




M B S E i n t r o d u c t i o n

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Simulia Days 2025

 PUBLIC

CONTENTS



1. What is MBSE?
2. Dassault Systèmes and MBSE
3. MBSE in IDIADA and Conclusion

MOTIVATION:

WHAT CAN MBSE SOLVE?

Car incident:

You sit in a hot car, turn the A/C to maximum, and start to reverse...
...the rear-view camera doesn't work – and a collision with another car occurs.



MOTIVATION:

WHAT CAN MBSE SOLVE?

Why:

- A/C unit was running at full power.
- High current draw from A/C wiring interfered with rear camera power supply.



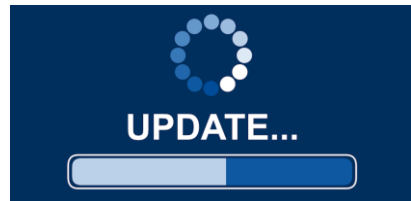
CAR HARNESS ARE COMPLEX

Various systems are working together or not but are coexisting together,
with their connections closely tightened in the same harness.

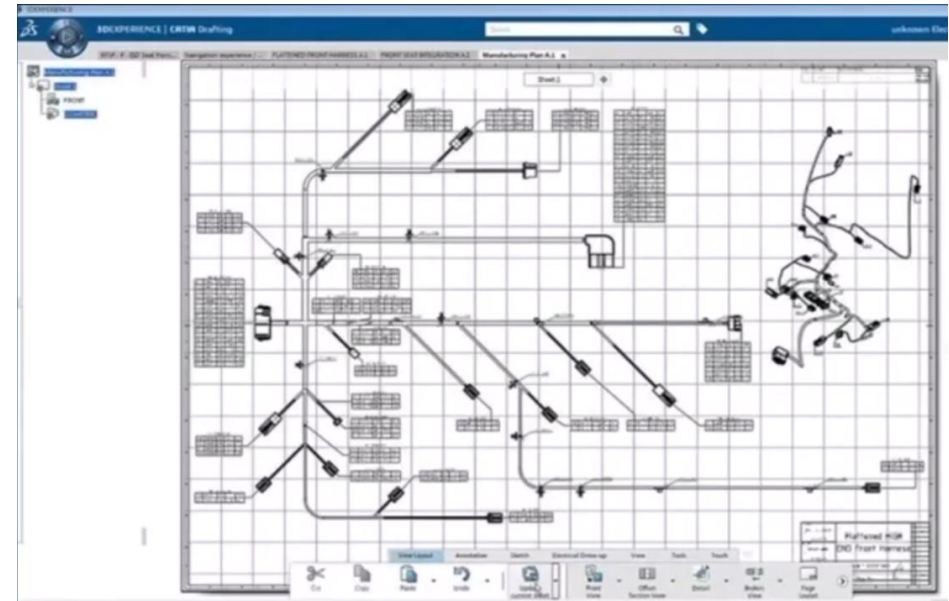
MOTIVATION: WHAT CAN MBSE SOLVE?

Solution:

- Software update – A/C power reduced automatically during reversing.



- Production fix – shielded HVAC power cable implemented.

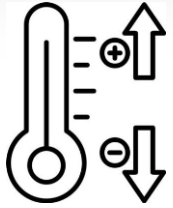


Lesson learned:

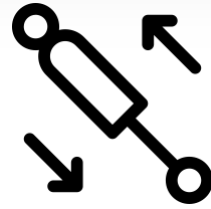
*Never skip **system-to-physical modelling, simulation, and optimization.***

WHY IS IT SO DIFFICULT?

MULTIPLE DISCIPLINES IN THE PRODUCT DEVELOPMENT



Thermal control



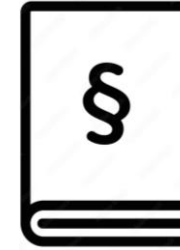
Hydro engineering



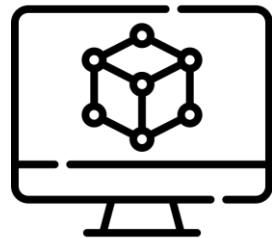
Your boss requirements



Marketing



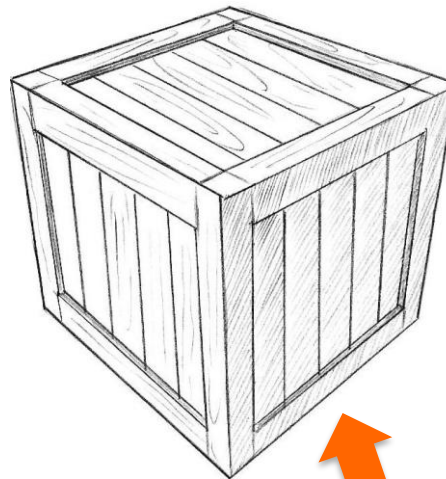
Legal requirements



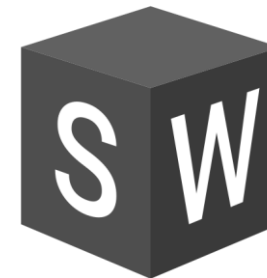
Simulations



Software engineering



Place your product HERE



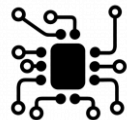
Mechanical design



Testing



Service
support



Electronics engineering



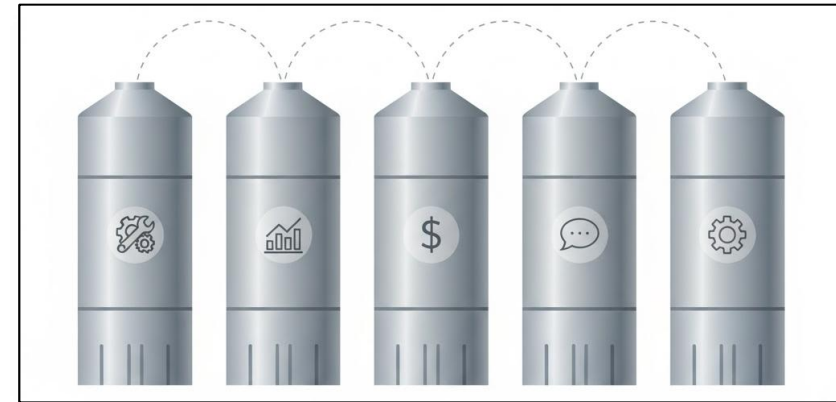
WHY IS IT SO DIFFICULT?

INDUSTRY PAINS

Lack of global system
definition and collaboration



Inconsistent silos of
Engineering disciplines



Raising systems
complexity and safety

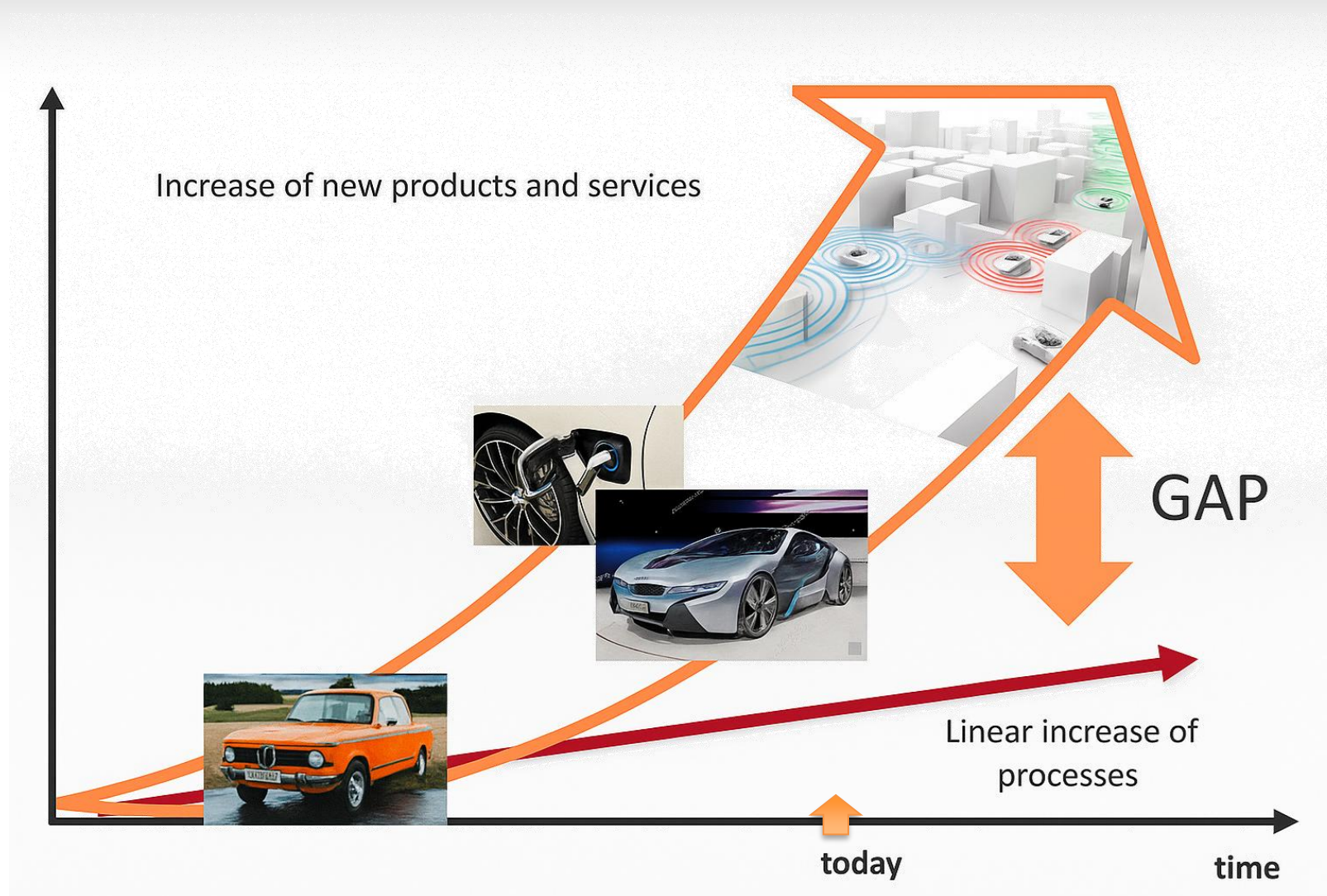


Costly compliance to
regulatory standards



WHY IS IT SO DIFFICULT?

