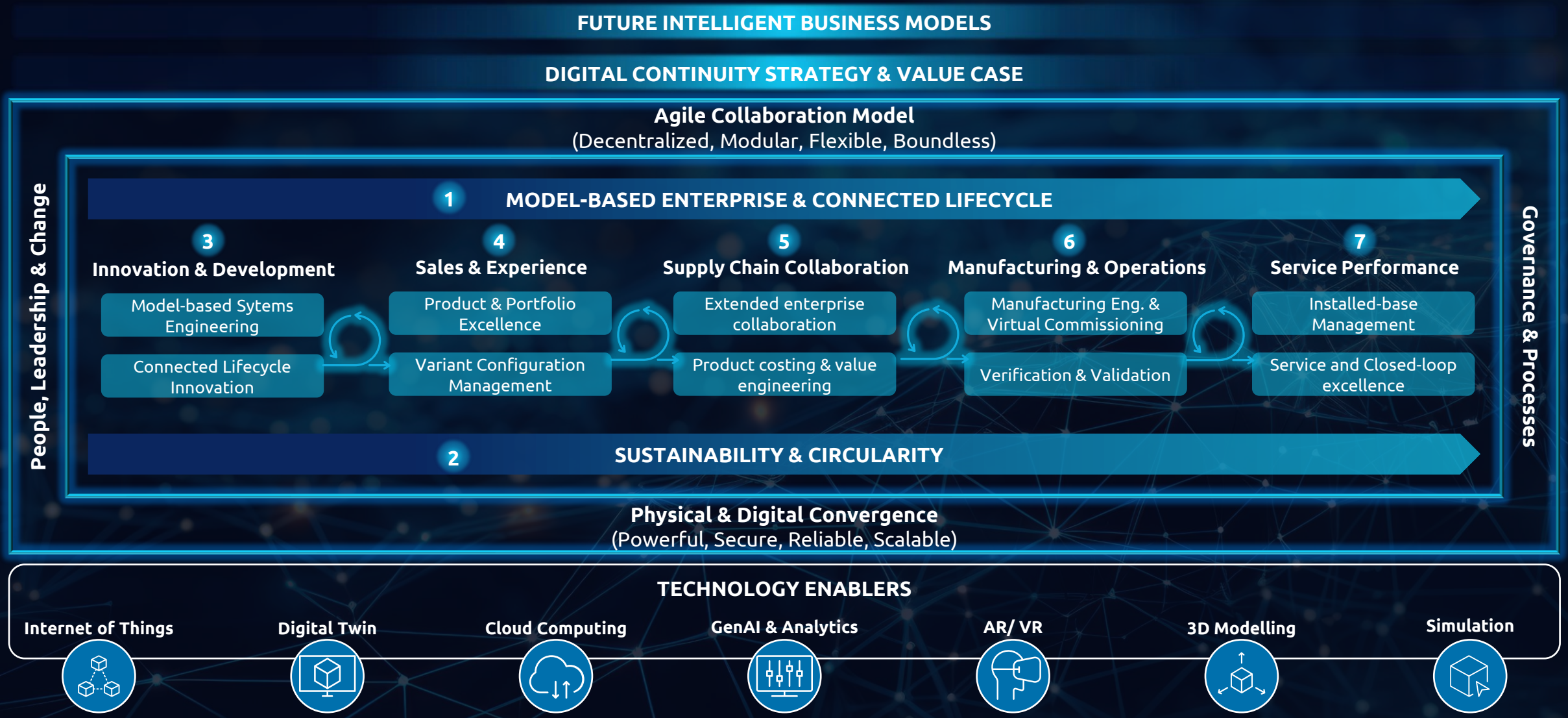
# Building the bridge to infinity

## Driving Digital Continuity: A Framework for End-to-End Value Chain Excellence

Capgemini invent

# Our extensive service portfolio covers all aspects of Digital Continuity bundled in different focus topics





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# Model-Based Enterprise & Connected Lifecycle



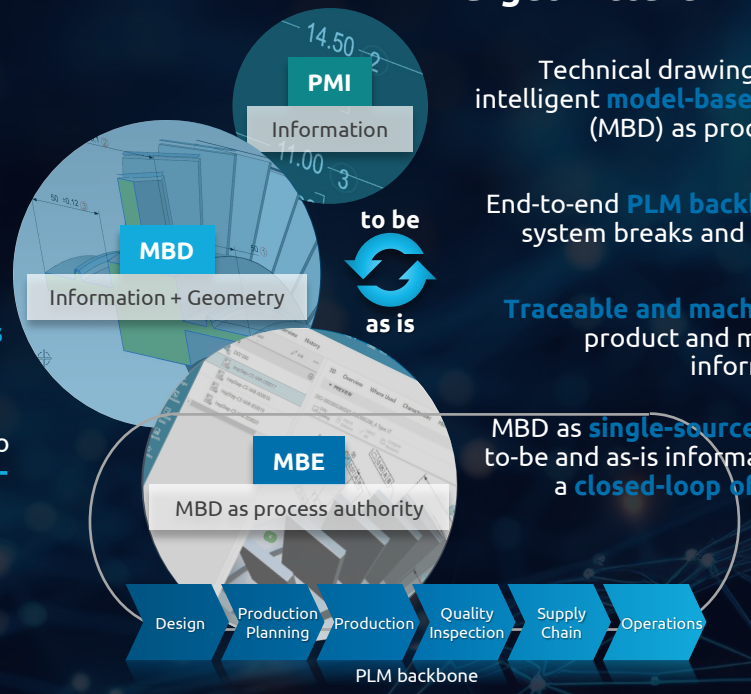
 

# The impact of Model Based Enterprise (MBE) and connected lifecycle increases the efficiency and communication

## Key Challenges

- Silo-oriented and document-based processes struggling to master **increasing complexity of products**
- **Lack of transparency and traceability** of data as obstacles for quality and efficiency
- **Data redundancy and system breaks** leading to high process leading times
- Lack of resources and opportunities to **reduce development costs and time-to-market**

## Target Picture




- Technical drawings replaced by intelligent **model-based definitions** (MBD) as process authority
- End-to-end **PLM backbone** without system breaks and redundancies
- **Traceable and machine-readable** product and manufacturing information (PMIs)
- MBD as **single-source-of-truth** for to-be and as-is information creating a **closed-loop of information**

## Success Stories

**Aerospace OEM**

Enabling the PLM backbone and interfaces for MBE in agile implementation.

**Aerospace Supplier**

End-to-end MBE transformation including process re-design.

## Your benefits*

**Increased efficiency** up to:
15% in design
30% in production planning and manufacturing
60% in quality inspection

Enhanced communication and **compatibility** internally and to **partners and suppliers**

