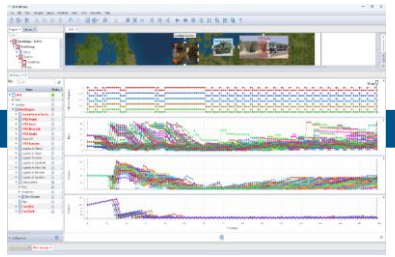
FROM SYSTEM (OF SYSTEMS) ARCHITECTURE TO VIRTUAL TWIN EXPERIENCE

System of Systems Architecture

CATIA | Magic UAF

- Missions & ConOps*
- Operational Structure
- Operational Scenarios
- Logistics and Support Systems

Behavior definition & debug



STIMULUS

- Executable semantics for requirements and constrains
- parametric stochastic simulations for non-deterministic behaviors

System of Systems Experience "what-if scenarios"

Systems Simulation Design

- Web-based parametric System of Systems behavior execution

System of Systems Experience to support decision making

Data Perspectives

- Web-based "ready to use" dashboard

*ConOps: Concepts of Operations

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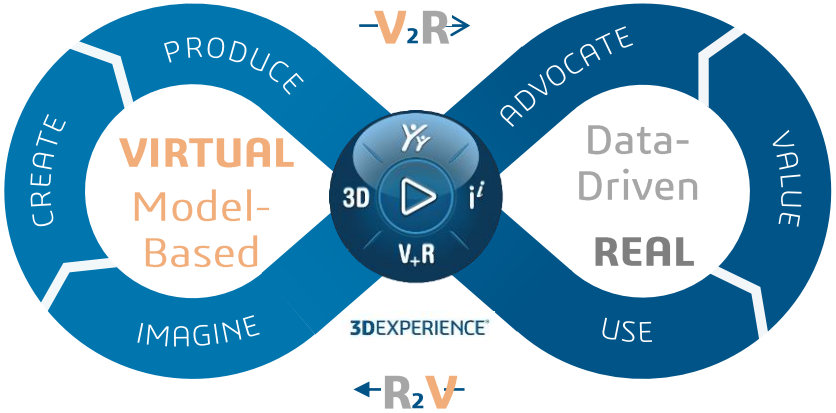
DEMONSTRATION

VIRTUAL TWINS EXPERIENCE HELP TO UNDERSTAND AND IMPROVE THE REAL WORLD

The real system is built and deployed with high confidence, leveraging MBSE to ensure it is done right



As the physical system is operated, operational data, feedbacks, responses go back to the virtual to improve the real

Virtual Twin Experience enablers:

System (of systems) architecture
Stochastic simulation
From data to insights in V+R

DASSAULT SYSTEMES Products Industries Learn Support About

MBSE CYBER SYSTEMS SYMPOSIUM 2025

Agenda Speakers Sponsors Call for Presentations Location/Accommodations REGISTER

MBSE Cyber Systems Symposium 2025

April 7 - 10, 2025

Grand Sierra Resort and Casino, Reno, Nevada, USA

EARLY BIRD DISCOUNT EXTENDED!

Register soon to get a $100 Discount; expires at midnight CST on February 14, 2025.

REGISTER HERE

THE CALL FOR PRESENTATIONS IS NOW OPEN!

SUBMIT YOUR ABSTRACTS HERE

Due by 4 February 2025

STAY CURRENT WITH THE LATEST TECHNOLOGIES AND INNOVATIONS

MBSE/SysML, PLM, PLE, Modeling, Enterprise Architecture, Business Architecture, BPMN, Concept Modeling and Ontology

CATIA MBSE Cyber Systems Community

Community for everyone interested in the CATIA systems engineering, No Magic solutions like CATIA Magic, Cameo and MagicGrid as well as DYMOLA solutions.

CLICK TO JOIN THE COMMUNITY

Day 3 | Wednesday April 9th 2025

10:30am - 11:30am

MBSE Data Intelligence Dashboarding (I)

Location: Crystal 2

System architectures developed using modeling languages like SysML or UAFML are typically crafted by specialists with in-depth knowledge of systems engineering and modeling methodologies. While these architectures provide a detailed blueprint for complex systems, one of the main challenges is democratizing this information so that it can be accessible and understandable to all stakeholders, including those without specialized technical backgrounds. This democratization process is essential for ensuring broad stakeholder communication and engagement, which is critical for successful project outcomes. Additionally, effective management of system architecture requires the implementation of metrics that can provide insight into the monitoring of the architecture development progress and the management of complexity, and provide support for decision-making. This workshop demonstrates the value of data intelligence technology to build dashboards to explore, manage and monitor complex systems.

Gauthier Fanmuy | *Dassault Systèmes*

Berenger Winckler | *Dassault Systèmes*

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