RISING PRODUCT COMPLEXITY

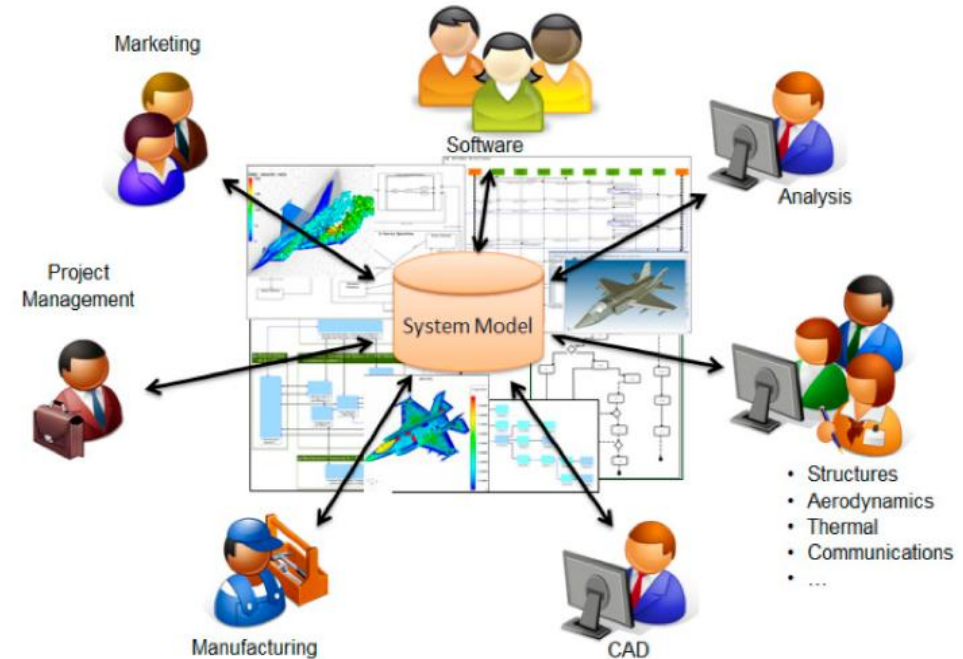
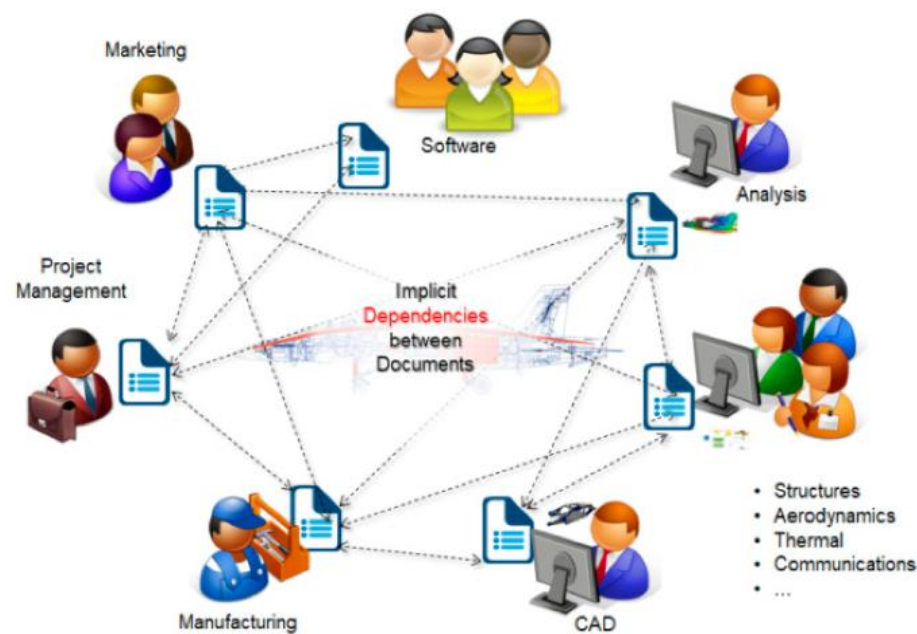


INTRODUCTION

DIGITAL TRANSFORMATION

Digital transformation is the process of using digital technologies to create new or modify existing business processes, culture, and customer experiences to meet changing market needs. It is a fundamental rethinking of how an organization operates, driven by the strategic adoption of digital tools to improve efficiency, innovate, and deliver better customer and employee experiences.

MBSE is part of digital transformation!



INTRODUCTION

WHAT IS SYSTEMS ENGINEERING?

Important links for Dassault Systemes MBSE videos:

- CATIA MBSE:
<https://www.youtube.com/@3dsCATIAMBSE/playlists>
- MBSE Execution:
<https://www.youtube.com/channel/UC3b6aj3VbOlap084ZzsdyKA>
- SysML2:
https://youtu.be/txEBWlQxAQc?si=t3f6_qJHDqVHo9m8

INTRODUCTION

WHAT IS SYSTEMS ENGINEERING?

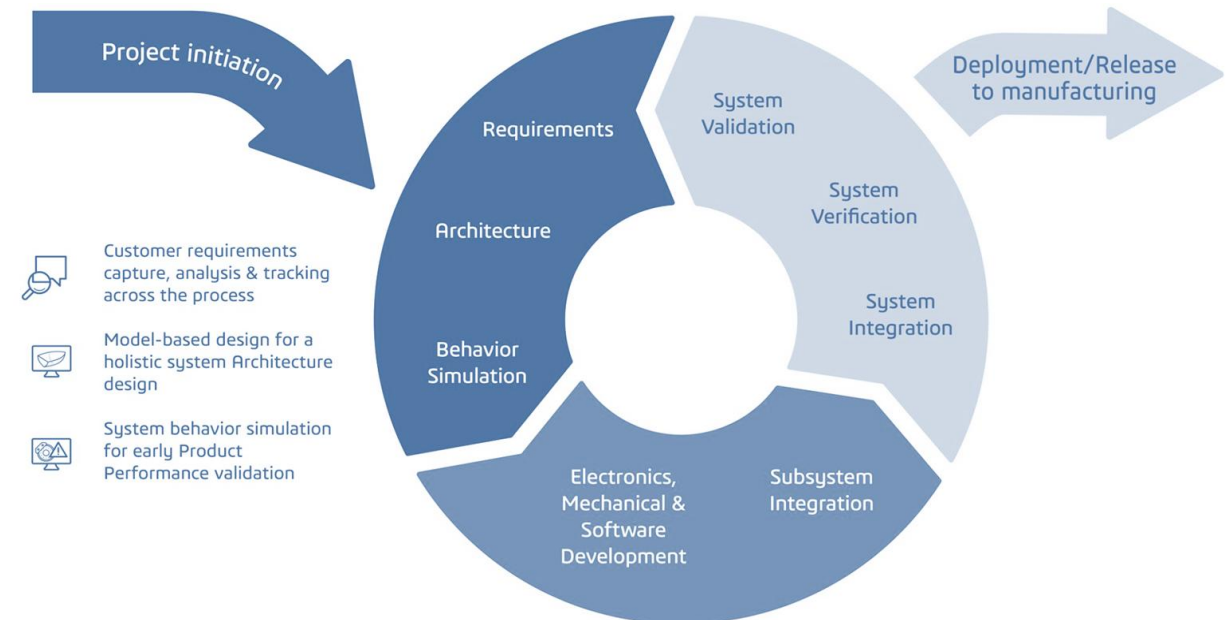
“Systems Engineering ensures that the whole works – not just the parts.”

INCOSE SEBoK

Systems Engineering is a **transdisciplinary and integrative approach** used to realize successful systems. It links people, processes, and technology through the **entire lifecycle** – from concept and design to operation and retirement.

Key focus areas:

- Understanding and managing **requirements**
- Defining system **architecture and interfaces**
- Ensuring **traceability and validation**
- Coordinating across disciplines and teams



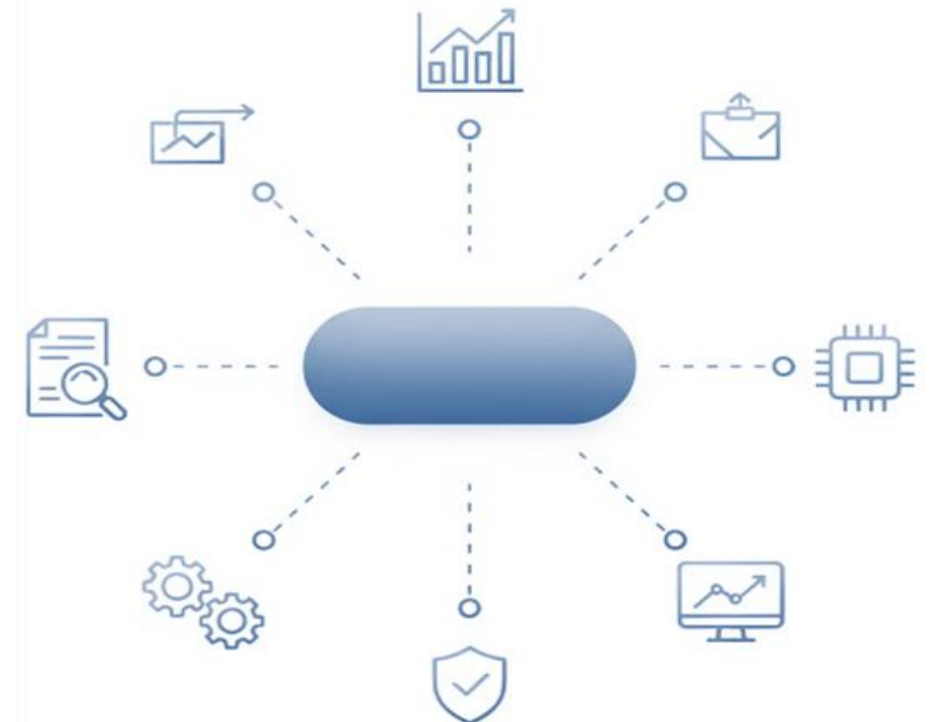
INTRODUCTION

BENEFITS OF SYSTEMS ENGINEERING

Systems Engineering helps organizations **manage complexity** and **deliver reliable systems**.

