Advancing Industrial Systems (Of Systems) Engineering:
Leveraging Model Based Systems Engineering (MBSE) with OMG Standards

OMG Europe Information Day 2025

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1. Corporate Overview and Contributions to Standards

2. Industry Trends

3. Use Cases Illustrations

4. Key Success Factors & Next Challenges

DASSAULT SYSTEMES

DASSAULT SYSTEMES

Accelerate sustainable innovation with 3DUNIVERSE & Virtual Twin

- **Software Solutions** for Model-based Systems Engineering, 3D Modeling & Simulation, Product Lifecycle Management, Collaboration and Data Science
- Created in **1981**
- 6.2 b€ **revenues** (FY 2025, Non-IFRS)
- 22 500 **Employees** in 130+ countries
- 300 000 **Enterprise Customers**
- 45 million **Users**
- 17 000 **Partners** (Technology, Consulting, Sales, Integration & Services)

Deliver software solutions for 12 Industries

Collaborate with Industry Leaders

DASSAULT AVIATION · AIRBUS · BOEING · KNDS · BELL · LOCKHEED MARTIN · NAVAL GROUP · LEONARDO · SAFRAN · BAE SYSTEMS · MBDA · U.S. AIR FORCE · L3HARRIS · NAVSEA · RENAULT · STELLANTIS · JAGUAR · LAND ROVER · BMW · TOYOTA · TESLA · BOSCH · JOHN DEERE · CLAAS · ERICSSON · EDF · BOUYGUES · asics

…

…and new “market shakers”

VERKOR · naarea · RIVIAN · VERTICAL · BOOM …

3DEXPERIENCE® Lab

DASSAULT SYSTEMES

Participation in INDUSTRY STANDARDS Co-Creation & Adoption

KEY PARTNERSHIPS

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

UAF · UPDM · SysML · SysML v2 · UML · fUML · RAAML · …

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

digital twin CONSORTIUM · AREA

- 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)

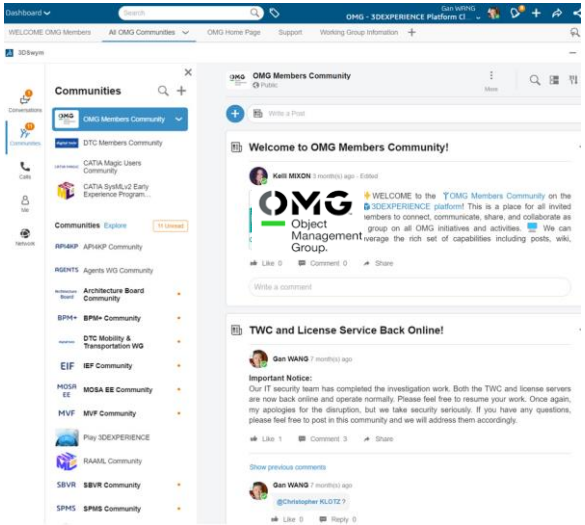
- Support of key **industry consortiums & standards**
  - **CONCERTO** **C**onstruction **O**f **N**ovel **CERT**ification meth**O**ds and means of compliance for disruptive technologies,
  - **AUTOSAR** **AUT**omotive **O**pen **S**ystem **Ar**chitecture
  - **Digital.auto** Software Defined Vehicle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

Key Collaboration with OMG® Open Management Group

Participating in Architecture Board and Specification definition

OMG STANDARD NAME	ACRONYM	VERSION	STATUS	PUBLICATION DATE
Action Language for Foundational UML	ALF	1.1	formal	June 2017
APIs for Knowledge Platforms	API4KP	1.0	formal	August 2024
UML Profile for BPMN Processes	BPMNProfile™	1.0	formal	July 2014
Commons Ontology Library	Commons	1.2 beta	beta	December 2024
CubeSat System Reference Model Profile	CSRM	1.1 beta	beta	March 2024
FACE Profile for UAF	FACE	1.0	formal	April 2023
Semantics of a Foundational Subset for Executable UML Models	FUML™	1.5	formal	June 2021
Kernel Modeling Language	KerML	1.0 beta 2	beta	April 2024
Metamodel Extension Facility	MEF	1.0	formal	September 2021
MOF to RDF Mapping	MOF2RDF	1.0	formal	September 2021
Ontology Definition Metamodel	ODM™	1.1	formal	September 2014
Precise Semantics of UML Composite Structures	PSCS™	1.2	formal	June 2019
Precise Semantics of UML State Machines	PSSM	1.0	formal	May 2019
Risk Analysis and Assessment Modeling Language	RAAML	1.1 beta	beta	June 2024
Space Telecommunications Interface	STI	1.0	formal	August 2024
SysML-Modelica Transformation	SyM™	1.0	formal	November 2012
OMG System Modeling Language	SysML®	2.0 beta 2	beta	April 2024
SysML Extension for Physical Interaction and Signal Flow Simulation	SysPhS	1.1	formal	May 2021
Systems Modeling API and Services	SystemsModelingAPI	1.0 beta 2	beta	April 2024
Tools Output Integration Framework	TOIF	1.3	formal	March 2019
Unified Architecture Framework	UAF	1.2	formal	July 2022
Unified Modeling Language	UML®	2.4.1	formal	July 2011
Unified Profile for DoDAF and MODAF	UPDM™	2.1.1	formal	May 2017
XML Metadata Interchange	XMI®	2.5.1	formal	June 2015

Supporting OMG Task Forces and Communities



digital twin CONSORTIUM

AREA Augmented Reality for Enterprise Alliance

Developing webinars for knowledge sharing among practitioners

https://www.omg.org/spec/company/dassault-systemes/About-dassault-systemes/

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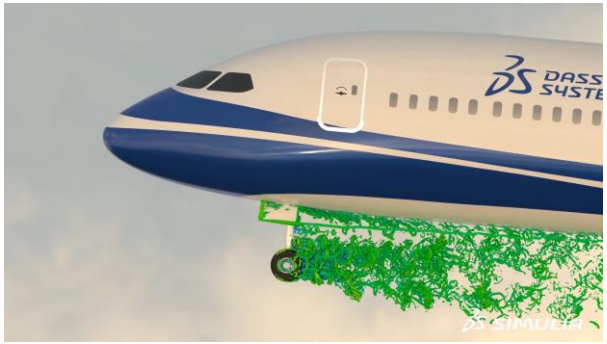
MBSE as enabler for Digital Transformation…