**Time and cost savings** supported by data continuity and **automations based on the MBD and PMIs**

* Numbers based on Capgemini's project experience



# The hurdle to manage increasing complexity of systems, products and supply chains is aggravated by data discontinuity

Overview of discontinuities in siloed data and process implementation


**lead to**

**High development times** due to lack of automation

**High development costs** due to late validation and errors

**Inferior product and process quality** due to system breaks

**Missing transparency** due to siloed data and process implementation

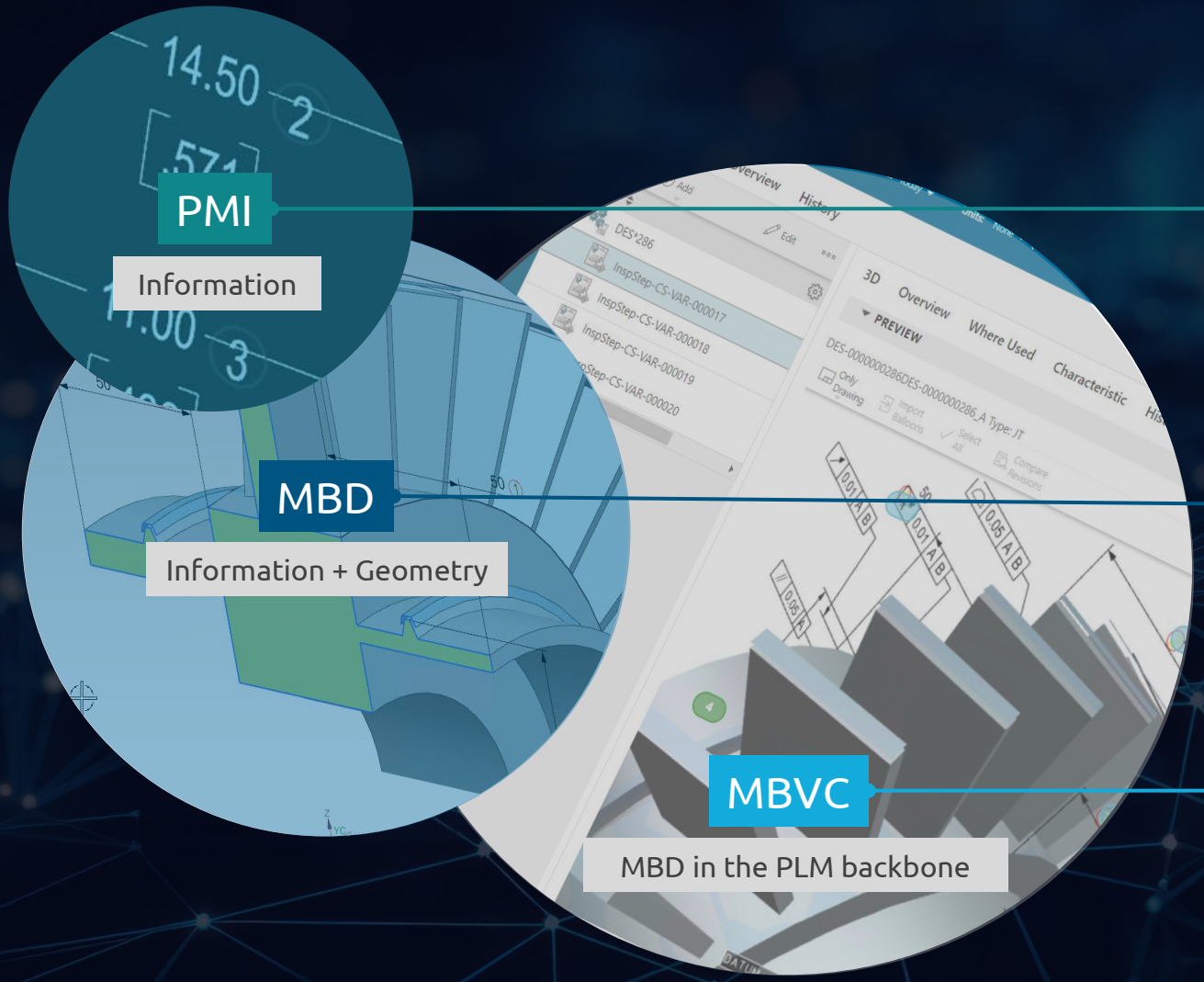
**Siloed data and processes generate discontinuities** along the value chain and are **not sufficient to tackle the** rising complexity of **current and future products & processes**



# Introducing PMIs as central information carriers creates the foundation for Digital Continuity

Valuable information is introduced and consumed along the entire value chain




**Product and manufacturing information (PMI)**

PMI describe semantic, machine-readable information like e.g. orientations, dimensions, tolerances or materials as well as supplier specific information.

**Model-based definition (MBD)**

The MBD describes the 3D-CAD master model annotated with all relevant PMIs required for all product-related processes.

**Model-based value chain (MBVC or MBE)**

The MBVC describes a company or rather an E2E digital process where MBDs are used as the single-source-of-truth through the entire product lifecycle.



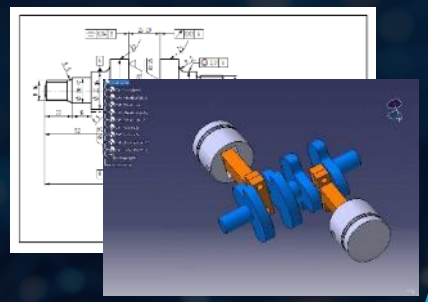
# We propose the path to a Model-Based Enterprise as the first necessary step towards a Digital Twin

Journey from a 2D drawing-based to a 3D model-based information model

**Drawing centric**
2D Design

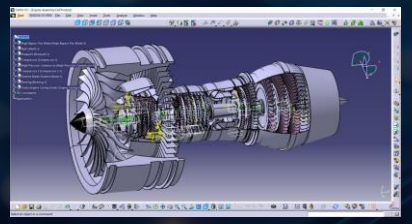
- No process automation
- Very high manual effort

**Drawing centric**
3D Design



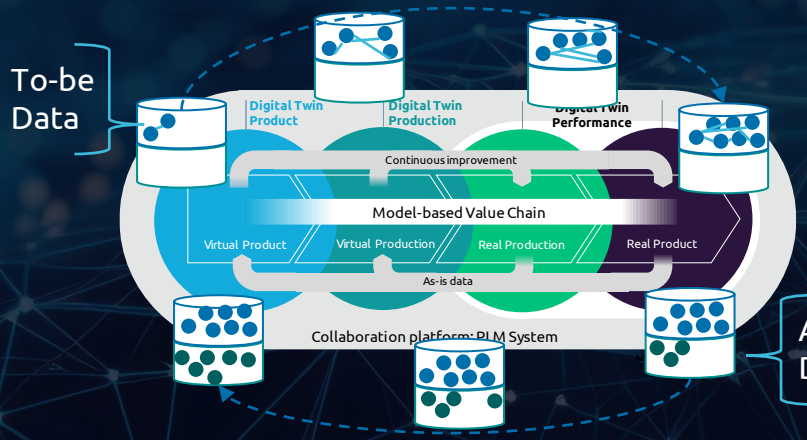
- Partly automated processes in product development
- Manual effort reduced
- Process reliability increased

**Model-based definition**
3D Design



- 3D data set as single point of truth
- Machine-readable information stored in 3D data set
- Central information platform available
- Data maintenance effort reduced

**Model-based value chain**
3D Design




Closed Loop (Information Feedback)

- Model-based enterprise
- Single-source-of-truth = Model-based definition
- Full product data access at any point in the value chain
- Complete consistency of data along the product lifecycle
- Automation potential maximized
- No data redundancy



The model-based value chain is a key enabler to establish **Digital Continuity** and manage the complexity of the **next generation of (smart) products**.



# The model-based value chain addresses urgent challenges of today's connected product development and operation

A holistic approach for tangible business impact along the value chain

## The Model-Based Value Chain

**Digital readability**
*Dimensions, tolerances, criticalities, norms, instructions.*

**3D digital processes**
*Business processes fully digital and based on the 3D master models.*

**Detailed traceability**
*Lifecycle information detailed up to the level of a single dimension.*

**Accelerators**
*Workflows, rule-based settings, checks, searches and filters.*

**Collaboration tools**
*Conversations and 3D markups linked to specific information.*

## Perceived benefits

- Less manual data handling
- Elimination of redundant tasks
- Earlier traceability of dependencies
- Elimination of 2D-to-3D tasks
- Earlier recognition of errors
- Enhanced user comprehension
- Tailoring of information for targeted tasks
- Consumable information downstream

## Demands and corresponding improvements

**Tech complexity at the limit of manageable**

Supports specialists in handling overall increasing complexity and amount of information

**Insuficcient operational efficiency**

Streamlines and standardizes processes, reduces blocking of high-demand professionals

**Pressure to accelerate time-to-market**

Accelerates processes while eliminating redundancies and time waste with system breaks

**Limited business growth opportunities**

Meets standards of the next generation of engineering endeavours and corresponding business opportunities