Main benefits include:

- Clear definition and management of **interfaces and dependencies**
- **Risk reduction** through early analysis and verification
- **Traceability** from stakeholder needs to tested solutions
- **Better communication** between teams and suppliers
- **Reduced rework**, time, and cost across the lifecycle
- Delivers more reliable and compliant products



INTRODUCTION

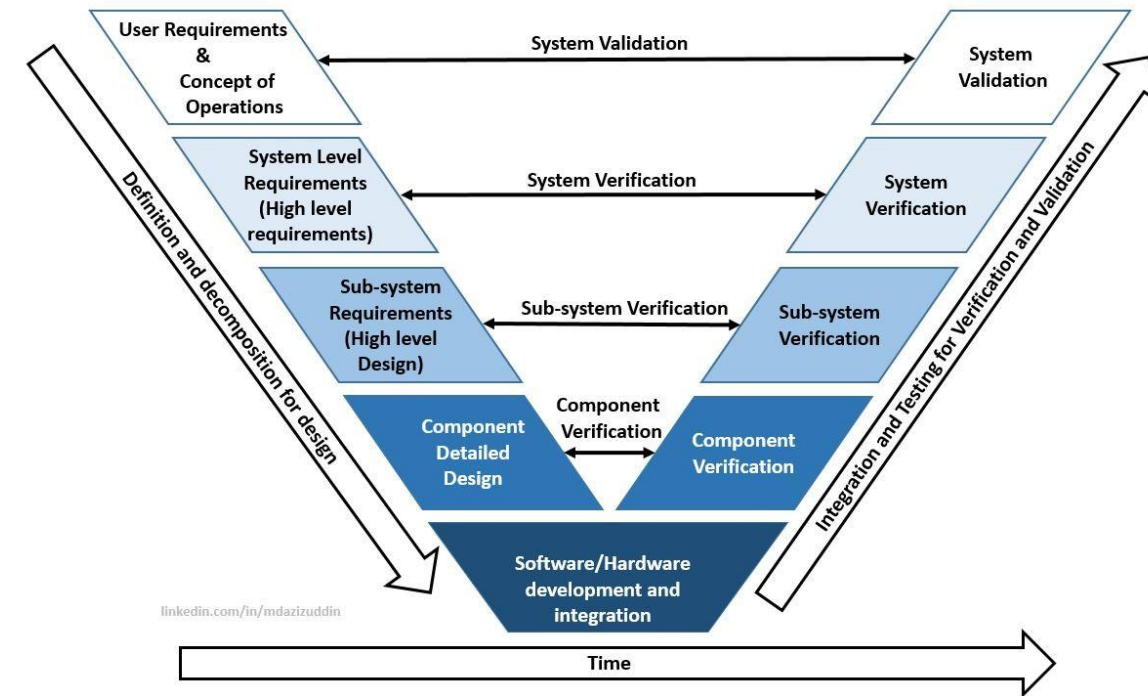
V – DIAGRAM OF DEVELOPEMENT

V-diagram is a visual model of the **system development lifecycle** linking **definition → implementation → validation**.

“Define on the left, build at the bottom, verify and validate on the right.”

Purpose

- Ensures **traceability** between requirements, design, and testing
- Helps plan **verification and validation** early
- Supports a **structured, model-based approach** to system development



- **Validation:** Are we building the right product – meaning the product meets the needs and expectations of users or customers.
- **Verification:** Are we building the product right – meaning the product is being developed correctly according to specifications, standards, and technical requirements.

INTRODUCTION

WHAT IS MBSE?

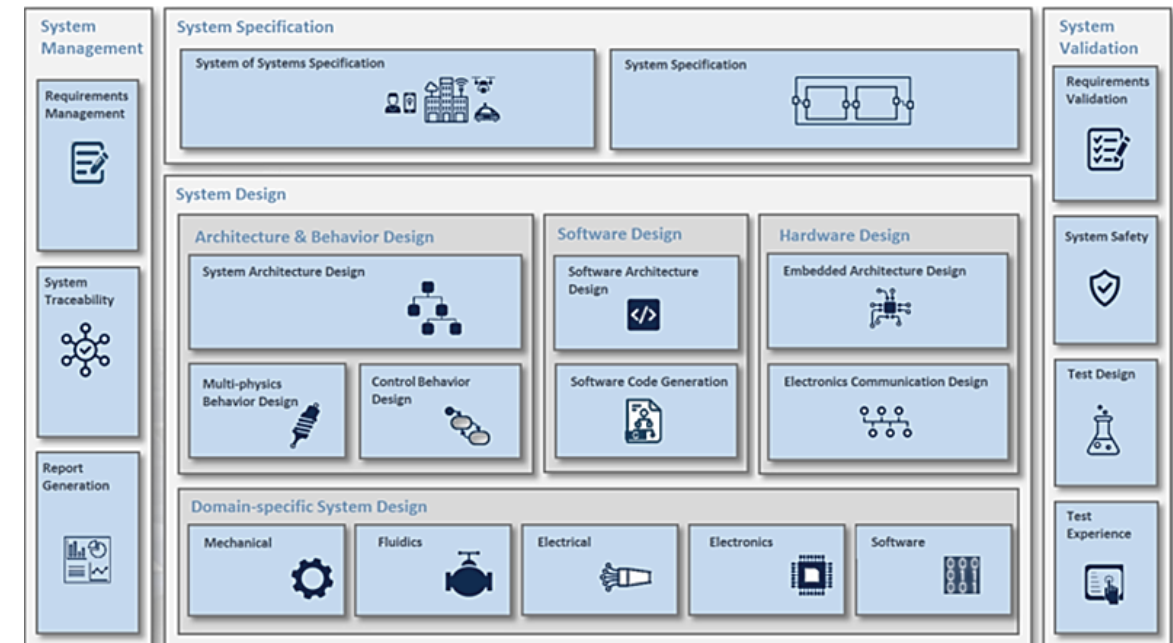
Model-Based Systems Engineering (MBSE) is the formalized use of models to support system requirements, design, analysis, verification, and validation throughout the lifecycle.

MBSE replaces static documents with **connected digital models**.

It allows simulation and validation before **physical prototypes exist**.

Benefits:

- Unified, traceable representation of the system
- Integration of mechanical, electrical, software, and control domains
- Early risk discovery and optimization
- Foundation for **Digital Twin** and **Digital Thread**



INTRODUCTION

WHAT IS MBSE?

- Modelling solution is a combination of a **modelling language(s)**, a **methodology** and a **modelling tool** that together provide a productive infrastructure for applying model-driven development in the context of a particular organization.

Methodology
Magic Grid

		Pillar			
		Requirements	Structure	Behavior	Parameters
Domain	System	Stakeholder Needs	System Context	Use Cases	Measures of Effectiveness (MOE)
	Subsystem	Conceptual Subsystems	Functional Analysis	MeEa for Subsystems	Conceptual Subsystems
	Component	System Requirements	System Structure	System Behavior	System Parameters
	Implementation	Subsystem Requirements	Subsystem Structure	Subsystem Behavior	Subsystem Parameters
		Component	Structure	Behavior	Parameters
		Component Requirements	Component Structure	Component Behavior	Component Parameters
		Implementation Requirements			

MBSE

CATIA | Magic

Tool

Catia Magic



Language

SysML

Methodology
Scrum or Agile

Programming

Language

Python

Tool

PyCharm

Methodology
V-model, X-design

Mechanical Design

Language

Parametric Design

Tool

SolidWorks

WHAT IS A SYSTEM MODEL

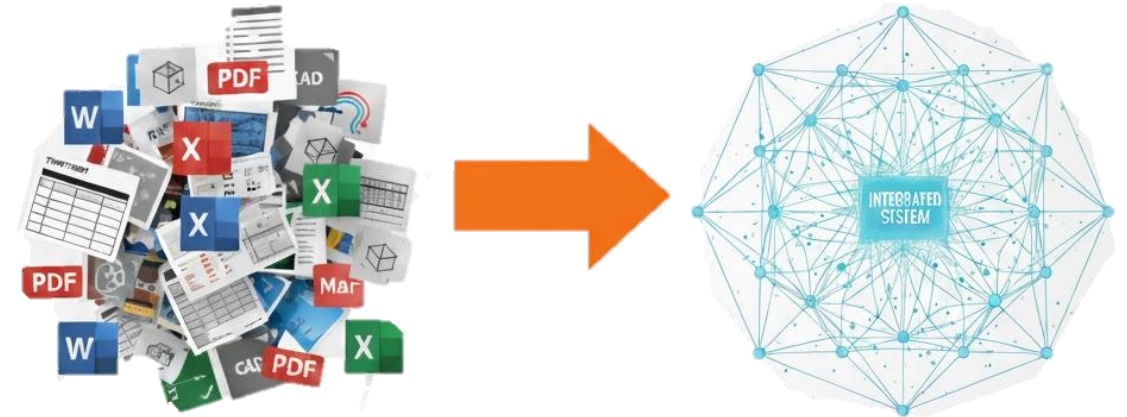
FROM DOCUMENTS TO MODEL

From fragmented files → to one living, digital model.

Traditional engineering relies on static documents: requirements, CAD, Excel, test sheets...
Each change must be manually updated.

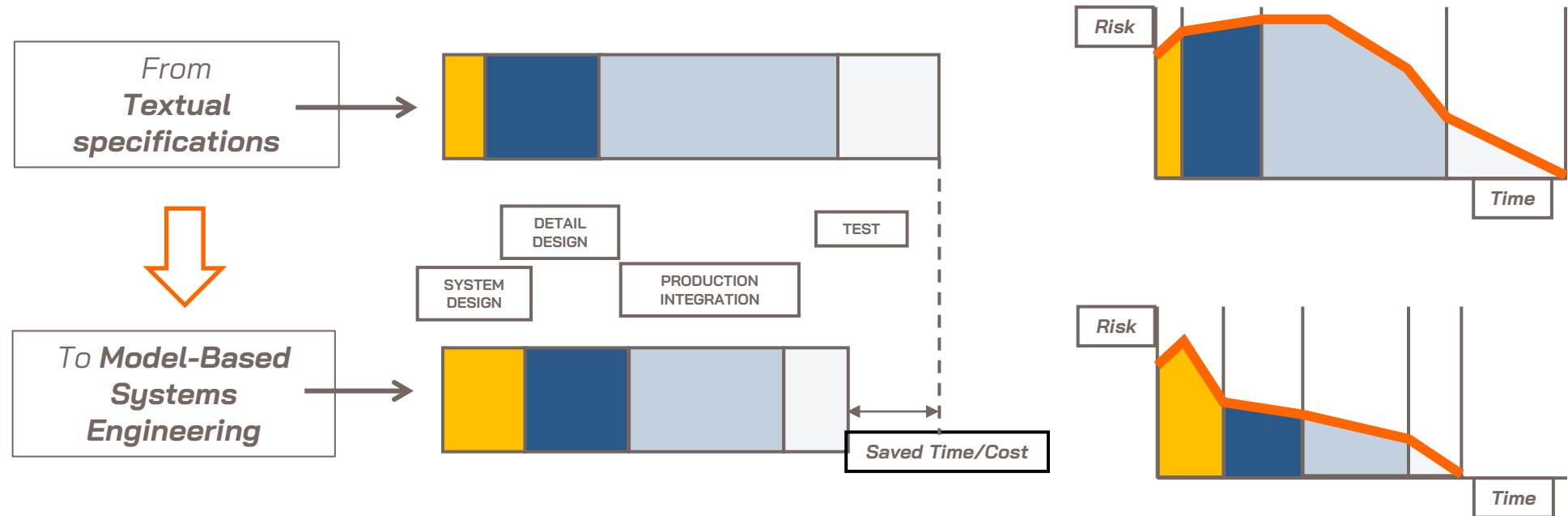
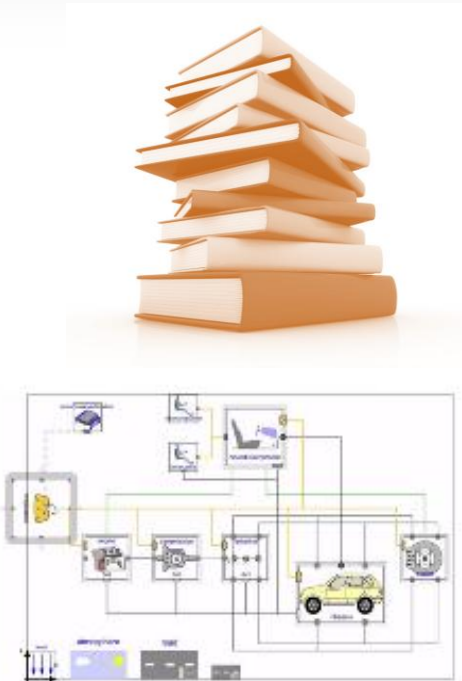
With MBSE, all system information is **linked in a single model** – ensuring consistency, version control, and impact analysis.