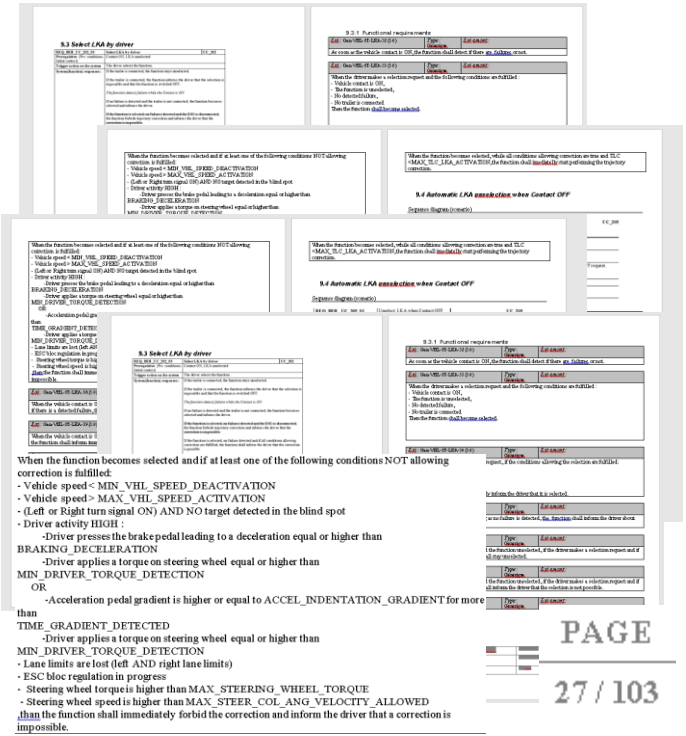
40 years ago for Mechanical…

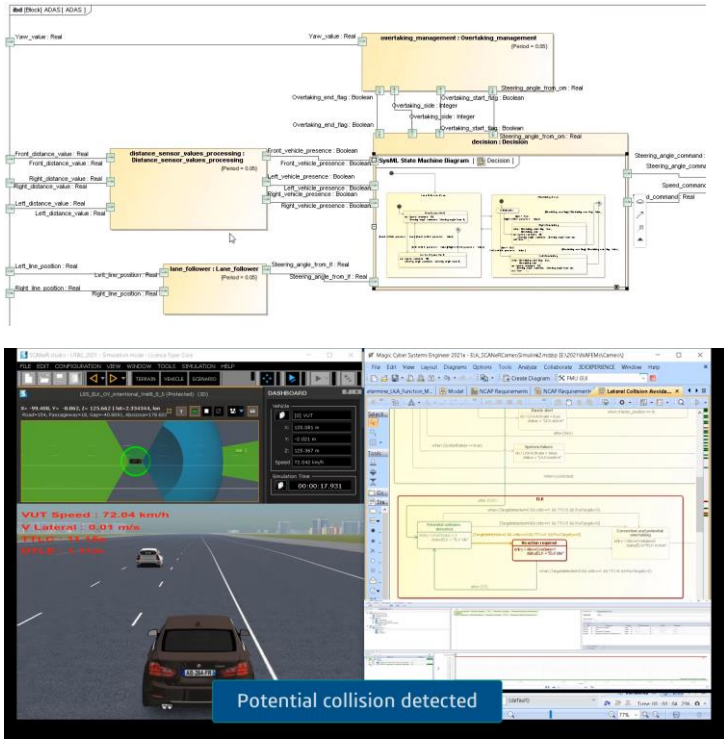


MBSE as enabler for Digital Transformation…

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

…for multi-disciplinary systems





Evolution of Complexity
Towards Emergent Behaviors

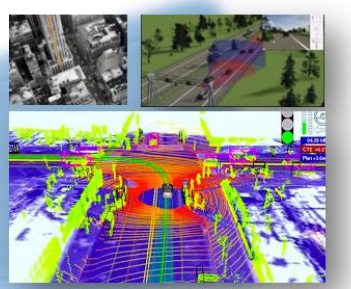
Product

Mechanical System

Mono-discipline

Mechatronics Systems

Multidisciplinary field that includes a combination of mechanical, electrical, control and software



Software-defined Systems of Systems

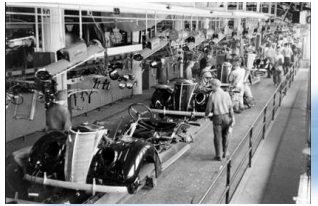
Software-intensive distributed systems interacting together in an unpredictable world

... in a PESTEL ^ VUCA environnement

Political, Economic, Sociocultural, Technological, Ecological, Legal

Volatility, Uncertainty, Complexity, Ambiguity

Industrial System



Industry 2.0

Mass production assembly lines using electrical power

Industry 3.0

Automated production using electronics, programmable logic controllers (PLC), IT systems and robotics

Industry 4.0

Smart factory. Autonomous decision making, machine learning, big data analysis, interoperability

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Evolution of Complexity
Towards new cross-Industries Ecosystems

Manufacturing Industries

Aerospace & Defense
- Hydrogen Aviation
- eVtol
- Defense & Space

Transportation & Mobility
- Electric Vehicle
- Automated Driving
- Mobility services

Industrial Equipment
- Heavy Mobile Equipment
- Autonomous Robots
- Wind Equipment

High Tech
- Consumer Electronics
- Batteries
- Datacenters

Marine & Offshore
- Autonomous Ship
- Shipyards

City & Infrastructure

Infrastructure, Energy & Materials
- Nuclear & SMRs
- Offshore Wind farms
- Gigafactories

Architecture, Engineering & Construction
- Smart Buildings
- Transportation infrastructures

Cities & Public Services
- Smart Cities

Life Sciences

Life Sciences & Healthcare
- Medical devices
- Pharmaceutics Infrastructures
- Precision Medicine

Création d'une Chaire d'Enseignement et de Recherche dédiée à l'architecture des systèmes complexes

INSTITUT POLYTECHNIQUE DE PARIS

AGENCE INNOVATION DÉFENSE

CIEDS CENTRE INTERDISCIPLINAIRE D'ÉTUDES POUR LA DÉFENSE ET LA SÉCURITÉ

DASSAULT AVIATION

KNDS

NAVAL GROUP

DASSAULT SYSTEMES

software république — un écosystème d'open innovation qui façonne la mobilité de demain

EVIDEN

orange

Renault Group

THALES

MEDITWIN réunit l'excellence des sciences et des technologies françaises autour du jumeau virtuel pour le futur du soin médical

Quirnel codoc Neurometers iHU

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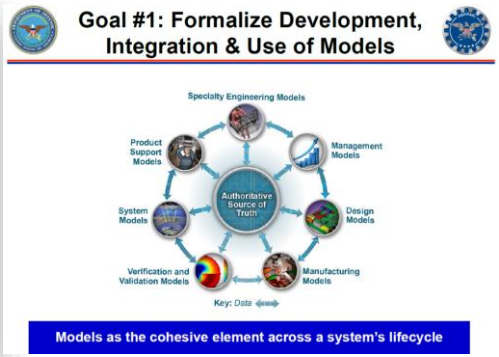
MBSE as Authoritative Source of Truth

US Department of Defense Digital Engineering Strategy with MOSA Standardization

DEFENSE STANDARDIZATION PROGRAM
MAKING SYSTEMS WORK TOGETHER



Source: DoD, June, 2018

Systems Engineering **Models** used as a
"Authoritative Source of Truth"
for the **full lifecycle phases**