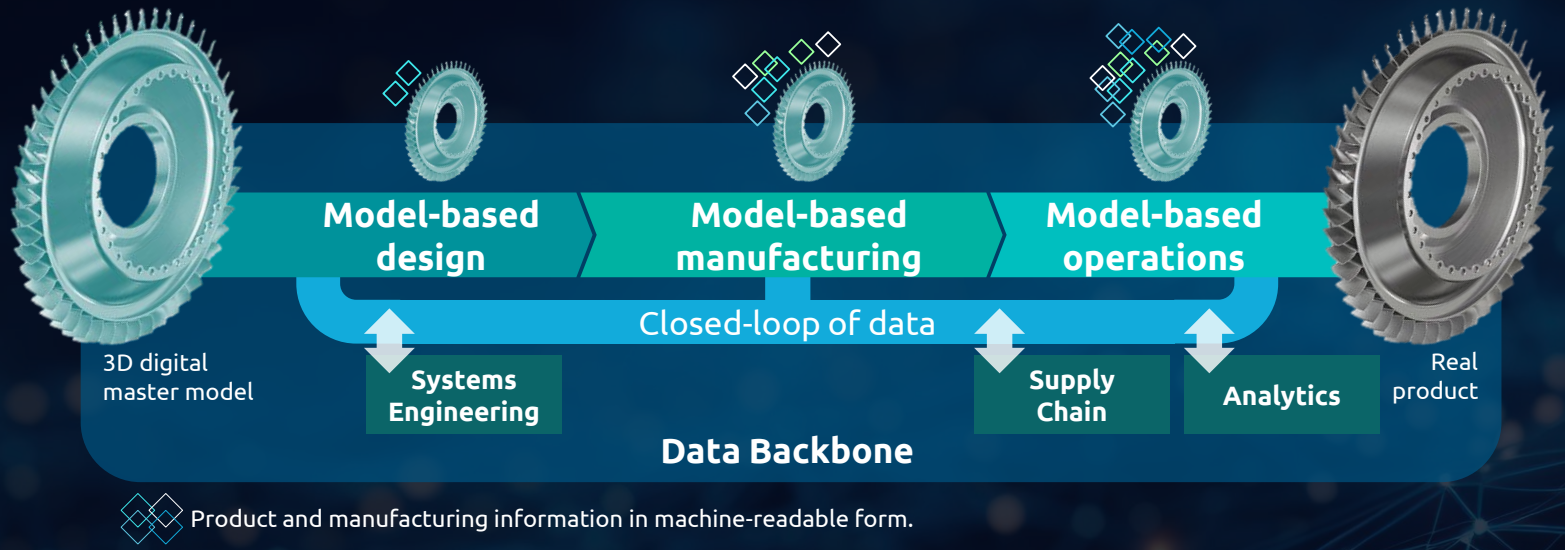
**Up to 30% overall efficiency increase**



# The model-based value chain establishes a 3D digital master as single-source-of-truth with focus on digital continuity

## Target picture and foundations of a successful transformation




### MBVC and Digital Continuity

The model-based value chain establishes a **3D digital master model as a single-source-of-truth** integrated with all relevant product and manufacturing information.

Combined with an E2E data backbone and master data management, a **continuous and consistent stream of information** across the entire product lifecycle is enabled.

- **E2E data backbone** without system breaks and data redundancies
- Model-based definition as **single-source-of-truth**
- **Software-readable information** for higher degree of automation
- **Information accessible by role** from 3D digital master model
- Compatible **exchange formats** for external collaboration
- **Closed-loop of information** for data-driven optimizations

# E2E vision for Digital Continuity: intelligent & adaptive value chain leveraging data-driven excellence, speed & flexibility

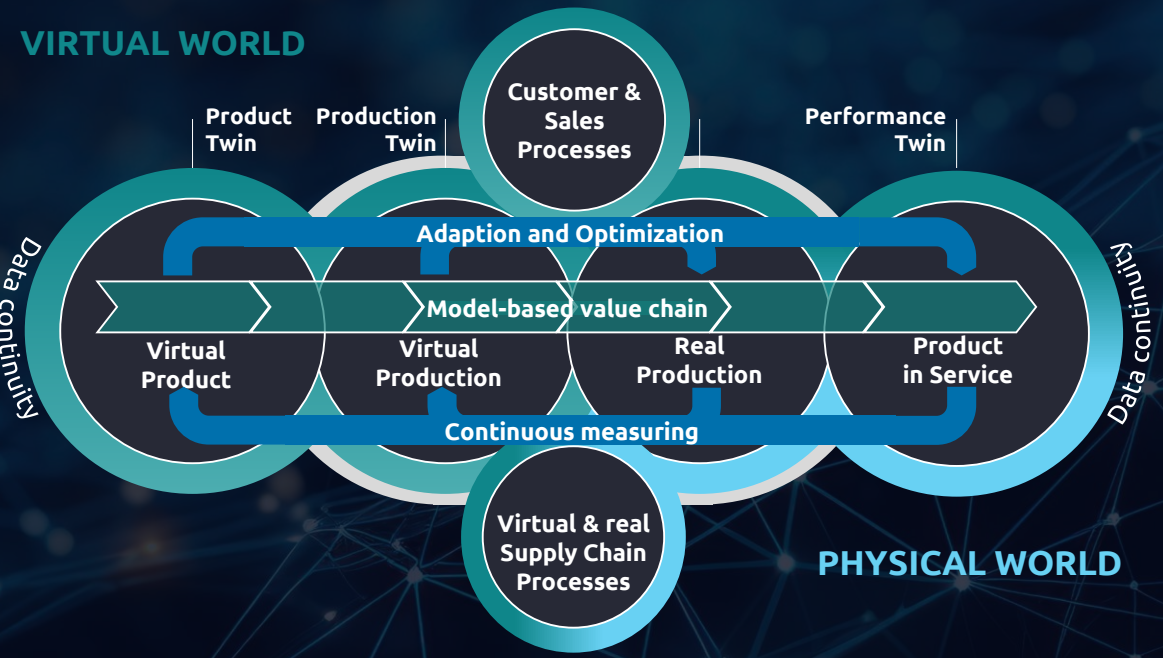
4 gamechangers set up Digital Continuity to empower the value-driven transformation

## DATA CONTINUITY

**E2E data availability, analytics & AI** empower the **data-driven (r)evolution** of the entire value chain to unleash its **full potentials**

## VIRTUALIZATION FIRST

**Parallel Co-Design** drives **best products** in **best value chains** delivered




## CLOSED-LOOP OPERATIONS

**Self-optimizing operations** and **assets** based on **real-time data**

## MODULAR DIGITAL ARCHITECTURE

A **microservice-based** modular **architecture** enables a **step-by-step Implementation** & agile **adaption**



# Capgemini ensured delivery of the product lifecycle management for an Aerospace OEM

## Aerospace OEM

### The Challenge

- Product Delivery Team (PDT) has been dedicated to cover the full lifecycle from requirements to operational support
- Capgemini supported the set up of this PDT and assisted major activities in the project

### The Solution

- Acceleration of the project decision cycle
- Improve maturity of requirements
- Ensure commitment of project actors
- Improvement of project management with respect of key project processes specially the processes with strong businesses participation
- Recognition of important contribution by the client

Definition of Business Requirements & Use Cases

Assistance to the global steering of the project

Organization of the operational deployment within the OEM in Extended Enterprise (>5.000 users of PLM solutions in 75 companies worldwide)

Set up and run of an AZ (Acceleration Zone) in order to speed up the whole program

**Definition of business requirements**

**Transformation acceleration**

**Operational roll-out**



# Re-Setup of an E2E PLM Transformation

## The Challenge

Our client worked over 2.5 years on a Digital Transformation initiative for R&D (PLM), Manufacturing and Operations but had to postpone Go-lives repeatedly which resulted in high sunk costs.

## The Solution

Re-setup with focus on agile ways of working based on SAFe Framework as the basis for all future engine programs.