Documents describe; **models connect and simulate.**



WHAT IS A SYSTEM MODEL

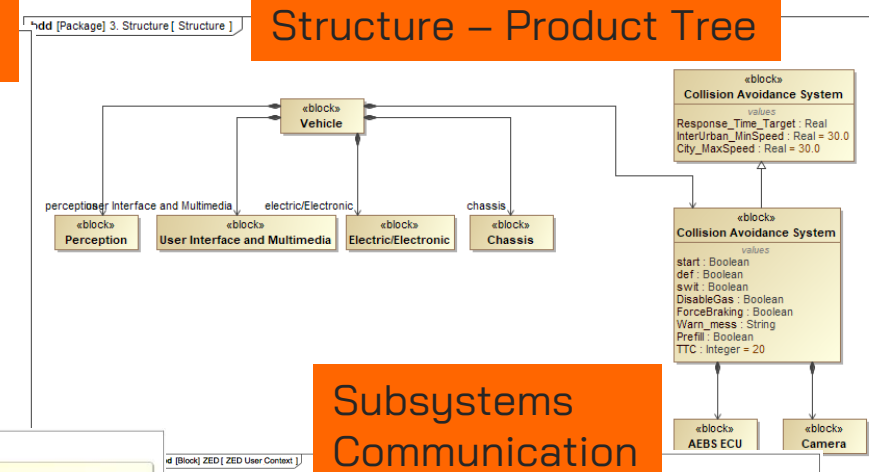
FROM DOCUMENTS TO MODEL



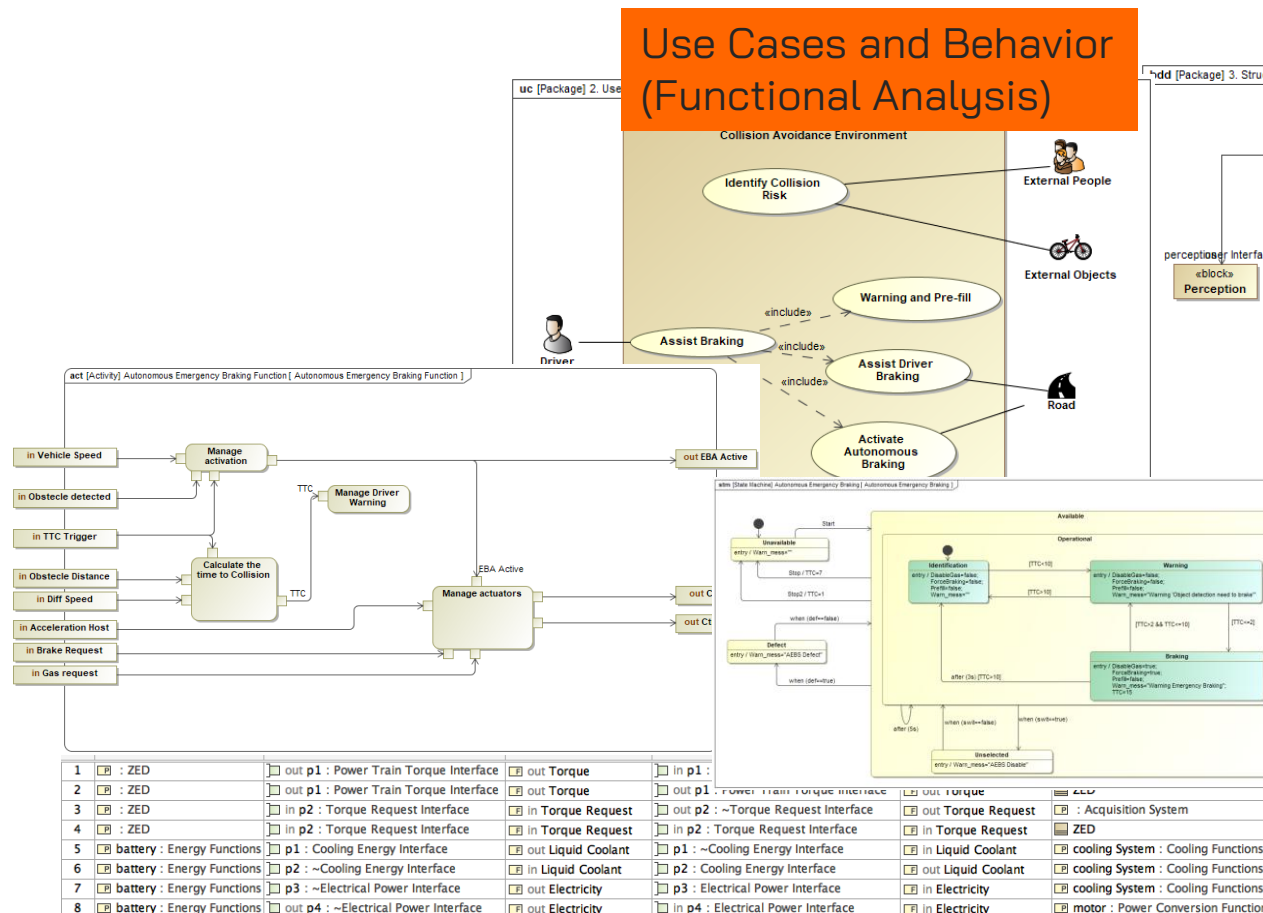
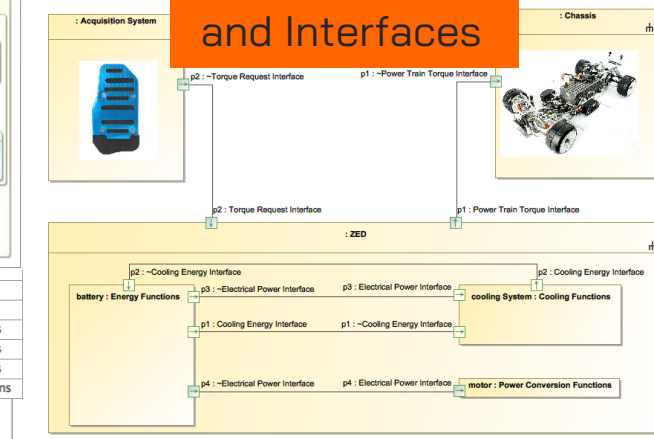
Product Design using an MBSE approach brings significant gains in project performances (quality, cost, schedule)

Use Cases and Behavior (Functional Analysis)

Structure – Product Tree



Subsystems Communication and Interfaces

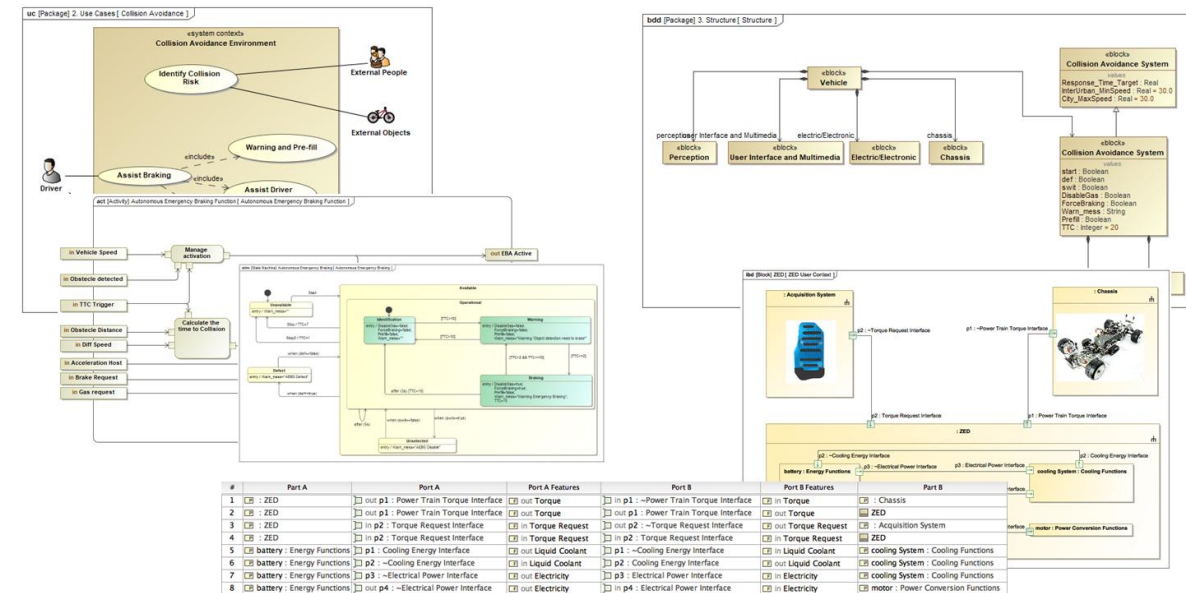


WHAT IS A SYSTEM MODEL

BASIC INTRODUCTION

A **System Model** integrates:

- **Requirements** – what the system must achieve
- **Structure** – components, interfaces, hierarchies
- **Behavior** – interactions, states, activities
- **Parametrics** – physical relationships, performance
- **Verification** – how requirements are tested