MOSA: Modular Open Systems Approach

MOSA can be defined as a **technical and business strategy for designing an affordable and adaptable system**.
MOSA is required by United States law. Title 10 U.S.C. 2446a.(b), Sec 805 states **all major defense acquisition programs (MDAP) are to be designed and developed using a MOSA.**

The U.S. Department of Defense breaks down MOSA into **five key objectives:**

- Significant **cost savings** or **cost avoidance**
- **Schedule reduction** and **rapid deployment** of new technology
- Opportunities for **technical upgrades and refreshes**
- **Interoperability**, with system of systems and mission integration
- Other benefits, ex: **sustainment phase** of a major system

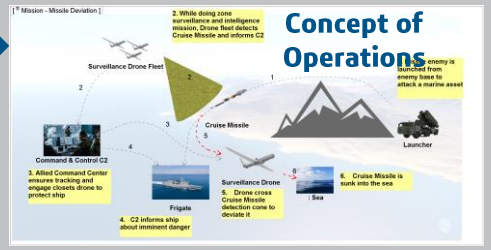
DASSAULT SYSTEMES

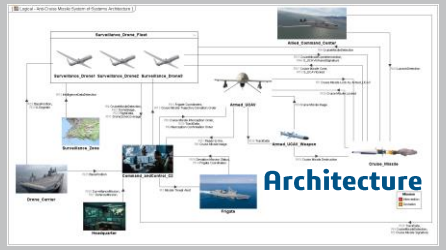
MBSE for Digital Continuity from Mission to Disciplines

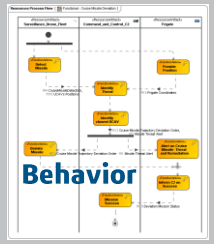
UAF

System of Systems

Surveillance Mission







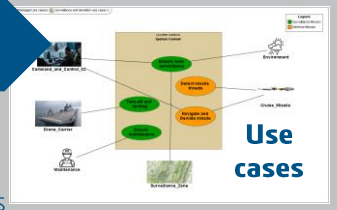
Missions and contributing systems

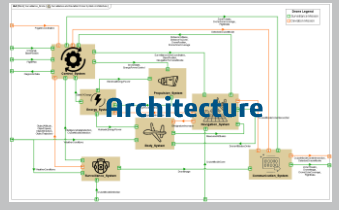
SysML

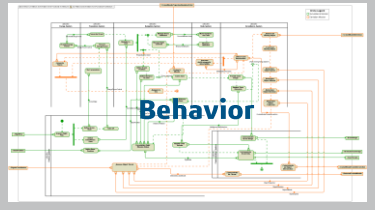
System

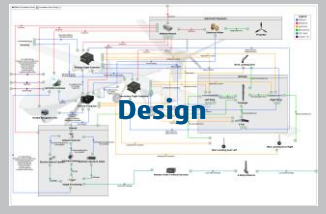
Drone

In SoS context
Cross-disciplines







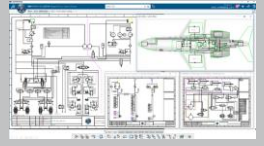


Component

Discipline-specific

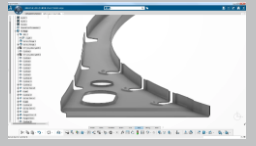
E/E Architecture

Software



Electrical

Fluid



Mechanical

Safety, Security, Traceability & impact

RAAML

DASSAULT SYSTEMES

MBSE as a Key Enabler in the Virtual Twin Lifecycle

Out-of-cycle & Market Needs | Customer Needs | Configuration Selection | Firm Concept | Authority To Offer | Firm Configuration | Start Major Assembly | First Flight | Certification & Delivery | End of Life

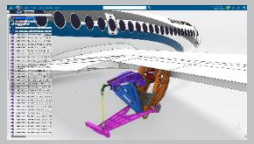
AS NEEDED

CONCEPTUAL STUDIES

AS SPECIFIED

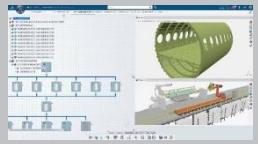
PRELIMINARY DESIGN & JOINT DEFINITION

AS DESIGNED



DETAILED DESIGN

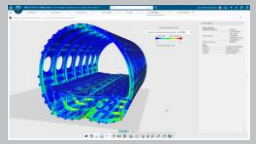
AS PLANNED



AS BUILT

MANUFACTURING & ASSEMBLY

AS CERTIFIED

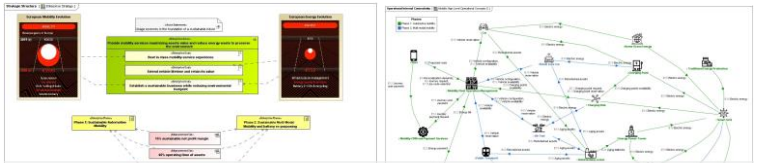


GROUND & FLIGHT TESTS

AS MAINTAINED

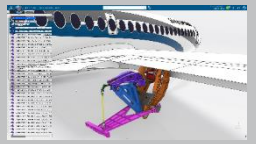
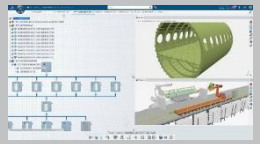
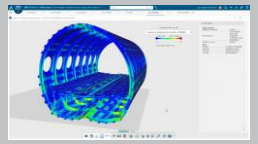
IN-SERVICES OPERATIONS & SUPPORT

MBSE as a Key Enabler in the Virtual Twin Lifecycle



1. Enterprise Business Transformation

Out-of-cycle & Market Needs | Customer Needs | Configuration Selection | Firm Concept | Authority To Offer | Firm Configuration | Start Major Assembly | First Flight | Certification & Delivery | End of Life

AS NEEDED	AS SPECIFIED	AS DESIGNED	AS PLANNED	AS BUILT	AS CERTIFIED	AS MAINTAINED
						
CONCEPTUAL STUDIES	PRELIMINARY DESIGN & JOINT DEFINITION	DETAILED DESIGN	MANUFACTURING & ASSEMBLY		GROUND & FLIGHT TESTS	IN-SERVICES OPERATIONS & SUPPORT