- **New Operating Model** according to SAFe
- **Portfolio Management** to control CxO objectives
- **Model-based definitions (MBDs)** for E2E digital continuity
- **CI/CD Pipeline** as continuous IT-Backbone
- **Earned Value Management** for transparent Reporting in agile way of working
- **Change Management, Training & Enablement**

**Global leading aerospace supplier**

**New Operating Model**

**Agile PLM, Manufacturing & Service Transformation**

**Model-Based Value Chain**

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# Sustainability & Circularity



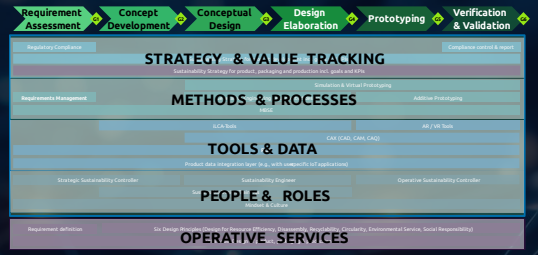
# Boost innovation and increase profitability by promoting sustainability and circularity

## Key Challenges

**Lack of Data Continuity**
Fragmented tool landscape with high error potential, system breaks and extensive manual efforts.

**Need for rapid data availability**
Pressure to access accurate and timely information quickly, requiring streamlined processes and systems.

**Compliance**
Non-compliance with ESG regulations may result in significant penalties.




## Target Picture

**Strategy**
Every corporate strategy includes sustainability goals for engineering processes to ensure a competitive, future-oriented market position.

**Tools & Data**
A knowledge base for sustainable action is created by using PLM systems to generate data-driven insights for targeted decision-making.

**Methods & Processes**
Products are designed for disassembly, reuse, or remanufacturing, while innovative processes e.g., generative design are integrated.

**People & Roles**
Engineers are digitally empowered and embrace a mindset shift to prioritize sustainability.

## Success Stories

**Design for Sustainability @ Automotive OEM**

We support our client with the exploration and concept design for the continuous provision & monitoring of sustainability KPIs in the product development process. Furthermore, we enable engineers to develop dismantlable and resource-efficient vehicles to comply with an upcoming EU Directive.

**Product Passes @ Automotive OEM**

We support our client in implementing various product passports, including the Battery Passport, to meet regulatory requirements. As an electronic record, the Battery Passport ensures transparency and sustainability across the battery value chain, reduces environmental impact, and supports battery reuse.

## Your benefits

Mitigate risks

**>67%**

have seen a **reduction** in **carbon emissions***

*of organizations actively pursuing sustainable product design initiatives

Boost innovation

**>51%**

report that **benefits** achieved have **already outweighed costs today***

Increase profitability

**<27%**

**higher profitability** has been reported*

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# Capgemini designed tool-supported target disassembly processes to comply with upcoming directives and enable vehicle circularity

## Automotive OEM

### The Challenge

- The client is a leading automotive OEM and is fully committed to make mobility more sustainable and circular
- With the introduction of an PLM platform at the end of 2025, the topics of ‘Design for Circularity’ and the ‘Paris climate targets’ are to be brought more into the focus of vehicle development
- Extensive requirements for the disassembly process due to new upcoming legal regulations (ELV)
- Heterogeneous tool and data landscape and large number of affected departments
- Limited availability of internal resources due to parallel initiatives and challenging schedule

### The Solution

- The aim is to empower internal and external vehicle designers with the functionalities provided in the PLM platform so that they can efficiently and sustainably develop resource-saving and recyclable products
- Central points for achieving these goals are the display of the dismantling capability and the dismantling effort as well as CO2e values for individual components
- Development of an implementation roadmap for the display of dismantling capability and provision of CO2e values in vehicle development

Development of a requirements catalogue for a tool-supported assessment of dismantling capability and time to be best prepared for the upcoming directive

Research and fit-gap analysis of the relevant PLM platform functionalities for product sustainability to make transparent whether the target tool comprehensively fulfils the requirements

Development and documentation of a concept for the interaction of the PLM platform with other tools to offer the customer the best possible solution

## Vehicle Circularity



3

# Innovation & Development



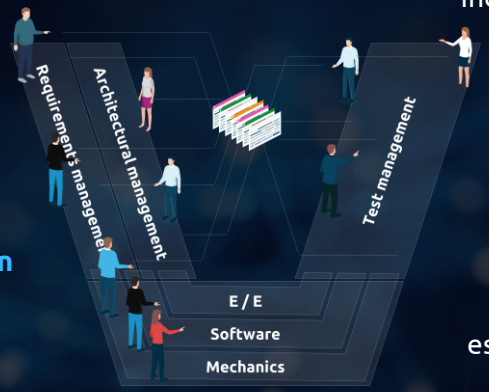
# Leveraging Software and Model-Based Systems Engineering for Digital Continuity to ensure best quality and traceability

## Key Challenges

**Product Complexity**
Silo structures and lack of data continuity & availability make tackling product complexity increasingly difficult

**Data Continuity and Centricity**
Lack of Single Source of Truth, central platform, traceability, and consistency

**Collaboration & Communication**
Lack of flexible & adaptable operating models which facilitate interdisciplinary and cross-unit collaboration




## Target Picture

**Reduction of Development Time & Costs**
The integration of digital models, simulations, and virtual tests based on connected models contribute to the significant reduction in time-to-market & increase in development efficiency

**Ensure Quality & Traceability**
MBSE supports bilateral traceability from requirements to functional, logical, and physical design

**Improved Collaboration**
Process, methods, and tool harmonization and the establishment of data governance enable efficient cross-unit and interdisciplinary collaboration

## Success Stories

**Automotive Supplier**

Our client is creating and establishing a compliant and future-proof A-SPICE level 3 development process

**Automotive OEM**

We supported our client with the definition and operationalization of a functional systems engineering (FUSE) approach

## Your benefits*

Systems Engineering correlated to shorter schedules by

**>40%**

Enhanced communication and **compatibility** internally and to **partners and suppliers**

Time and cost savings despite higher product complexity by

**>30%**

* Numbers based on Capgemini's project experience

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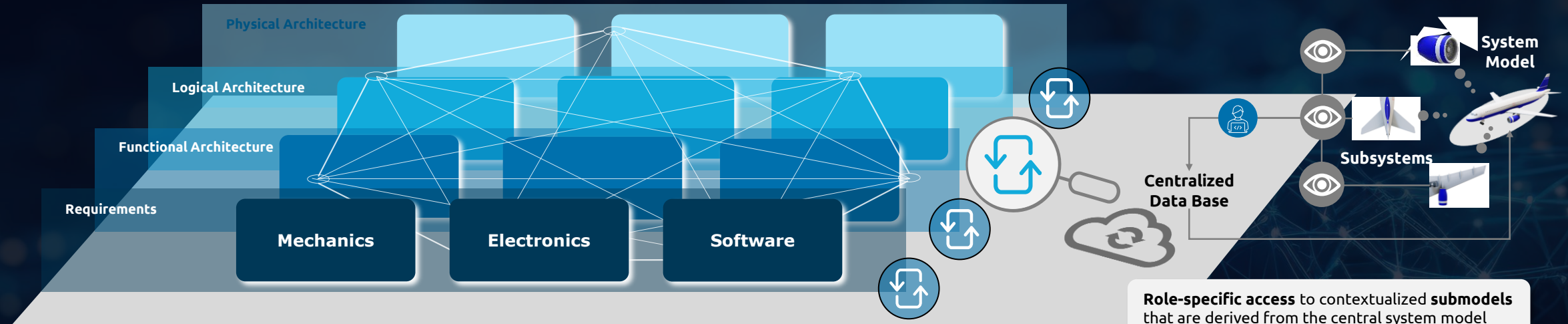
# MBSE enables the reflexive, interrelated and consistent product developement across different disciplines and dimensions






**Role-specific access** to contextualized **submodels** that are derived from the central system model

**Standardized data transfer** from different disciplines to the **central system model**

**Pass through of system requirements**

Centralized data storage allows every dimension to access system requirements

**Linking changes across system**

Dependencies of interconnected models are visualized to identify development conflicts between system components

**Transfer of changes across system**

Changes in submodels are directly transferred to the central system model and all other relevant submodels

**Direct communication**

The development-related information exchange can take place via the central system model improving communication across all stakeholders

**Multiple Perspectives**

The Centralized system model can be viewed and analyzed from multiple perspectives by all stakeholders