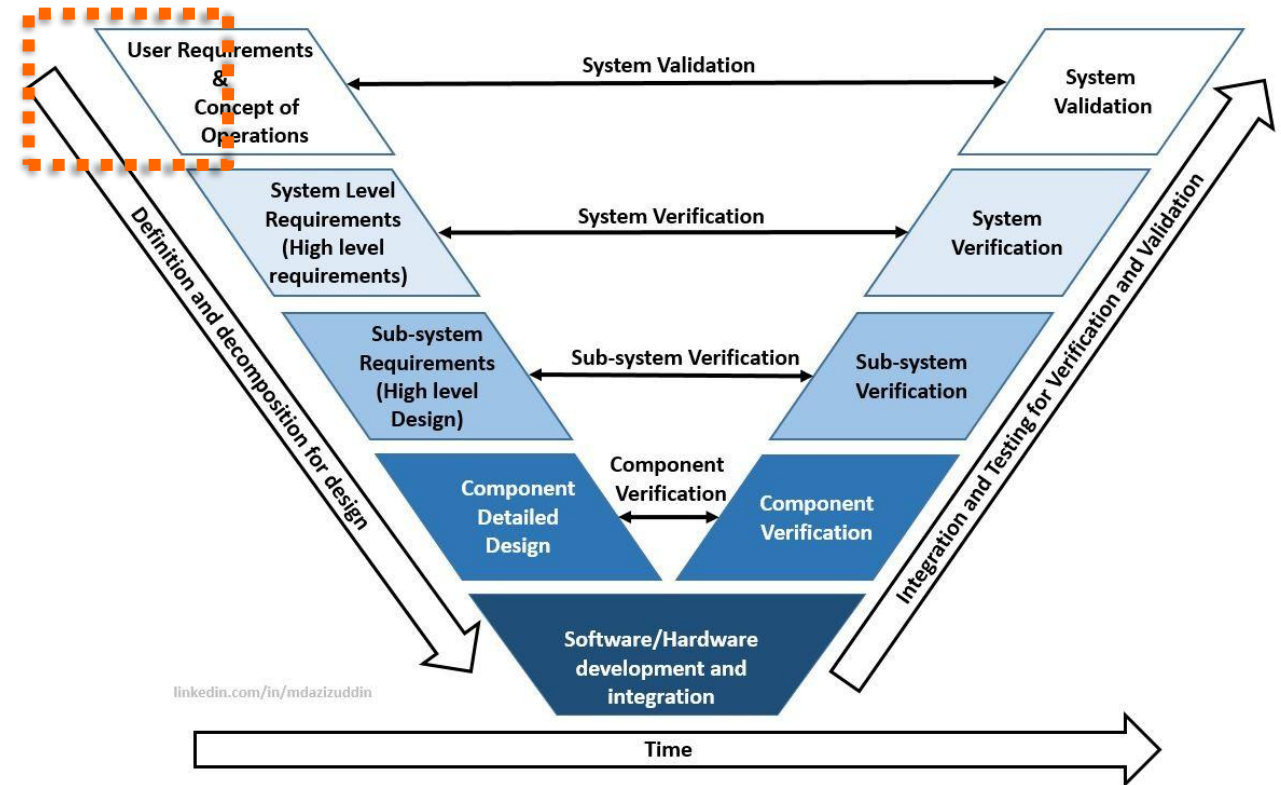
It serves as **the single source of truth** connecting all domains and enabling simulation-driven design.

How MBSE Works in Practice

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders



1

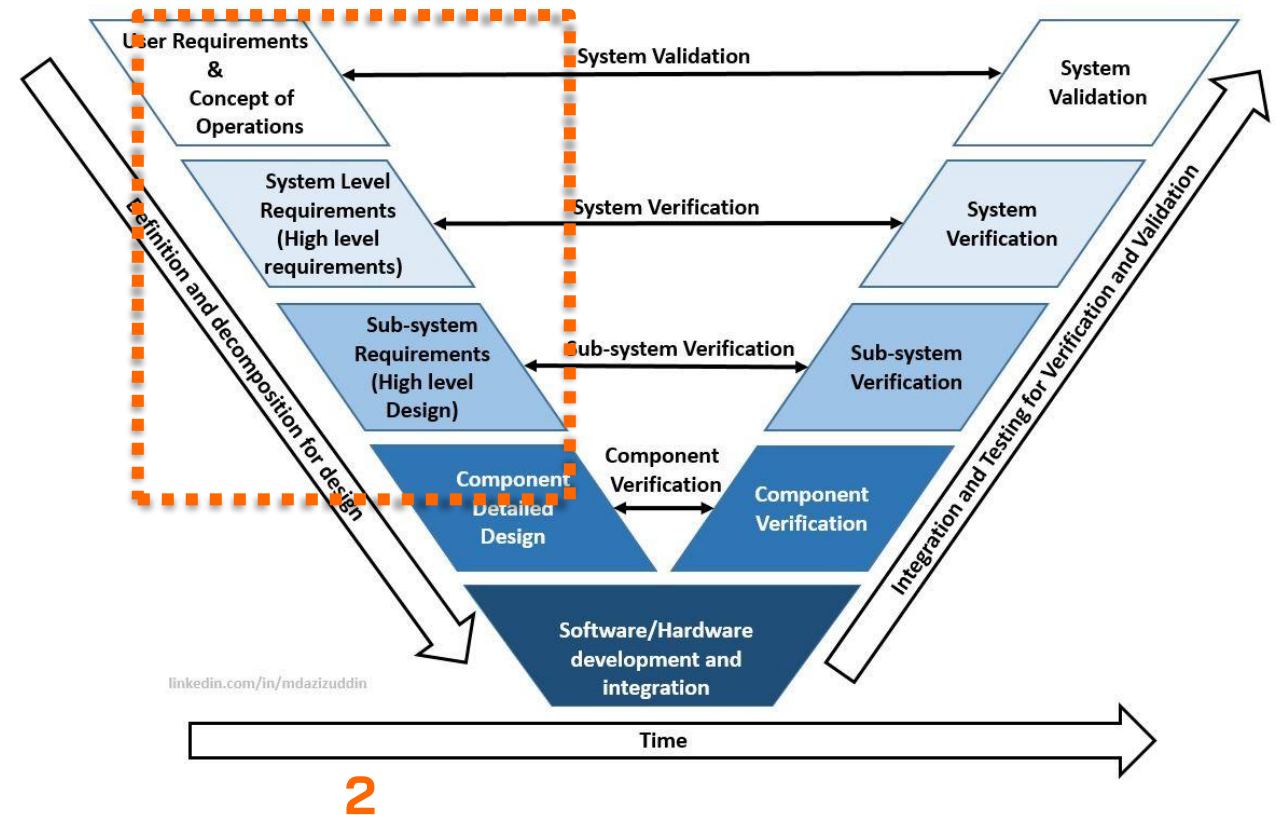
The model grows and evolves with the project – it's a **living representation** of the system.

How MBSE Works IN PRACTICE

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders
2. Capture requirements and constraints



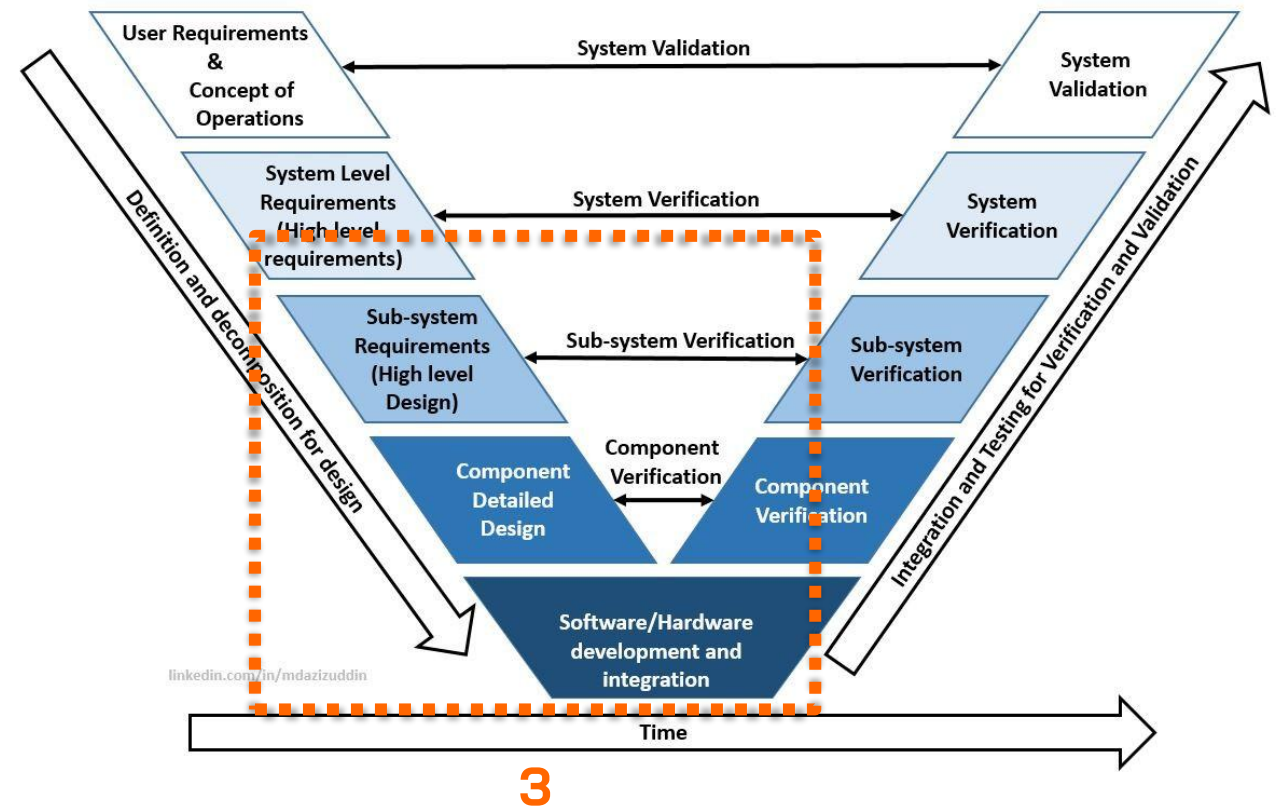
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How MBSE Works in Practice

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders
2. Capture requirements and constraints
3. Model architecture and functions



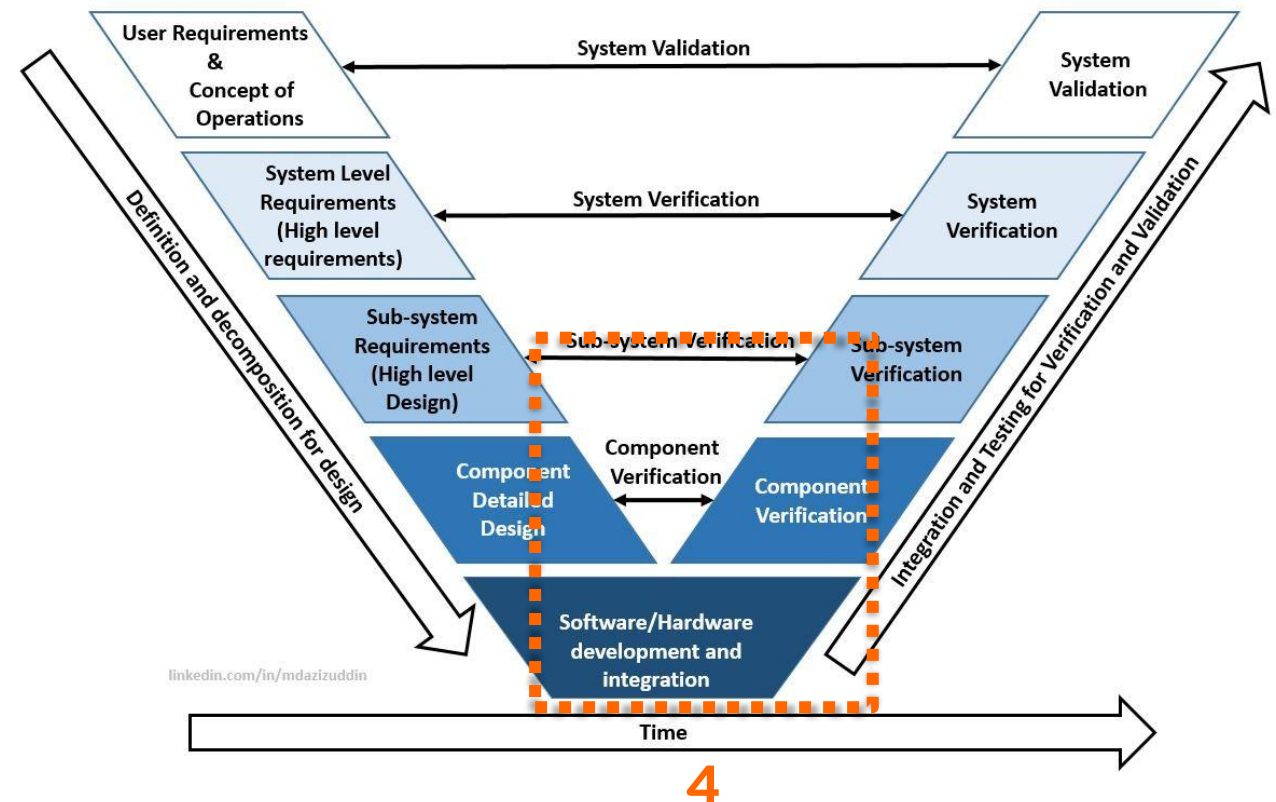
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How MBSE Works in Practice