2. Mission Engineering

3. Safe & Secured "by design" Product

4. Manufacturing and Supply chain

5. Operations and Support

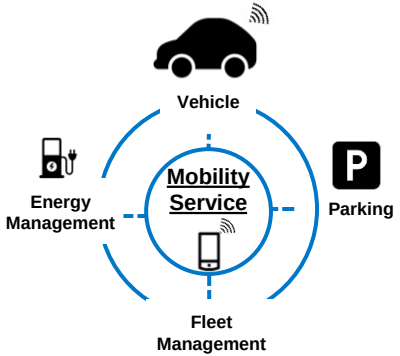
1. Enterprise Business Transformation

Example: from Carmaker to Mobility as a Service Provider

Physical Product

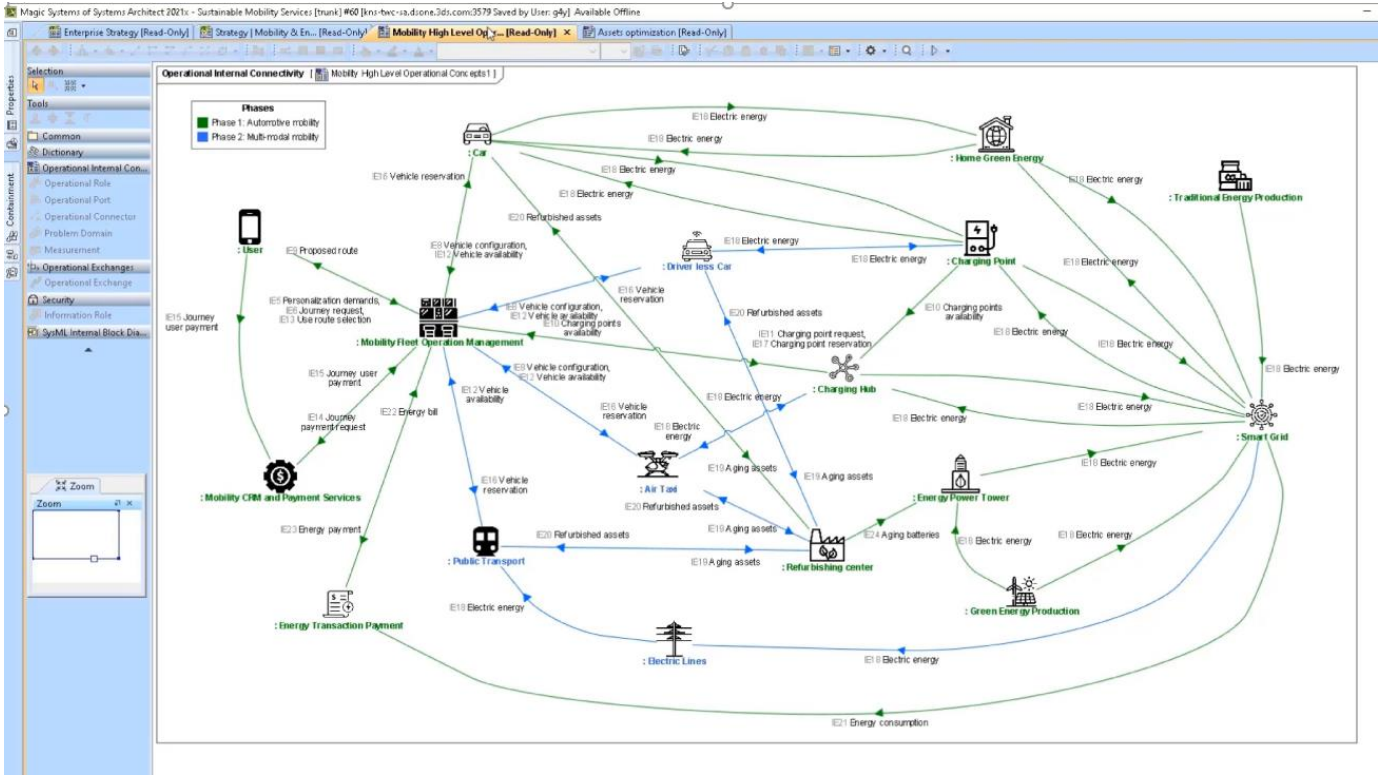
Highly Automated & Connected System

Software Defined Experiences (System of Systems)