**Traceability**

Bilateral traceability from requirements to validation



# MBSE improves product quality as well as reduces development time and development costs

The benefits of MBSE can be clustered in four categories

## Improved Product Quality

- Early and continuous verification of requirements lead to **early defect detection** and **risk reduction**
- **Bidirectional traceability** enables **compliance according to standards**

## Improved Collaboration

- Clearly defined and modeled **interfaces of systems and sub-systems**
- Models can be viewed from **multiple perspectives** within interdisciplinary development teams

## Reduced Development Time

- **Bidirectional traceability** enables **automatic impact examination** of changed requirements
- MBSE gives the ability to simulate and test the system behavior virtually to enable **agile systems development**
- System behavior is known before the integration

## Reduced Development Costs

- Reduced development time directly leads to reduced development costs
- **Reuse** of **requirement architectures**
- **Reuse** of **system architectures**



# Capgemini supports an OEM to define and operationalize a functional Systems Engineering (FUSE) approach

## Automotive OEM

## Functional Systems Engineering (FUSE)

### The Challenge

- Increasing complexity of vehicle development projects due to greater integration of software, hardware and electronic components
- SE is used to introduce end-to-end systems engineering in the OEM, in which PMTO (processes, methods, tools, organization) are developed for a function-oriented product development process
- The goal is to achieve A-SPICE CL-2/3 compliant process maturity and to harmonize and integrate supporting PMTO content

### The Solution

- Performing technical evaluations in vehicle development processes regarding FUSE / A-SPICE conformity
- Identification of stakeholder needs and closing gaps regarding FUSE/A-SPICE conformity in all A-SPICE relevant development processes through a fit/gap analysis
- Development of enablement concepts for the operationalization of a functional Systems Engineering approach
- Active enablement of the organization in the transition to FUSE and A-SPICE compliant work methods

Successful assessment of the A-SPICE capability CL-2 of the FUSE processes

Seamless implementation of the FUSE approach by actively empowering the new organization in transition and to A-SPICE compliant processes

Identification of stakeholder needs and development of functional system engineering solutions to achieve A-SPICE CL-2 compliance as well as traceability and efficiency

Acceptance and transparency of the new ways of working by involving the relevant stakeholders and users



# Capgemini supported an automotive supplier in creating and establishing an A-SPICE Level 3 development process

## Automotive supplier

## A-SPICE Level 3 - compliant development process

### The Challenge

- Creation of a future-proof development process that fulfils A-SPICE Level 3, functional safety, cyber security requirements and customer-specific demands
- To solve future challenges, a future-oriented Idea-to-Produce process is to be created to fulfil future customer requirements.
- Switch to agile and lean product development processes to shorten development cycles and solve the increased complexity

### The Solution

- Designing a future-proof process house for the idea-to-produce process according to agile principles and values
- Promoting an integrated development process based on system engineering, combining hardware, software and mechanics into a joint cross-functional development team
- Designing the future process with a view to the latest technologies such as digital twin development, AI-based software development and MBSE model-based system engineering

Future proof and compliance-compliant development process

Merging systems engineering with lean and agile principals

Passing A-SPICE Level 3 and customer-specific process audits

Empowerment and operationalization of process users and establishment of a continuous improvement process



# Data driven product development enables a faster response to the market and improved decision-making

## Key Challenges

**Identification of right product feature:** **Not able to identify** whether the product meets the needs of its target market

**Lack of Innovation:** Unable to create new, unique, and valuable products/ services that meet the evolving needs of their customers

**Lack of data availability:** Gathering/ analyzing information can be slow & expensive in **absence of right tools**.

**Poor Data quality** leads to in an **inaccurate conclusions**

## Target Picture

Integrated Data sources and real-time data access with robust data platforms to handle large data

**Innovation** and improvement by constantly evaluating product performance and customer feedback.

Using advanced analytics **to understand past trends, predict future behaviors, and prescribe actions for improvement.**

Improved Product quality**: By automatic usage of past data, measuring product performance & integration of data insights & feedback**

## Success Stories

### Aerospace OEM

Implementation of AI-based system allowing earlier integration and increased direct influence of industrial architects in product design process

### Automotive OEM

Capgemini developed a digital and cross-functional development process to enhance process and product performance for an international automotive OEM.

## Your benefits

### Faster response to market

Enables company to **respond more quickly** to changing **market trends(user data/product data)**, giving a further competitive advantage

### Improved decision-making

To make **decisions based on data** rather than guesswork or intuition by analyzing **customer needs**, **product performance**, and market trends

### Innovation & improvement

Encourages continuous innovation and improvement by constantly evaluating product performance and customer feedback



# Our software engineering maturity model helps to derive dedicated recommendations for action for ALM

Unser Software Engineering Reifegradmodell

## ANALYSIS OF THE CORE PROCESSES OF SOFTWARE ENGINEERING / ALM

- Requirements Management
- Design & Architecture
- Development
- Build & Test Management
- Release Management
- Configuration Management
- Deployment
- Operations & Service
- Asset Management
- Portfolio Management
- Quality Management
- Change Management
- Further project management topics

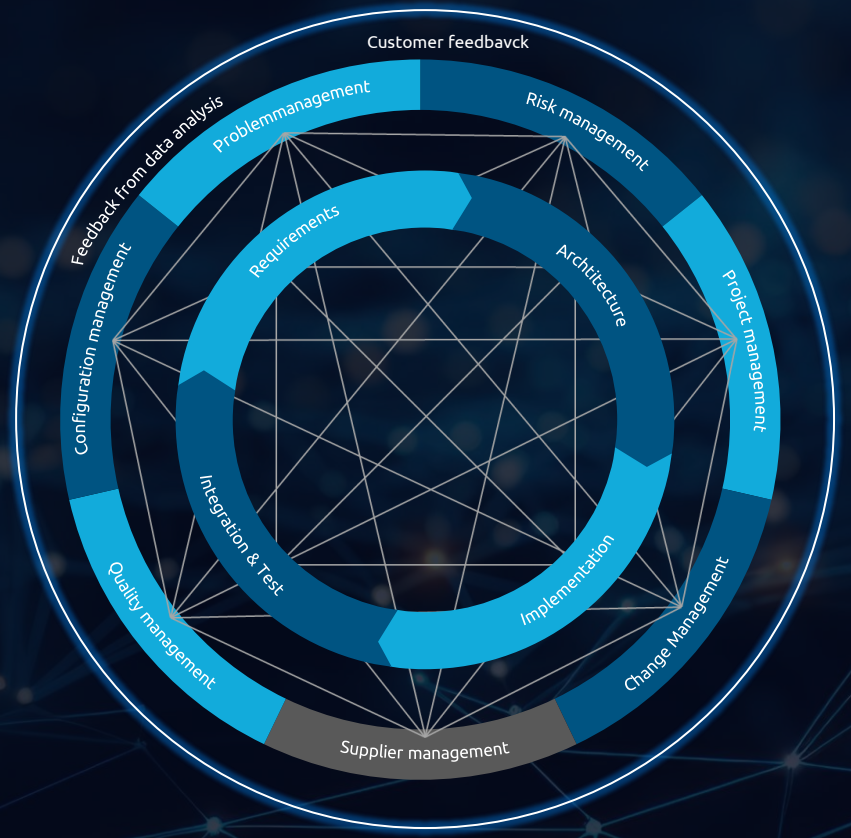
## SOFTWARE ENGINEERING MATURITY MODEL



# Using our software engineering reference process, we incorporate cross-industry best practices into the project from day one

## Overview of our software engineering reference process




## Benefits from the interaction of all processes e.g. through ALM tool

### Interlocking of all processes, departments and roles

The networking of processes, departments and roles creates transparency and offers strong synergy potential within agile procedures.

### Data based processes

The process model provides the assignment of roles to the processes, their interfaces to each other and the work products to be delivered.

### Strong communication focus

The focus on process interfaces ensures clear communication, early coordination and prompt change cycles.