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders
2. Capture requirements and constraints
3. Model architecture and functions
4. Simulate and optimize performance



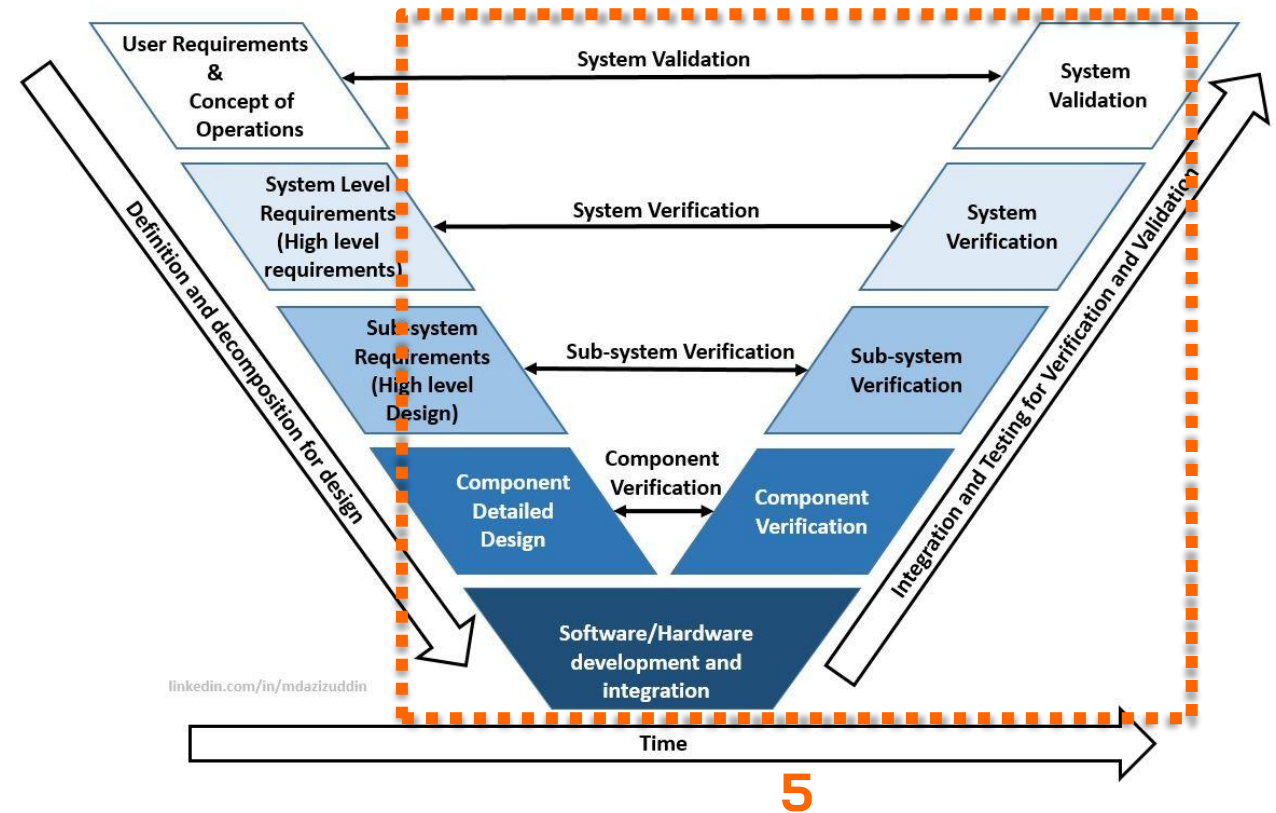
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How MBSE Works in Practice

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders
2. Capture requirements and constraints
3. Model architecture and functions
4. Simulate and optimize performance
5. Verify and validate virtually



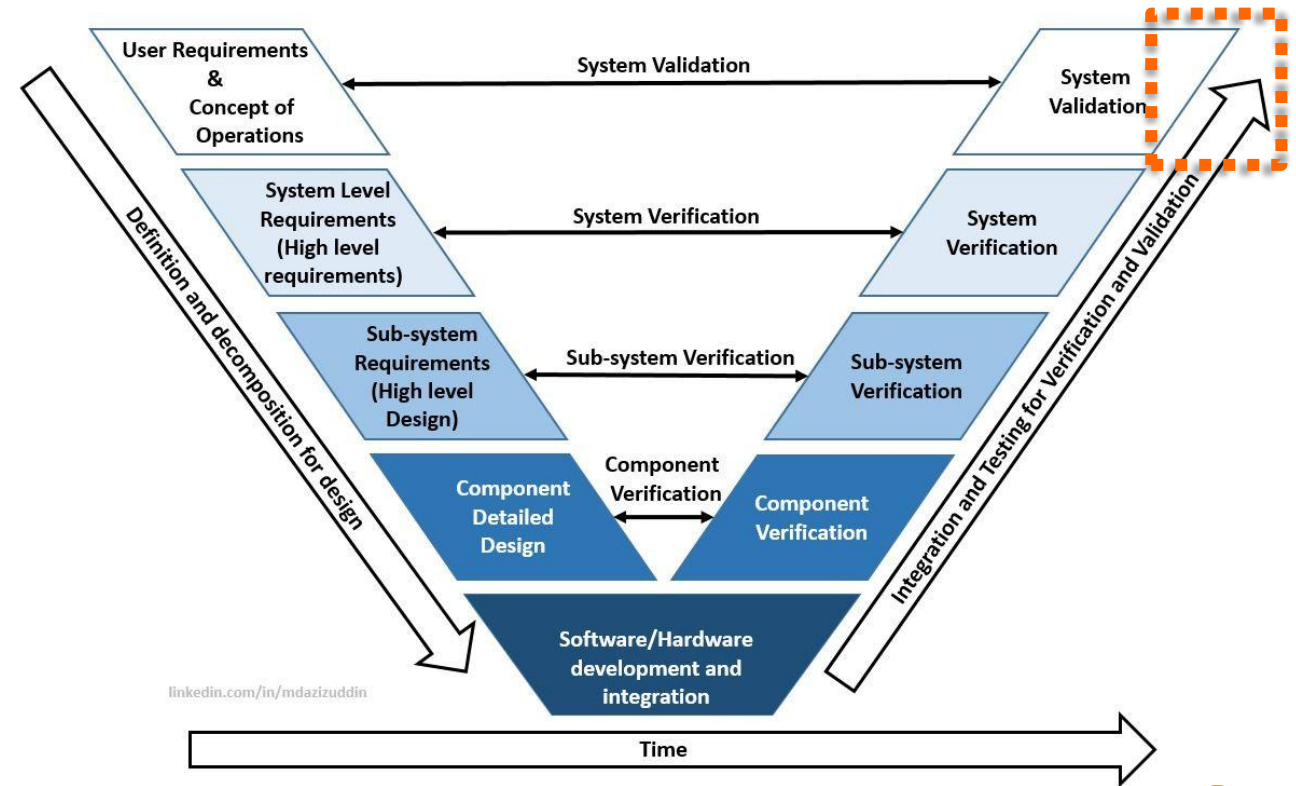
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How MBSE Works in Practice

MBSE WORKFLOW

Typical MBSE workflow (defines methodology):

1. Define mission and stakeholders
2. Capture requirements and constraints
3. Model architecture and functions
4. Simulate and optimize performance
5. Verify and validate virtually
6. Reuse models for production and certification



The model grows and evolves with the project – it's a **living representation** of the system.

HOW TO DESCRIBE SYSTEM MODEL

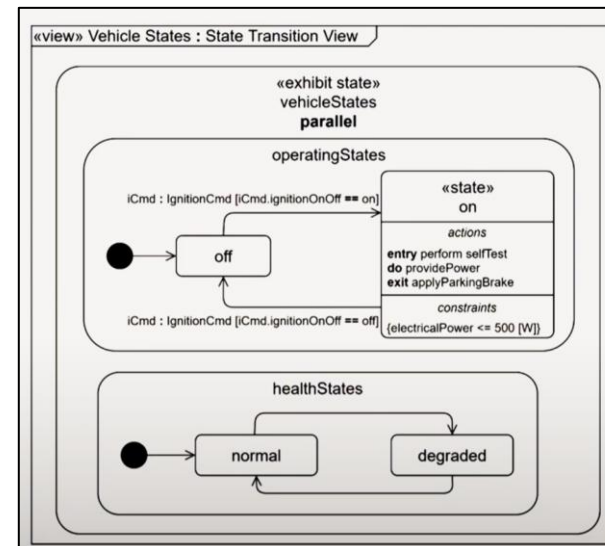
SysML AND MBSE TOOLS

SysML – Systems Modeling Language

- Standard by OMG and INCOSE
- Used for **specification, analysis, design, verification and validation** of systems

Common tools: CATIA Magic, Cameo, IBM Rhapsody, Ansys SAM, System Composer

- **SysML v2 (2025):**
- Unified metamodel, **graphical + textual syntax**
- Improved modularity and reuse
- Standard APIs for tool interoperability