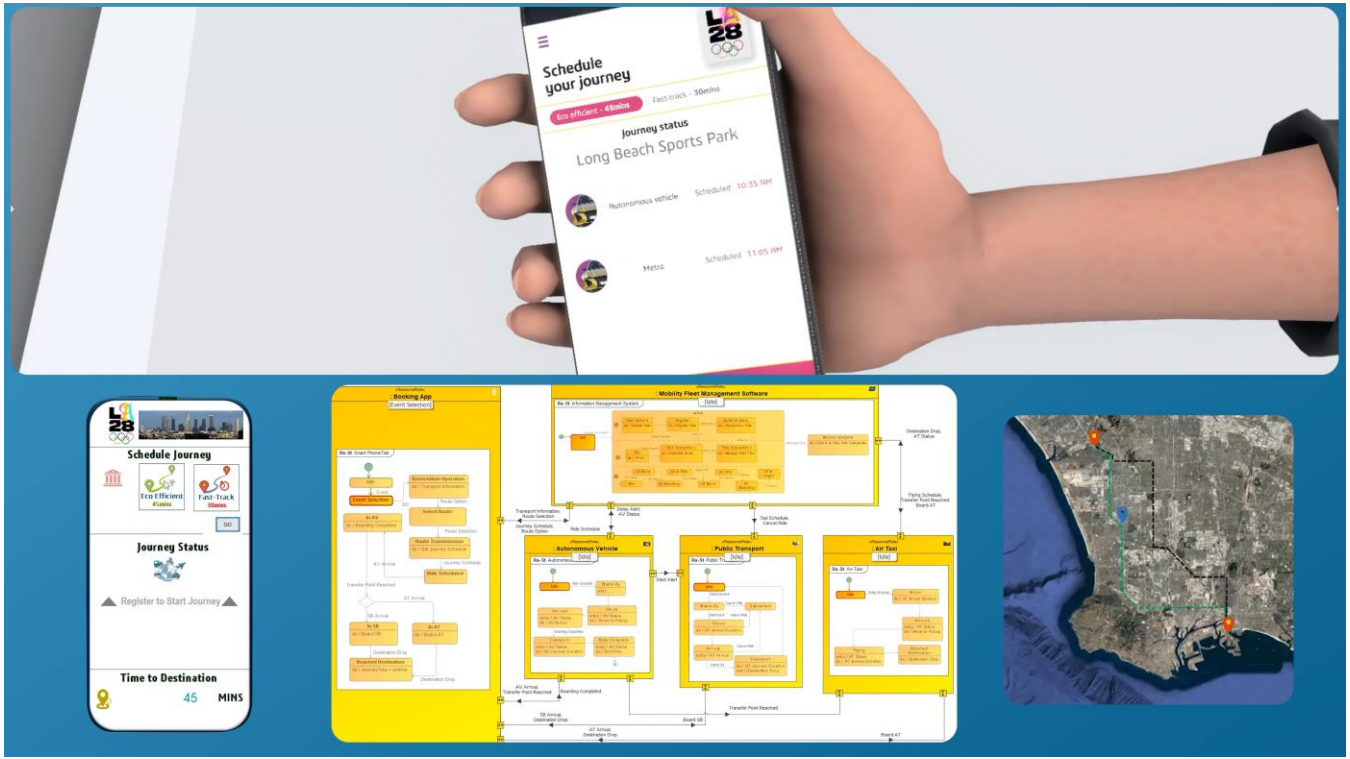
Illustrations: Renault Group & Mobilize

1. Enterprise Business Transformation



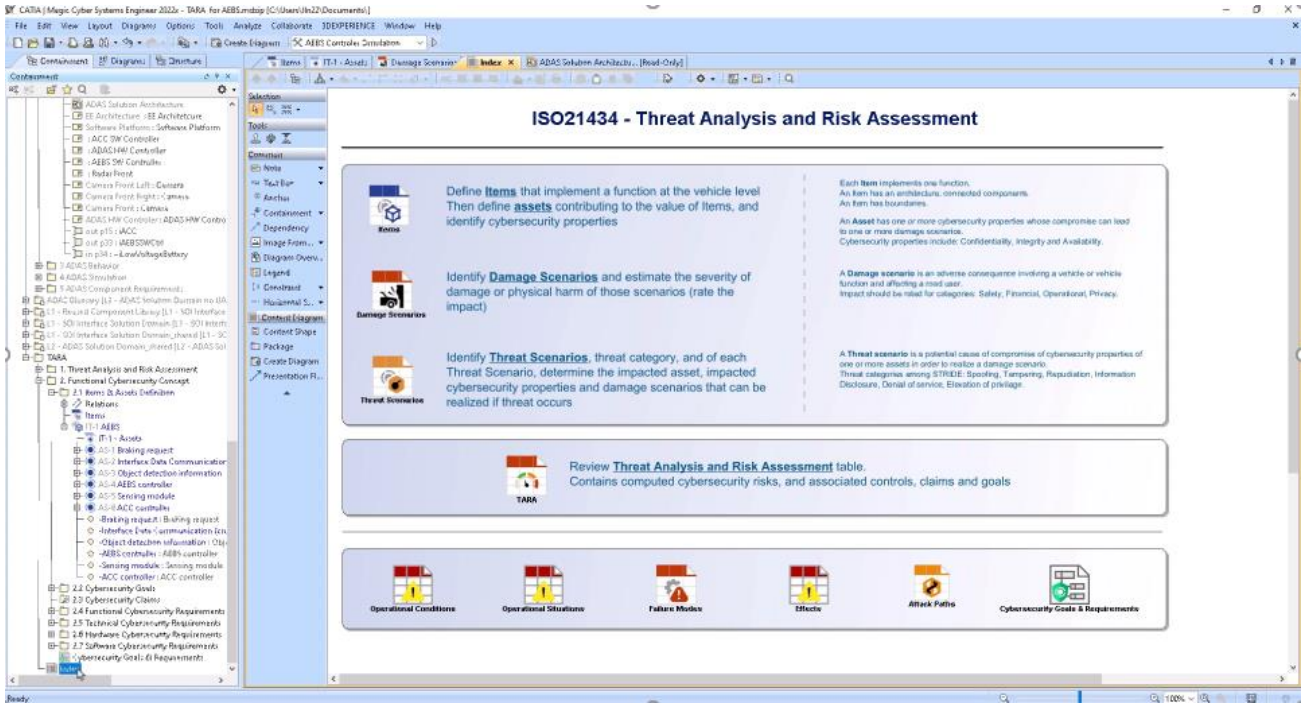
- Define **Enterprise new strategic vision** and establish **key metrics**
- Model required **capability, services and ecosystem**
- Explore alternatives and **evaluate new business opportunities**
- **Bridge strategy, operations** and existing / new required **resources** (in-house vs. partnership)

2. Mission Engineering



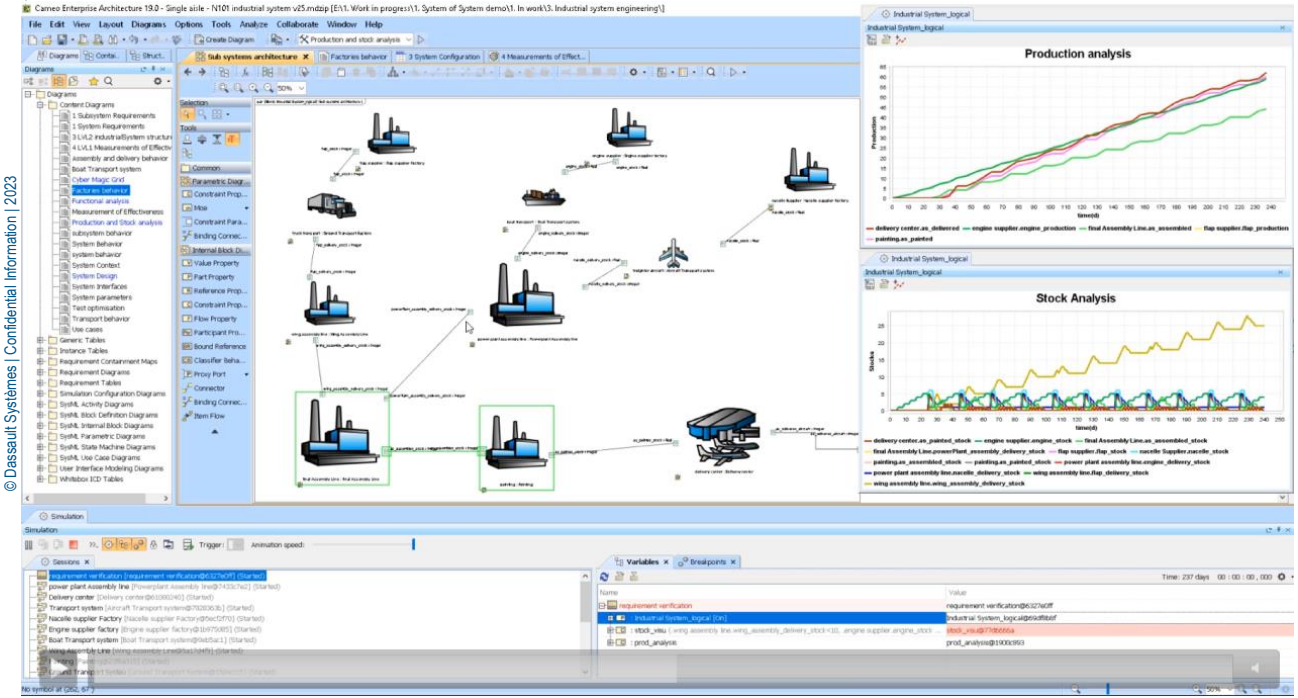
- Enhance **stakeholders alignment** and shared understanding
- Accelerate **concept evaluation** with “what-if” architecture trade-off
- Analyze interdependent systems to **identify emergent behaviors** and **reduce risks at early development stages**

3. Safe & Secured “by design” Engineering



- **Enrich systems architecture** models (SysML) with **safety and security semantics** (RAAML)
- **Facilitate collaboration** among **Systems Architect**, **Safety Engineers** and **Cybersecurity Experts** via a unified data referential
- **Continuously assess safety and security** from early design stages through to operational deployment