### Agility

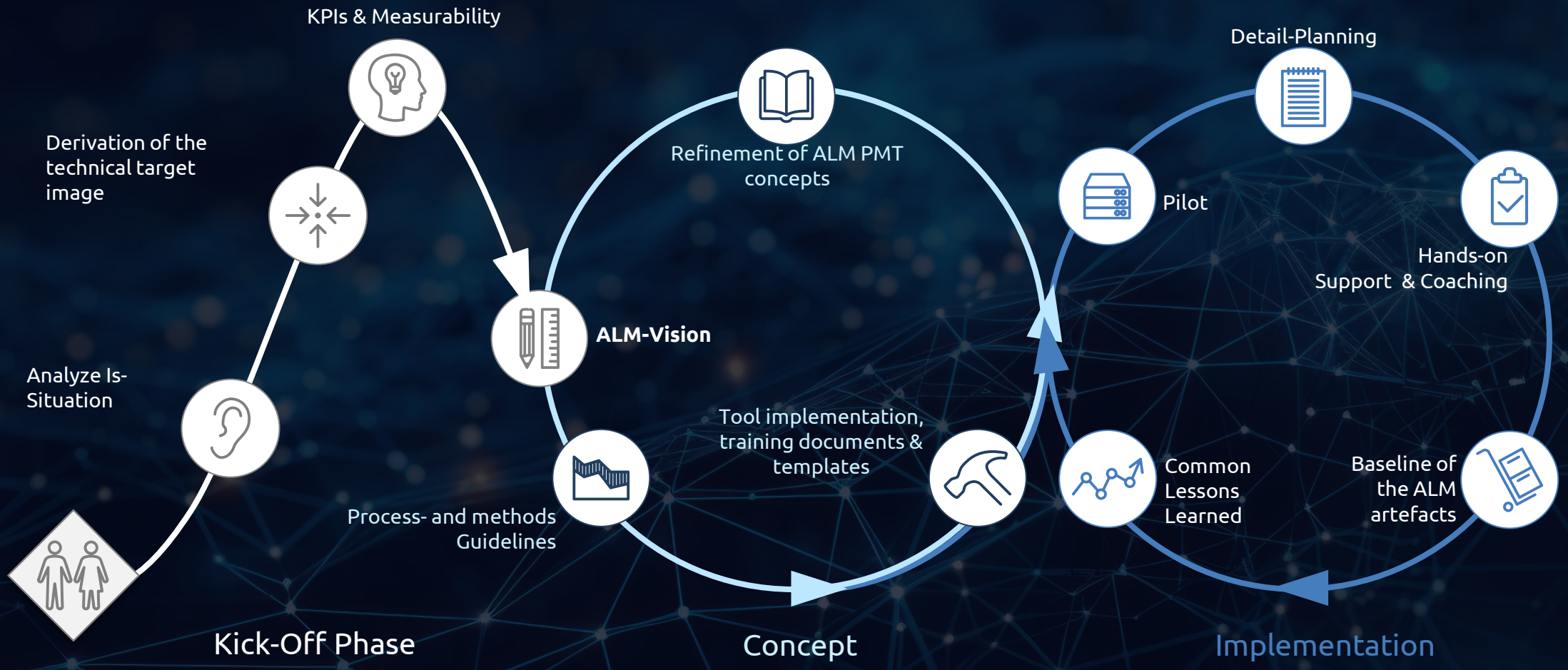
A combination of the process model with agile frameworks leads to greater flexibility and rapid customisation options thanks to iterative, recursive and incremental approaches.



# With our iterative ALM project approach, we enable user-oriented conceptualization and implementation

Übersicht und Ausblick auf die bevorstehenden Projektphasen





# Capgemini demonstrated potential of artificial intelligence driven industrial system design and performance prediction

## Aerospace OEM

### The Challenge

- Late involvement of industrial architects within the industrial system design prevents them from taking influence on product design
- Due to highly manual process of detailing industrial systems today only a limited number of scenarios can be considered by industrial architects
- Mismatch between industrial design and product design hinders innovation

### The Solution

- Involvement of industrial architects in first design drafts or at incomplete product design by providing AI-driven estimate of industrial structure
- Intelligent analytics uses industrial capabilities and product data to create multi-scenario design of industrial system and supporting future smart factories concepts
- Automated learning of the artificial assistant allows suggestions for improvement to product design, requirements and technologies

## Artificial intelligence assistant

## Multi-scenario development

## Industrial performance prediction

Enablement of scenario development based on early design drafts or incomplete product designs

Artificial assistant supports the development of system concepts by generating and predicting the performance of multiple assemblies and industrial scenarios

Implementation of AI-based system allowing earlier integration and increased direct influence of industrial architects in product design process



# Capgemini developed a digital and cross-functional development process to improve process & product performance

## Automotive OEM

### The Challenge

- The client is an international automotive OEM
- Increased number of product variances combined with shorter development cycles demand higher flexibility in product development and manufacturing
- The current product development process does not match the requirements

### The Solution

- Establish a future-oriented product development process over different units with common and continuous data basis
- Improve process and product KPIs and reduce product rejections
- Establish a foundation for digital business services and advanced engineering processes

## Integrated PDM process
## Mindset change

Developed and established cross-functional development processes through engineering, manufacturing and purchasing

Cross-functional data connectivity to support decision making

Implementation of intuitive and flexible engineering workplace

Mindset change in leadership and core development teams



# Sales and Experience



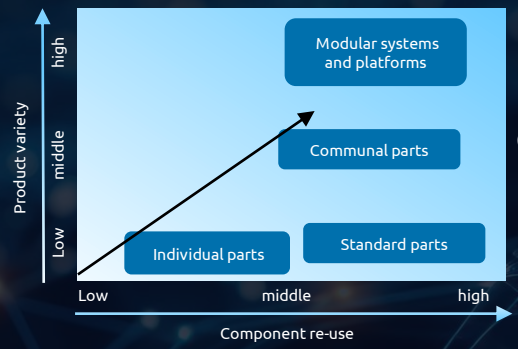
# Product and Portfolio Excellence enables a more costumer centric product development

## Key Challenges

**Lack of coordinated product Architecture and portfolio strategy**
No unified or consistent approach to product design and development across the organization

**Lack of standardized IT system** for classifying and managing product variants hinders transparency and comprehensive analysis across all product units.

**Increasing product complexity** and number of variants have a negative impact on product profitability




## Target Picture

**Individual customer solutions** and a wide range of products for the customer while minimizing product complexity

**Structured requirements and enforced re-use of existing solutions**
Product requirements captured with reference to defined architecture standard data structures

**Early stable architecture and concepts**
Common architecture components serve to apply portfolio management

## Success Stories

### Energy & Utilities

Capgemini supported a major European Energy player in identifying an annual standardization saving potential of 11-20 EUR m and established the relevant governance for execution.

### Automotive OEM

Capgemini's project for the Automotive OEM focused on modularizing wiring harnesses to reduce lead times, improve supply chain efficiency, and achieve cost savings while maintaining quality standards.

## Your benefits

- Improved decision-making through seamless integration of product and portfolio data.
- Reduction of engineering change costs
- Faster reaction on client needs and individual product creation
- Increased sales potential through data-driven analyses

# For a Energy player we identified an annual standardization saving potential of 11-20 EUR m and established the relevant governance

## Energy and utilities

## Parts and material standardization

### The Challenge

- Identify standardization measures to realize cost savings being to cope increasing margin pressure
- Pilot and execute standardization initiatives and establish the required governance in the organization

### The Solution

- Estimated standardization potential with specific involvement of Operations and Procurement experts
- Identified key levers to realize the potential for parts and materials: technical standardization, functional requirement sourcing, bundling of demand
- For services the key levers were standardized demand descriptions, contracting strategy, joint tendering

Identified 11-20 EUR m savings p.a. effective by 50% within two years and by 100% within five years time (ramp-up due to existing contracts, resource availability, maintenance schedules, etc.)