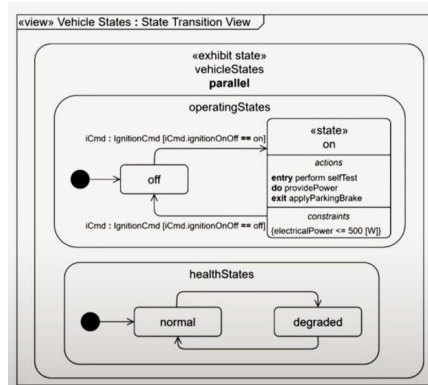
```
exhibit state vehicleStates parallel {  
  state operatingStates {  
    entry action initial;  
    state off;  
    state on {  
      entry action performSelfTest;  
      do providePower;  
      exit action applyParkingBrake;  
      constraint {electricalPower <= 500[W]}  
    }  
    transition initial then off;  
    transition off_To_on  
      first off  
      accept ignitionCmd:IgnitionCmd via ignitionCmdPort  
        if ignitionCmd.ignitionOnOff==IgnitionOnOff::on  
        then on;  
    transition on_To_off  
      first on  
      accept ignitionCmd:IgnitionCmd via ignitionCmdPort  
        if ignitionCmd.ignitionOnOff==IgnitionOnOff::off  
        then off;  
  }  
  state healthStates {  
    entry action initial;  
    state normal;  
    state degraded;  
  }  
}
```

HOW TO DESCRIBE SYSTEM MODEL

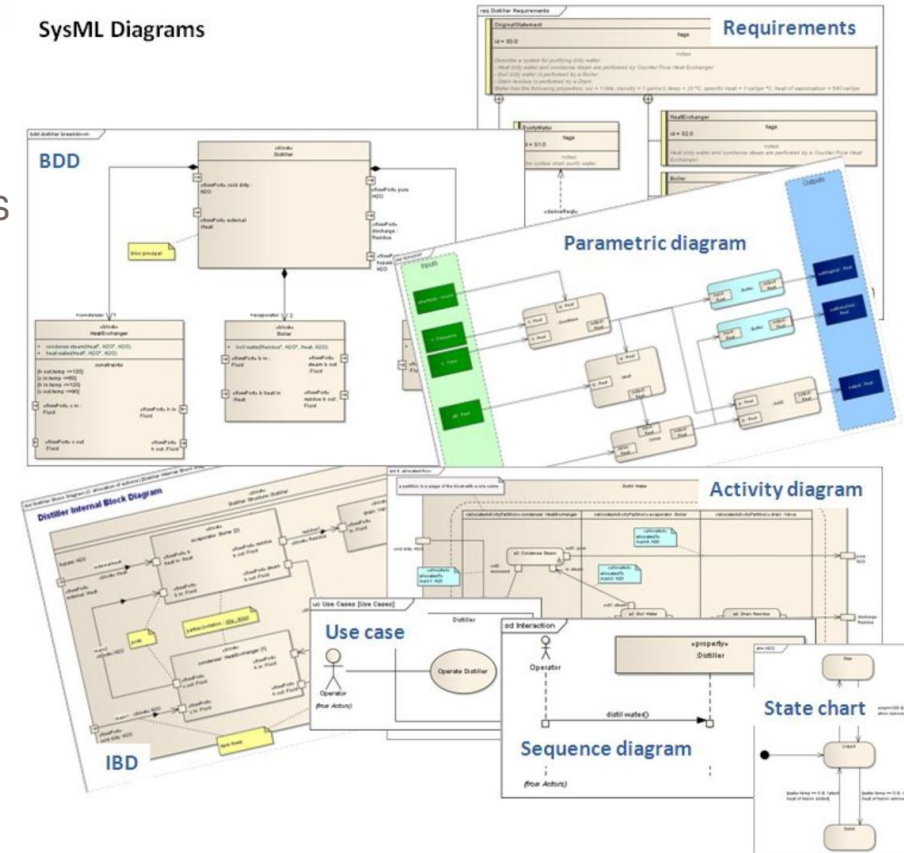
SysML VIEWS AND DIAGRAMS

SysML provides multiple **views** for describing a system:

- **Requirements diagrams** – link needs to design
- **Block Definition & Internal Block** – show structure and connections
- **Activity & State Machine** – describe behavior and logic
- **Parametric diagrams** – analyze performance and constraints



```
exhibit state vehicleStates parallel {
  state operatingStates {
    entry action initial;
    state off;
    state on {
      entry action performSelfTest;
      do providePower;
      exit action applyParkingBrake;
      constraint (electricalPower <= 500 [W])
    }
  }
  transition initial then off;
  transition off_To_on
  first off
  accept ignitionCmd: IgnitionCmd via ignitionCmdPort
  if ignitionCmd.ignitionOnOff == IgnitionOnOff::on
  then on;
  transition on_To_off
  first on
  accept ignitionCmd: IgnitionCmd via ignitionCmdPort
  if ignitionCmd.ignitionOnOff == IgnitionOnOff::off
  then off;
}
state healthStates {
  entry action initial;
  state normal;
  state degraded;
}
```



Each view supports collaboration and understanding between disciplines.

HOW TO DESCRIBE SYSTEM MODEL METHODOLOGY

From theory to practice – the MBSE process became reality.

MagicGrid is a proven MBSE framework that combines:

- **Method** – a structured modeling process
- **Language** – SysML
- **Tool** – CATIA Magic / Cameo

It **guides** engineers through:

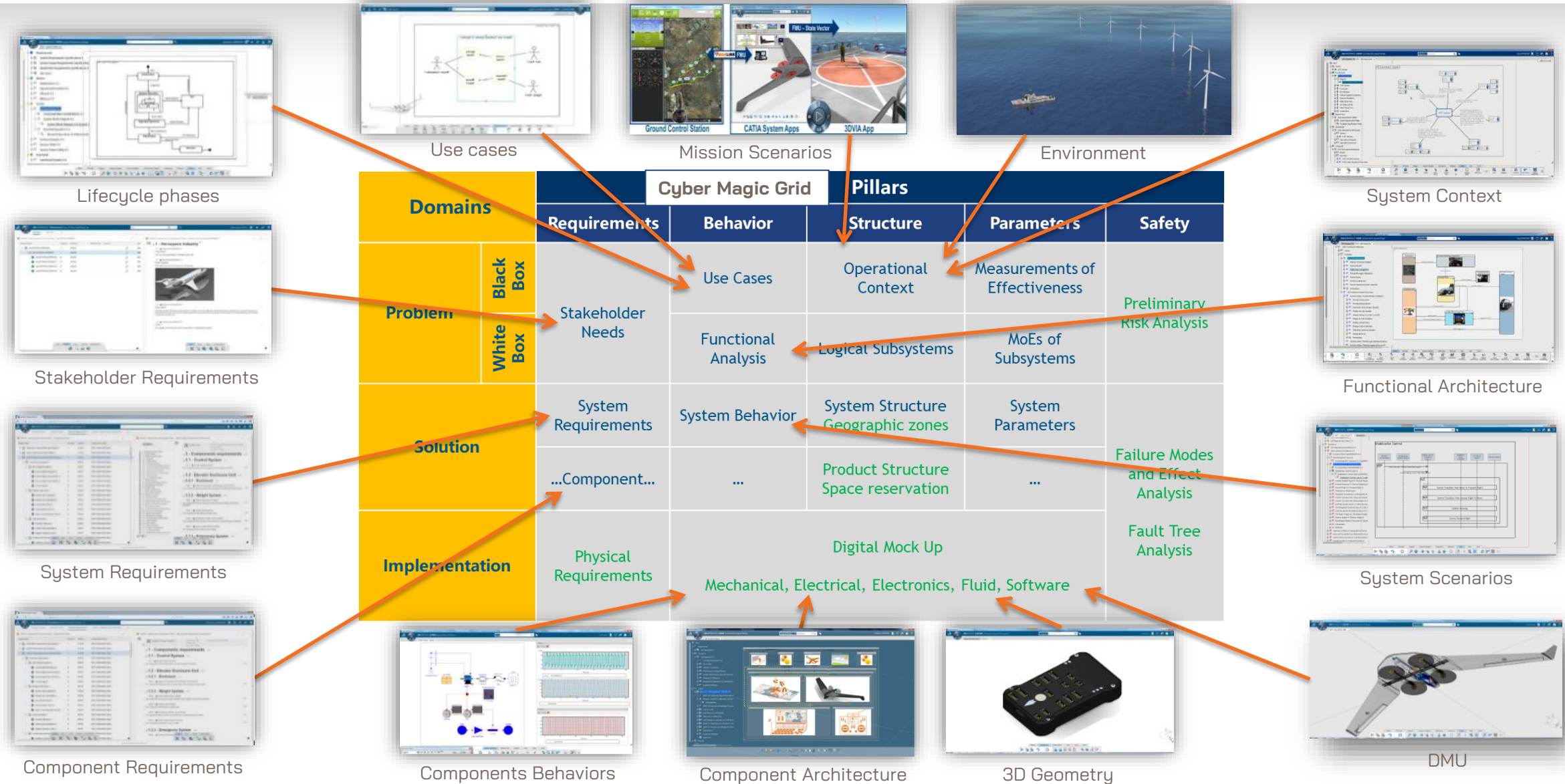
- Context and stakeholder definition
- System architecture and functions
- Behavior and logical design
- Verification and validation steps

Domains		Pillars				
		Requirements	Behavior	Structure	Parameters	Safety
Problem	Black Box	Stakeholder Needs	Use Cases	Operational Context	Measurements of Effectiveness	Preliminary Risk Analysis
	White Box		Functional Analysis	Logical Subsystems	MoEs of Subsystems	
Solution		System Requirements	System Behavior	System Structure Geographic zones	System Parameters	Failure Modes and Effect Analysis
		...Component...	...	Product Structure Space reservation	...	
Implementation		Physical Requirements	Digital Mock Up Mechanical, Electrical, Electronics, Fluid, Software			Fault Tree Analysis

Fully compatible with standard SysML and scalable for any industry.