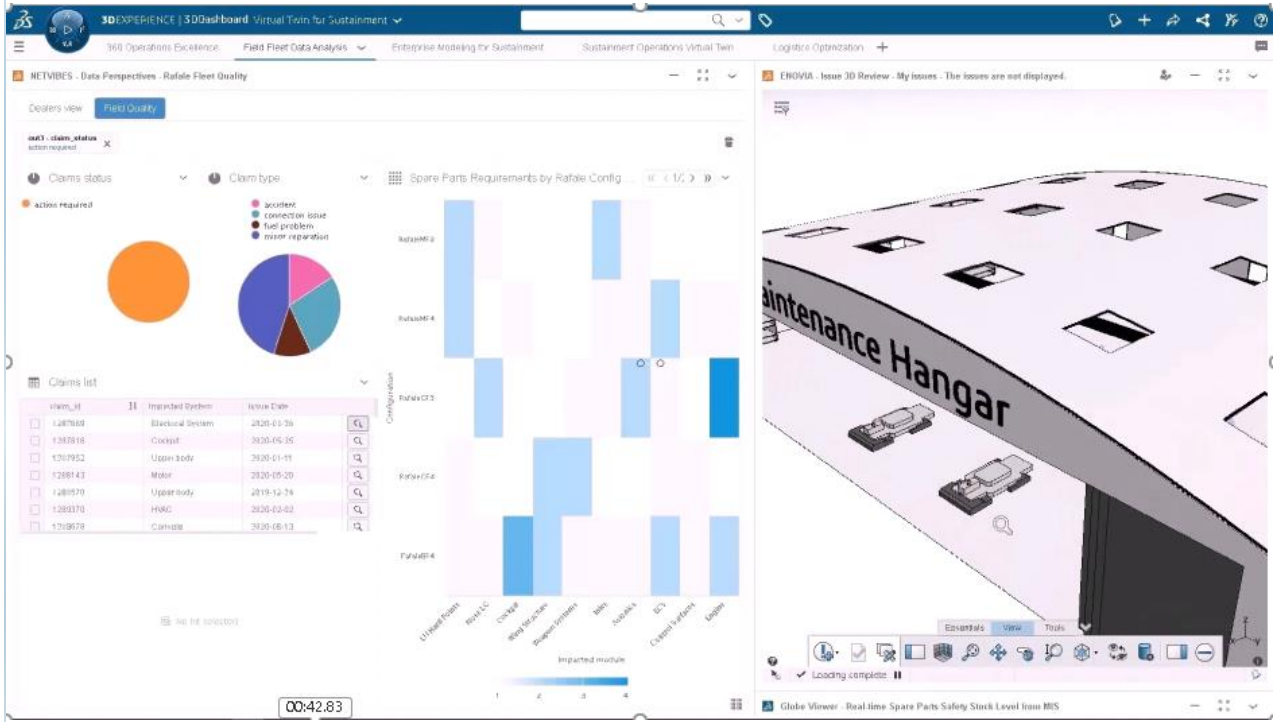
4. Manufacturing and Supply chain



- Capture **interactions** between **stakeholders** to **define the industrial system** and **key targets** (ex: delivery performance, budget performance, maximum storage capacity)
- Analyze **Supply chain configurations trade-offs** to reach **KPIs** (ex: stock level per supplier, delivery timelines, production rates)
- Perform early analysis at factory plant level to **evaluate equipment changes impacts on the assembly line** (ex: introduction of new automated guided vehicles)

INCOSE Working Group for Industrial Systems
https://www.incose.org/communities/working-groups-initiatives/systems-engineering-for-industrial-systems-(se4indus)

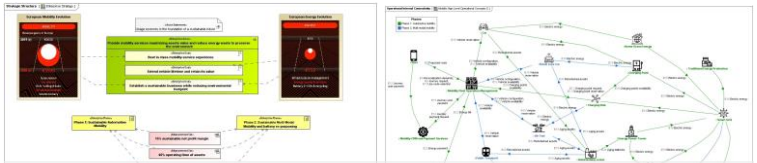
5. Operations and Support



- Simulate “what-if” scenarios for adaptive **Maintenance, Repair & Operations strategies**
- **Improve assets reliability** by detecting problems on the field and enhancing **proactive maintenance and logistics solutions**
- **Empower “non-systems engineering” experts** to leverage models, simulations and data informed decision-making

To be presented at INCOSE International Symposium 2025
A System-of-Systems Modeling, Simulation and Data Analytics Framework for Resilient Sustainment and Support Readiness Strategies

MBSE as a Key Enabler in the Virtual Twin Lifecycle



1. Enterprise Business Transformation

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		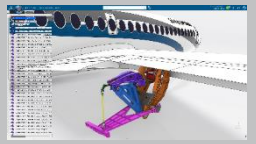	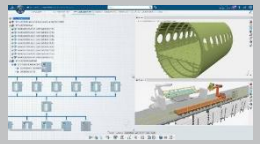		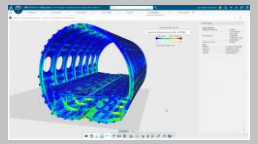	
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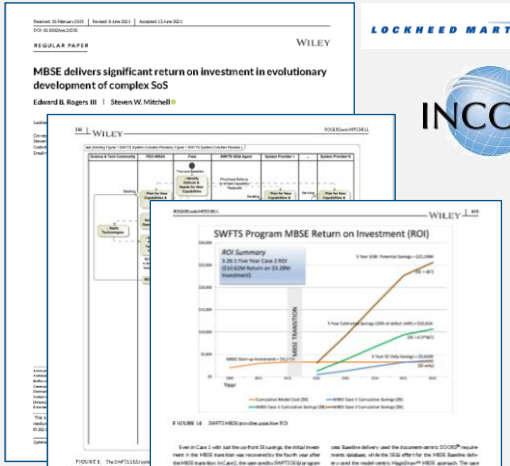
4. Key Success Factors & Next Challenges