Established governance to apply defined standards in daily operations



# We define the architectural design to evaluate its impact on the supply chain and define the optimal make/buy split

## Automotive OEM

## Modularization of wiring harness

### The Challenge

- This manufacturer of trucks was experiencing high operation cost due to a complex product with a high level customization done by the customer
- The complex product and the current supply chain network led to high labor intensive assembly in production, rescheduling of production due to missing parts, long lead-times, high inventory and quality issues
- Major requirements: capability to react quickly to customer requirements, decrease the lead-time and lower the total cost

### The Solution

- complexity and led to less labor intensive steps in the factory
- Early supplier involvement in the Order to Delivery process reduced the lead-time by ca. 15-20 working days (total 90 days)
- Introducing a frozen zone in the OtD process i.e. not allowing any customer to make changes to the order after a certain date provided stability to the process
- Introducing a sequencing centre close to the plant provided some flexibility for the operational planning using the customized modules shipped from Mexico

Modularization of the product reduced the headcount in the assembly area and enabled packaged based modules

Reduce the cost for obsolete stock

higher flexibility due to shorter lead-time (-15 to -20 wd)

Better solution quality by earlier involvement of suppliers



# Streamlining Variant Configuration Management to enhance the product development

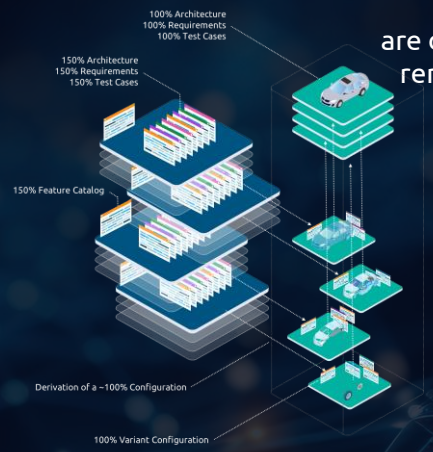
## Key Challenges

**Stricter** and **more complex regulatory environment** with different requirements per region result in many product variants

Demand for **highly customized products** results in many product variants

**Increasing complexity** and **interconnectivity** of technologies with faster cycles

Budgets & resources under pressure driving need for **more cost-effective** and **value-based solutions**




## Target Picture

**Variant Portfolio Planning**
Variants that have significant similarities are developed and managed together

**Individual variants**
are derived from the main model. They remain linked throughout the system life cycle

**Product Line Engineering**
Tracking variants along the product lifecycle and across engineering disciplines

## Success Stories

**Automotive OEM**

Capgemini supported an Automotive OEM to improve and tailor their PMTO-solutions for a development project

**Automotive OEM**

Support of an Automotive OEM to optimize their variant through a system-based transparency in product data

**Automotive OEM**

Capgemini helped establishing a central platform for steering configurations and integration across variants

**Agriculture machinery**

Capgemini supported a leading agricultural machinery manufacturer by enhancing their variant configuration process, improving user-friendliness, and harmonizing engineering and manufacturing processes.

## Your benefits

Variations can be managed in a traceable way across all artifacts from various sources

Intelligent re-use of artifacts decreases development efforts and engineering costs

PLE can significantly improve the time-to-market, quality and costs of systems

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# Capgemini helped an OEM to apply Variant Management in Systems Engineering in an A-SPICE compliant way

## Automotive OEM

## PMTO-Solutions for a Development Project

### The Challenge

- Increasing complexity of vehicle development projects due to higher integration of software, hardware and electronic components
- Introduction of end-to-end system engineering is required
- PMTO solutions had been prepared, but have not been accepted by vehicle project
- Multiple systems and methods for requirements management in place
- Handling of variant complexity was not defined
- Approval management was prepared in an inefficient, paper-based approach

### The Solution

- Continuous implementation of technical fit/gap analyses in vehicle processes acc. to A-SPICE
- Development of solutions to close gaps in all relevant development processes of VDA-scope
- Development of enablement concepts as well as active enablement of developers in the project
- Standardizing processes and methods for Requirements Management with Codebeamer
- Developing PoCs and first PMTO-solutions using Windchill, Cameo, Codebeamer and pure::variants
- Developing a MVP for a tool-based approval management using Codebeamer

Identification and addressing of +120 findings with respect to A-SPICE CL2 and applicability

Establishment of an end-to-end tool landscape

Continuous fixing of findings and addition of existing processes and methods

Enabled engineers in the vehicle project

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# Capgemini supports an OEM in variant optimization through system-based transparency in product data

## Automotive OEM

## Complexity and Variant Management

### The Challenge

- High product variants at a premium OEM result in high complexity throughout the company
- The OEM aims for optimal product variation at the customer with minimum complexity in product development
- Optimization requires creating transparency to identify and reduce variant drivers
- Lack of transparency about existing variants due to a complex product data world
- High manual efforts to actively manage complexity and variants because variant management takes place outside the central product data systems

### The Solution

- Development of a target picture for a reporting system in variant management
- Definition of as-is and to-be status as well as detailed pain point analysis and clustering
- Early development of an MVP through E2E approach leads to quick wins and lessons learned which enable short-term testing of requirements for future IT development and implementation
- Development of a fine concept which defines IT requirements and process workflows of a future tool for calculating and visualizing variants of defined scopes, structures, and modular releases

Creation of greater transparency in the variant analysis of different scopes and vehicle projects for a wide range of users

Use of product data as a lever for variant optimization

MVP allows first automatic analysis and enables users to track variants system-based along the entire value chain

Avoidance of time-consuming coordination processes



# Capgemini helped establishing a central platform for steering configurations and integration across variants

## Automotive OEM

## Concept & Rollout for ADO Integration Steering

### The Challenge

- Process gaps and low applicability of project processes for functional maturity planning, tracking, configuration and integration control
- Organisation and communication gaps, including low data availability due to Excel-based working methods
- Complexity of the interactions between the hardware and software releases to be orchestrated

### The Solution

- Development of an ecosystem in Azure DevOps to support maturity & integration control with a cloud-based knowledge database
- Replacement of the Excel-based solution and standardisation of processes & tools
- Scaling the solution in the organisation through agile development and rollout
- Successive expansion of the process chain to include the areas of test, error and configuration management in the sense of a holistic single source of truth

End-to-end integration platform with around 5,000 users that has switched to an agile approach to integration management and function development at network level

Data continuity through a holistic, cloud-based platform at the interface between architecture, development and integration

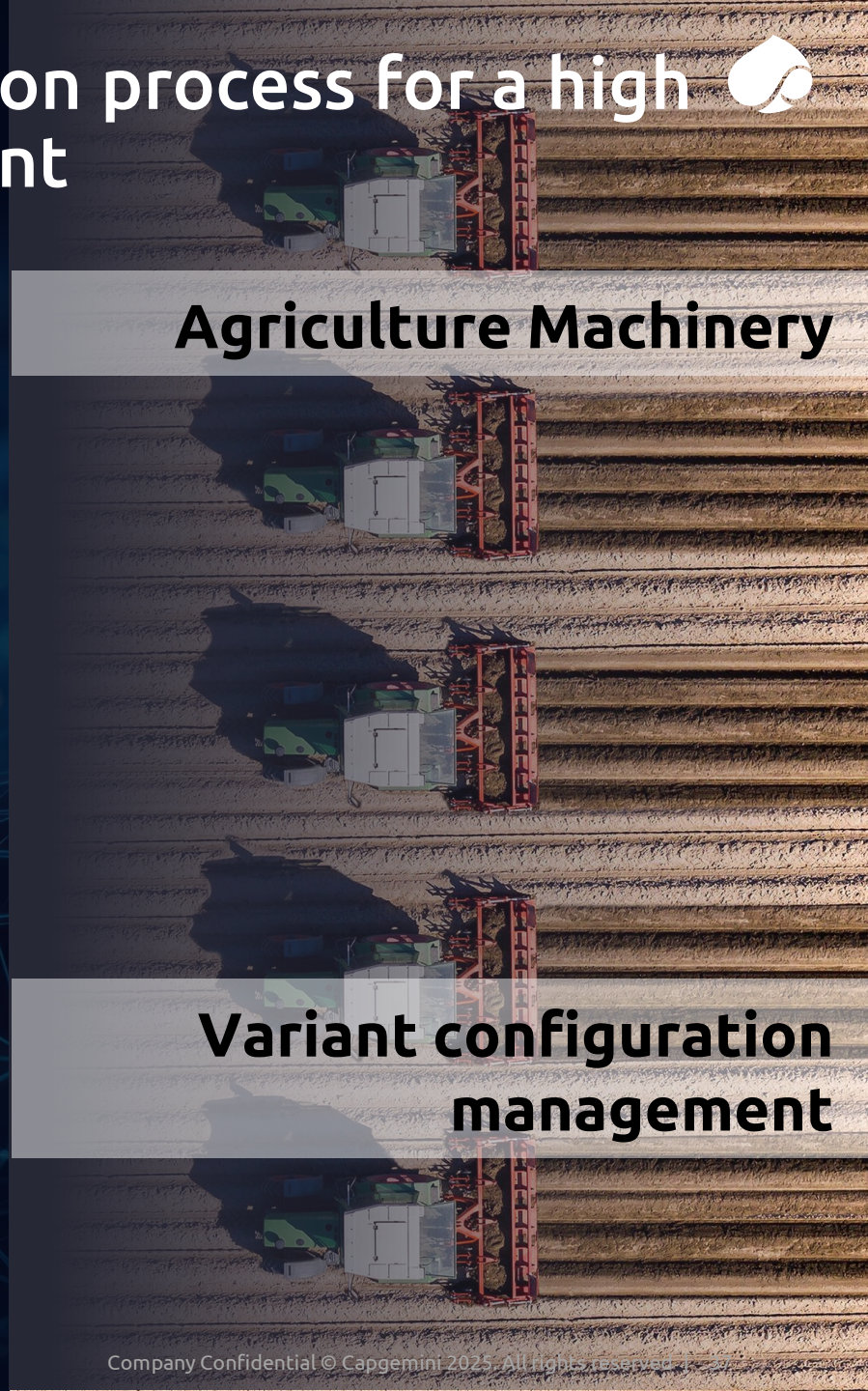
Increased transparency regarding the current and historical project status