HOW TO DESCRIBE SYSTEM MODEL

METHODOLOGY



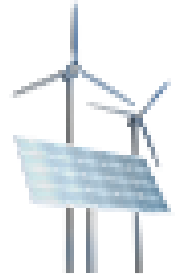
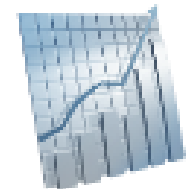
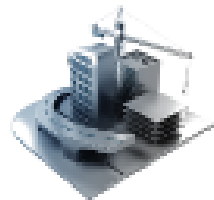
CONCLUSION ON MBSE

MBSE IN INDUSTRY

MBSE is now widely used across industries:

- **Aerospace & Defence** – traceability and certification
- **Automotive** – mechatronic integration, ADAS, E/E systems
- **Energy & Process** – control systems and plant simulations
- **High-Tech** – electronics, sensors, and embedded software

Results: *faster development, fewer integration issues, and improved compliance.*

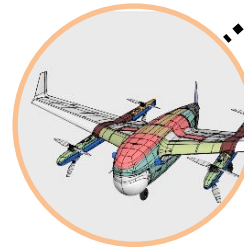
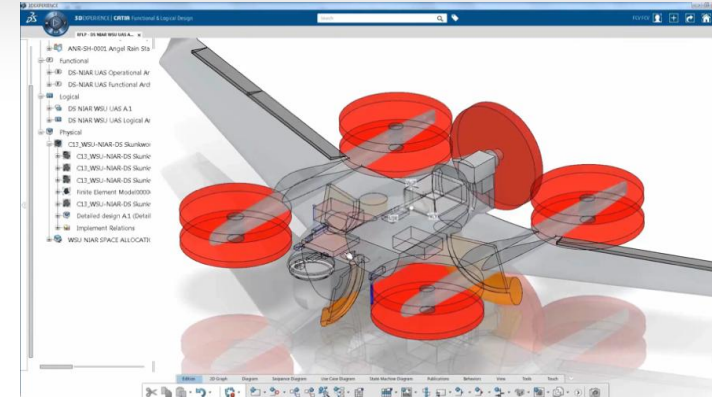


CONCLUSION ON MBSE

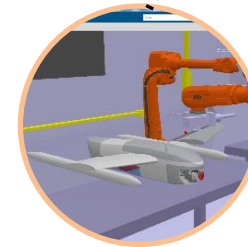
CHALLENGES AND ADOPTION

Adopting MBSE requires more than tools:

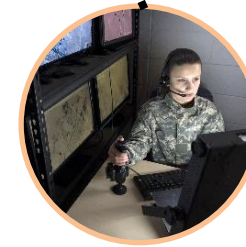
- **Cultural change** – from documents to models
- **Education and training** – new skills and roles
- **Integration** with existing PLM and CAD tools
- **Management support** for process transformation



How was it
designed



How can I
manufacture



How can I
operate



How can I
service

Start small, prove value, and scale gradually.

CONCLUSION ON MBSE

WHY MBSE MATTERS

“Complexity can’t be managed with documents. It must be modeled.”

MBSE brings together all engineering disciplines into a **shared digital environment**.

It enables:

- Continuous verification and optimization
- End-to-end traceability and compliance
- Better collaboration and faster innovation
- Confident decision-making before physical tests



MBSE is not just a tool – it’s a new way of thinking about systems.

CONTENTS



1. What is MBSE?
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DASSAULT SYSTEMES AND MBSE SOLUTION



Dassault Systèmes provides comprehensive Model-Based Systems Engineering (MBSE) solutions through its **3DEXPERIENCE** platform, with the core MBSE applications residing in the **CATIA Magic** suite.

Key Components & Tools:

- **3DEXPERIENCE Platform:** Provides a single source of truth for the entire product lifecycle, connecting all engineering disciplines.
- **CATIA Magic Suite:** The core MBSE toolset, based on SysML, for designing, modeling, and validating system architecture.

Comprehensive Toolset for Model Based Systems Engineering

No Magic offers a wide range of tools and products to support various aspects of model-driven engineering and systems engineering.



3DEXPERIENCE

NO MAGIC

Teamwork Cloud

Providing a Powerful Collaborative Environment for System Engineers Practicing MBSE with No Magic

NO MAGIC

Cameo Collaborator for Teamwork Cloud

A Web-based Product Designed to Present Models in a Simplified Form

NO MAGIC

Cameo Enterprise Architecture

A Comprehensive Solution for Organizations to Create, Analyze, and Manage Various Aspects of Enterpris...

NO MAGIC

MagicDraw

Award-Winning Business Process, Architecture, Software and System Modeling Tool with Teamwork Support

NO MAGIC

Cameo Systems Modeler

The Software Tool for Systems Engineering and Modeling

NO MAGIC

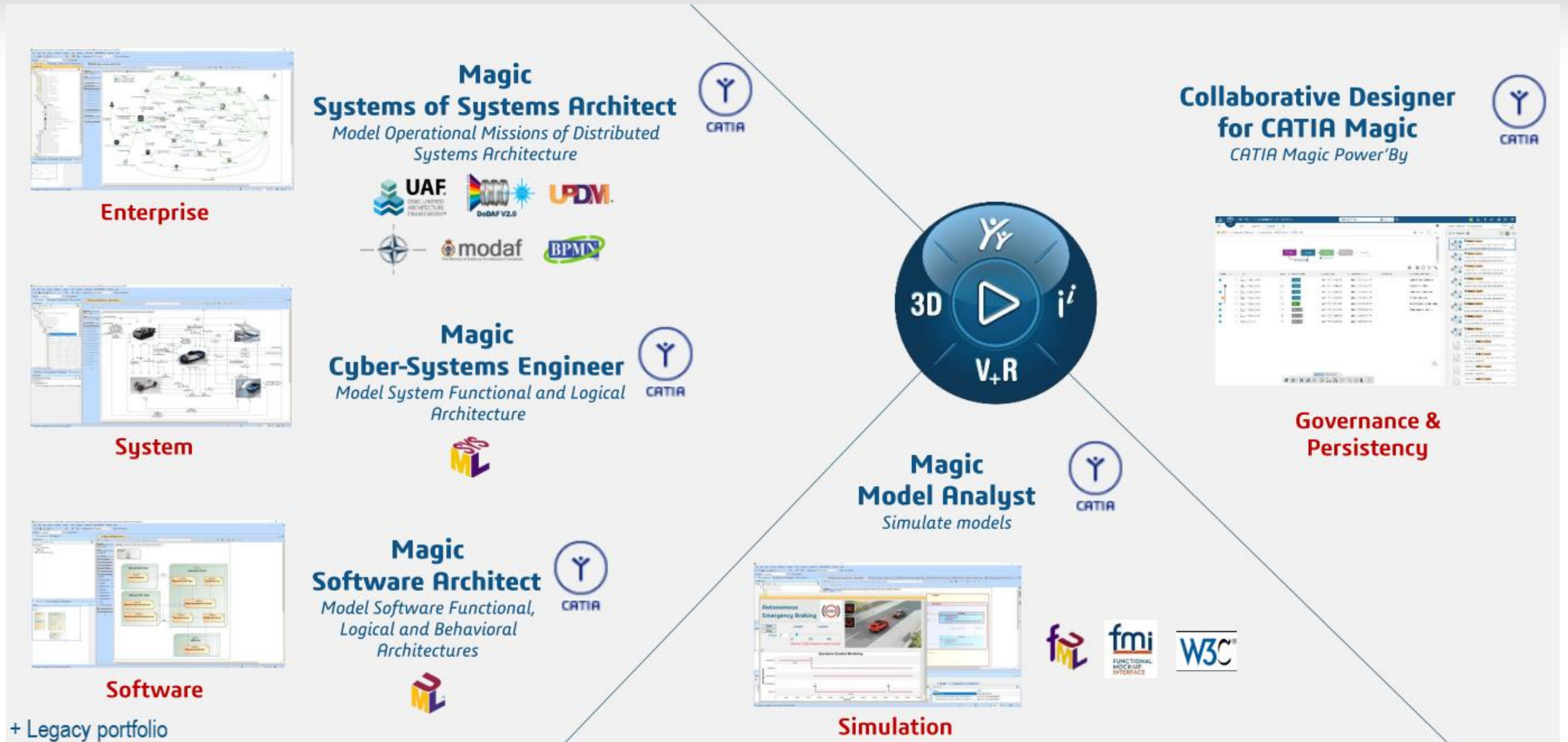
Cameo Simulation Toolkit

Provides the First in an Industry Extendable Model Execution Framework Based on OMG fUML and W3C SCXM...

 **CATIA** | Magic

DASSAULT SYSTEMES AND MBSE

PORTFOLIO FOR CATIA MAGIC



CONTENTS

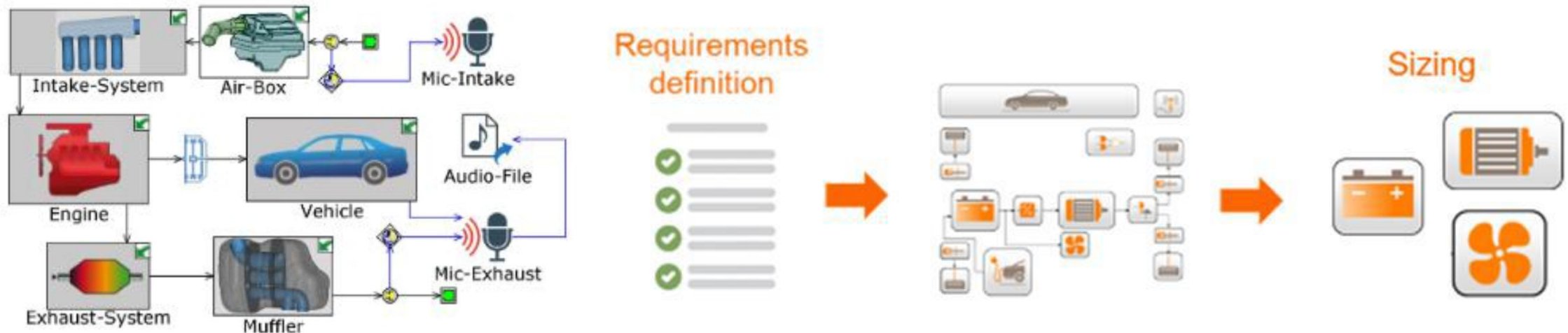


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IDIADA AND MBSE

MBSE INTO PRACTICE

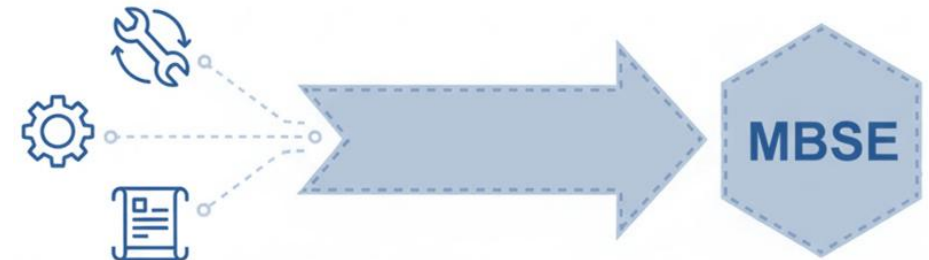
- An example from powertrain development in IDIADA:
 - Complete engine acoustic analysis
 - Prediction of orifice noise and pressure losses at the intake and exhaust system
 - Optimization of noise levels while constraining back pressure and balance tradeoff with engine performance
 - Creation of noise sources and audio output generation for subjective evaluation
 - System pre-dimensioning & component evaluation
 - Virtual assessment of vehicle performance and energy consumption at early-stage of design



CONCLUSION

IDIADA AND MBSE

- **Systems Engineering and MBSE are becoming an integral part of today's world.**
- Idiada CZ starts to offer MBSE software from Dassault Systèmes
- We are:
 - exploring the principles and possibilities
 - onboarding trainings and webinars
 - getting our certifications under DS as MBSE partner
- **Our goal is to offer you even more in the near future.**
- Many Abaqus, CST, Dymola, 3D Experience users are already using Systems Engineering to some extent.
- **However, it is not a tool for everyone** – it is suitable for the development of more complex products where multiple physical domains, testing, and changes are involved.



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