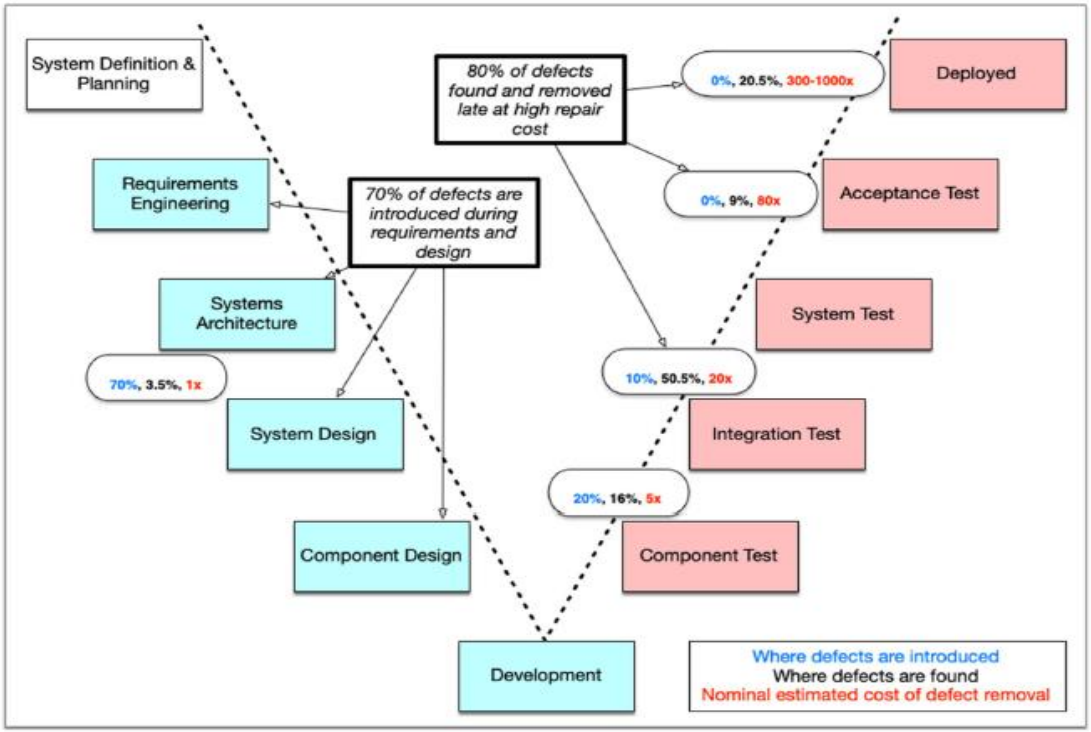
MBSE Adoption | Business Benefits



LOCKHEED MARTIN

INCOSE

ROGERS EB, MITCHELL SW. *MBSE delivers significant return on investment in evolutionary development of complex SoS.* Systems Engineering 2021;24:385–408. https://doi.org/10.1002/sys.21592

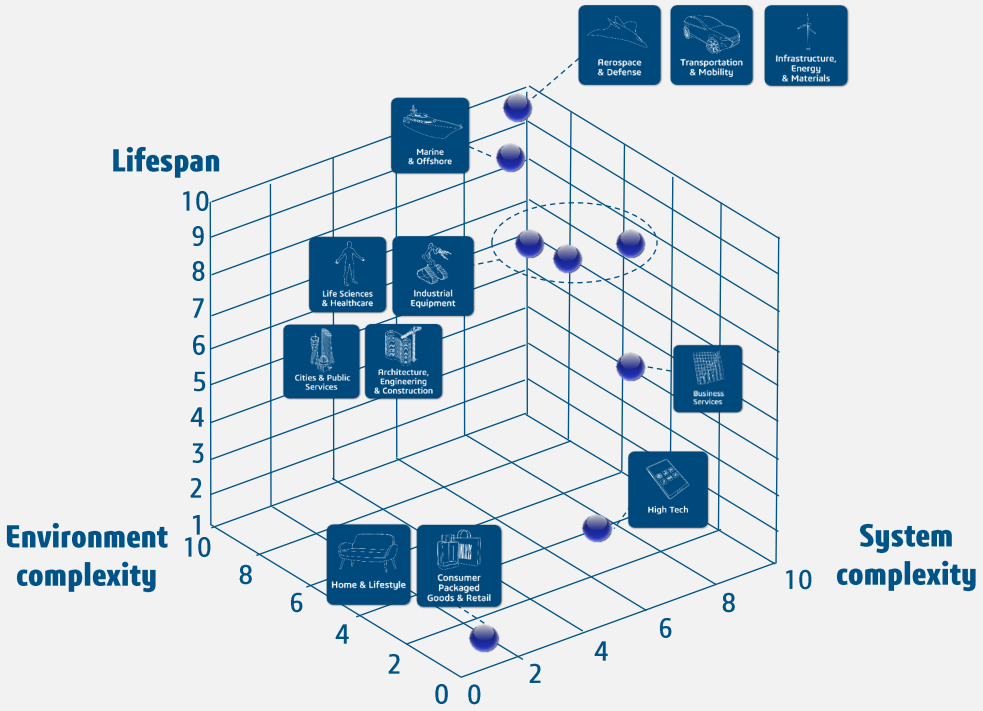


70% of defects are introduced during requirements and design

80% of defects found at high repair cost in test phase

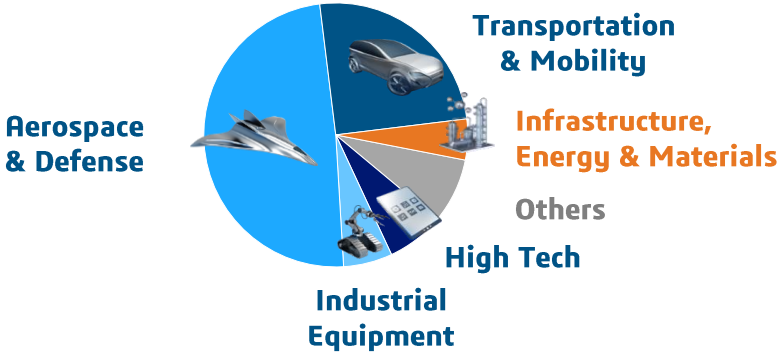
MBSE Adoption | Industry Maturity

"Maximum gains likely to be achieved with the adoption of MBSE"



Source: Azad M. Madni * and Shatad Purohit, "Economic Analysis of Model-Based Systems Engineering", University of Southern California, February 2019

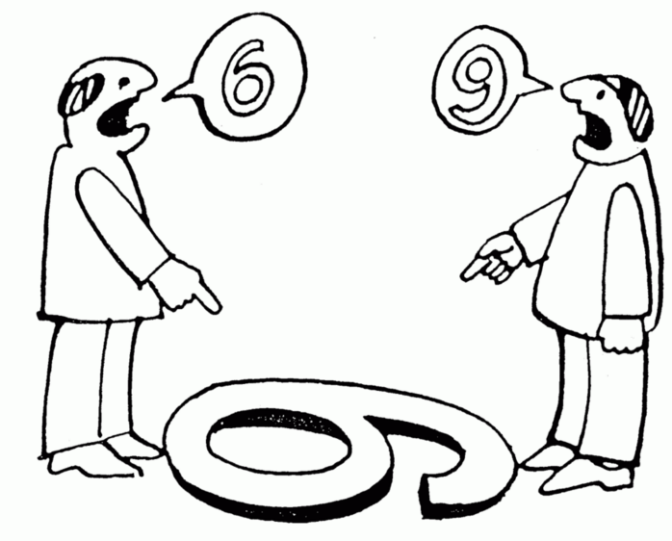
Observed "Industry Footprint" for Systems Engineering



DASSAULT SYSTEMES

Key Success Factors

"All models are wrong, but some are useful." George Box



a unambiguous formalism and semantics...

the relevant level of abstraction and viewpoints...

Key Success Factors

Why changing? **Processes**

supported by / *support*

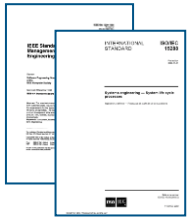
How to change ? **Methods**

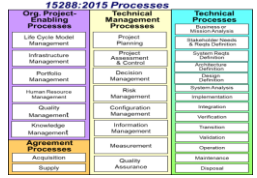
supported by / *support*

With what? **Tools & Languages**

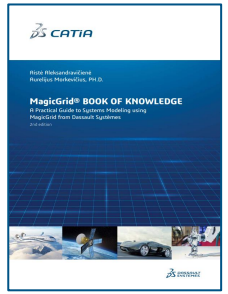
From theory to practice… **Change Management**

Process Referential
Define activities to transform and expected results





Methodology Framework
Define methodology frameworks and practices to implement the activities

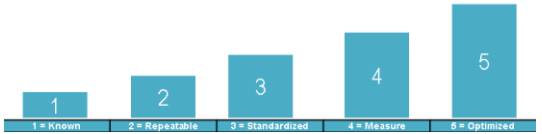


Software Tools
Improve the efficiency of processes implementation and methodologies

UAF · Modelica Association · Design with CATIA Magic · Change Governance · SysML · fmi · Behavior Modeling · Requirements

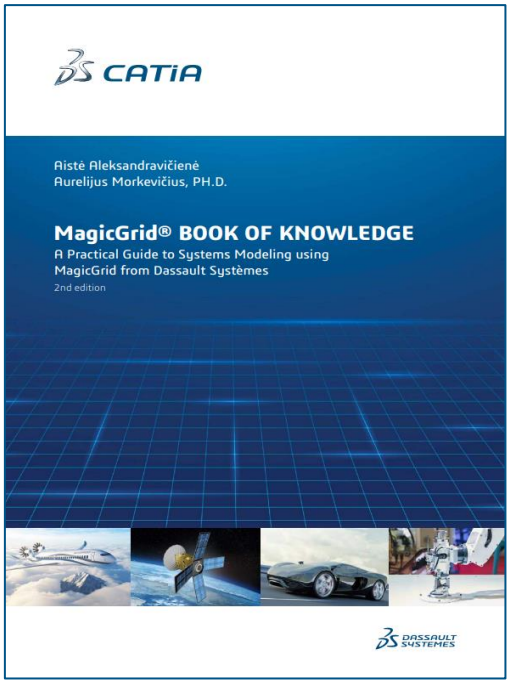
+ 3rd party tools integration

Implement & measure conditions of success
Value Assesment, Training & coaching, Community of Practitioners, Industrial pilot Projects, …

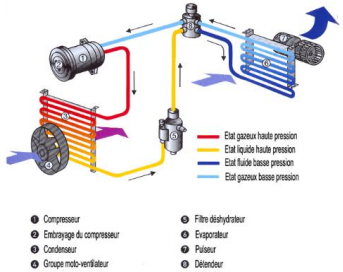


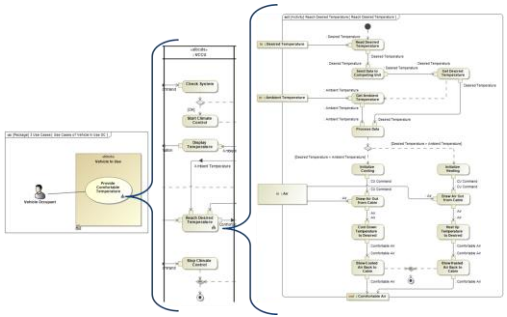
Method Example | “MagicGrid Book of Knowkedge”

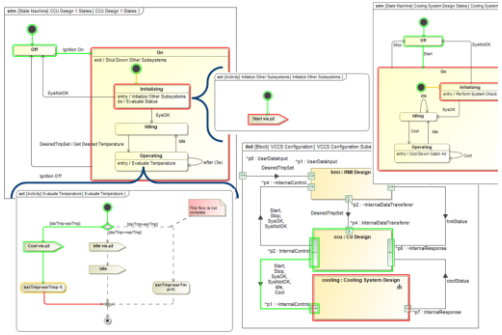
[Free Download: https://discover.3ds.com/magicgrid-book-of-knowledge](https://discover.3ds.com/magicgrid-book-of-knowledge)



The case study : Vehicle Climate Control System

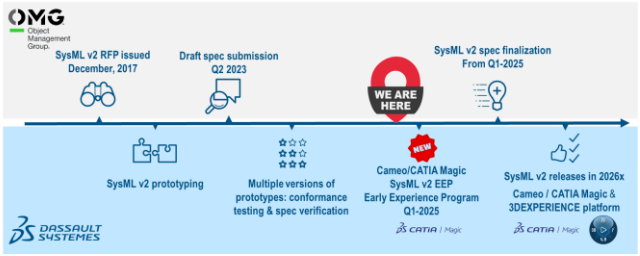




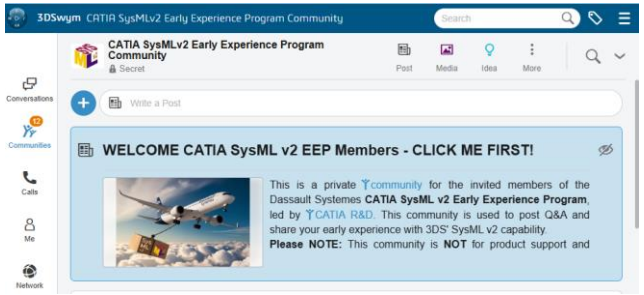


SYSML V2

- Active Participation since OMG SysML V2 inception
- **Early Experience Program** launched **in December 2024** and open to Clients & Partners



- **CATIA Magic SysMLv2** Community
  - Installation instructions
  - Tutorials and Videos
  - Best Practices, Tips and tricks
  - Collaborative SysMLv2 Models



https://3dswym.3dexperience.3ds.com/post/catia-user-community/discover-catia-sysml-v2-early-experience-program_UwLE13bMRgy8SAxvv-HHdw

DASSAULT SYSTEMES

Key Takeaways

- **MBSE drives digital transformation**
  - Acts as **the authoritative source of truth** throughout the system lifecycle, from concept to support
  - Empowers **"model & simulate"** approaches to evaluate **“what-if”** scenarios and inform decisions
  - Continuous align and engage stakeholders at **Product, Industrial System,** and **Enterprise & Value Network** scales
  - Supports the creation of **re-usable company assets**

- **Industry standards such as UAF and SysML accelerate MBSE adoption**
  - Ensure **semantic consistency** and foster **collaboration** across disciplines and organizations
  - Enables **interoperability** and toolchain integration
  - Create new **opportunities for tool democratization** (e.g. SysML v2, Generative AI and Knowledge Management)

- **Beyond tools, success depends on a supportive transformation ecosystem**
  - Process, method and **change management: “Value-based modeling”**
  - Investment in continuous **upskilling and coaching**
  - **Knowledge sharing** among practitioners, leveraging key communities (e.g. OMG, INCOSE)

DASSAULT SYSTEMES

CATIA MBSE USER DAYS FRANCE

May 20 & 21 | Dassault Systemes Campus, Velizy | Free in-person workshop

https://myevents.3ds.com/fr/catia-mbse-user-days-france-2025

May 20
Keynotes from
Industrial Practitioners

May 21
Trainings on CATIA
MBSE Solutions

Virtual Worlds for Real Life