Recording of target and actual configurations for different variants for testing and integration purposes



# Capgemini supported the variant configuration process for a high customer-value oriented product for the client



## Agriculture Machinery

## Variant configuration management

### The Challenge

- The client is the leading manufacturer in the agricultural market
- The client has defined a PLM roadmap to move from local engineering to global
- One of the important functional areas is the PDM-functionality of the system including variant configuration, engineering change management, and the integration to the stand-alone PLM system

### The Solution

- Description and new definition of Engineering requirements and configuration process
- Harmonisation of the client's configuration terms
- First draft of high level and low level configuration concept
- Concept description of a variant configuration prototype for SAP IPPE (integrated Product and Process Engineering)
- Developed concept for a out-of-the-box non SAP standard configuration tool to provide a user-friendly visual dependencies linking
- Data upload support for variant configuration data

Clarified Requirement of Engineering variant configuration process

Implemented a user-friendly, visual out-of-the-box tool to create and maintain dependencies

Defined and described end-to-end configuration processes with government concept

Improved alignment and stakeholder support for the designed solution across different engineering locations

Described functionality concept to implement engineering requirements in SAP IPPE

Improved alignment between engineering, manufacturing, product management and IT

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# Supply Chain Collaboration



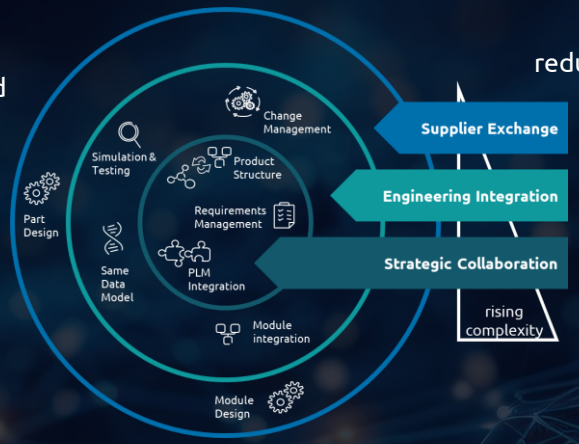
# Extended Enterprise Collaboration enables faster time to market while reducing business risk and controlling development costs

## Key Challenges

**Strategic Collaboration**
Harmonizing product structure and requirements engineering with the partner

**Engineering Integration**
Integration of the partner into the existing tool landscape and enable a seamless workflow with internal stakeholders

**Supplier Exchange**
Ensuring to seamless connect with the partner on a part and module design level




## Target Picture

**Scaling Engineering**
Leverage service providers to scale engineering capabilities and reduce own risk of over- and undercapacity

**Co-Development**
Development joint ventures to reduce R&D costs through synergies

**Module and component sourcing**
Source complete product modules from suppliers

**Strategic acquisitions**
Partnership as a first step for merger

## Success Stories

### Truck & Bus OEM

We supported the client to improve efficiency in engineering and thereby secure competitiveness. The target of the project is to establish a new process- and tool landscape to manage the development processes. The program leads to significant changes for 1600 employees in the R&D and affiliated departments.

### Aerospace Supplier

As part of a PLM initiative, we analyzed the partner integration and data exchange of the client to establish a transparent overview of the partner landscape, business processes and tools. Based on this we could simplify the business process and tool landscape to enable new ways of collaboration with the partners.

## Your benefits*

**Up to 20%** Reduction of Time-to-market can be achieved by integrating your partners and suppliers

**Up to 85%** Of the parts of OEMs vehicles are produced by suppliers

Partnering with engineering service providers **to control development costs**

* Numbers based on Capgemini's project experience



# Capgemini supported a truck & bus OEM to reshape the integration of external partners in engineering

## Truck OEM

## Integration of external partners in engineering

### The Challenge

- The client aims to improve engineering efficiency and secure competitiveness by establishing a new process and tool landscape for development. This program impacts 1600 employees in R&D and affiliated departments.
- Due to market pressure, the client is outsourcing significant R&D parts and sourcing components from suppliers.
- The actual data exchange with external partners is largely done manually with huge frictional losses and data quality concerns
- To better manage the network and collaborate with the external partners, a flexible, integrated and efficient collaboration solution is required.

### The Solution

- We supported the client in the concept, implementation accompaniment, validation and rollout of the solution.
- By defining standard processes and adapting the organization, efficiencies could be reached when collaborating with partners.
- Automation of key non value adding manual steps in the process
- With a strong focus on compliance an IP protection, potential risks were mitigated

Fast onboarding of partners into integrated data model, allowing for seamless handovers between parties

>30% faster operative data exchange, with quality gates to improve data quality entering the PLM system

Reduced costs for data exchange by outsourcing parts of the process



# We supported an aerospace supplier to analyse and conceptualise the product data exchange with partners

## The Challenge

- The client is a supplier in the aerospace market, which distinguishes itself with a very strong integration between the actors
- The client started a program to reshape its PLM process and tool landscape, from purchasing over engineering to production
- As part of the initiative, the partner integration and data exchange must be analysed to establish a transparent overview of the partner landscape, business processes and tools

## The Solution

- Analysis of all existing data exchange use cases related to product data in engineering, production, purchasing, validation, homologation and MRO
- Identification of as-is pain points and system breaks
- Design of a vision for future product data exchange and partner integration for all departments
- Process design to simplify business processes in alignment with the vision
- Vendor selection for the new tool portfolio

Simplify business processes and tool landscape for product data exchange with partners

Enable new ways of collaboration with partners

Secure compliance and export control in the data exchange

**Aerospace supplier**

**Conceptualization of product data exchange**



# Maximizing the value through successful Product costing & value engineering strategies

## Key Challenges

**Balancing Cost, Value and Performance**
Difficult trade off in ensuring cost reductions without compromising product quality, performance and customer value

**Intense Pressure to maintain Competitive Advantage**
Companies face intense competition from emerging markets, stricter standardization and regulations as well as changing customer behavior and requirements

**Supply Chain and Material Constraints**
Fluctuations in material costs, availability and supplier capabilities makes it difficult to meet cost targets without redesigning or altering the product

## Target Picture

**Faster Time to Market**
Reduced, focused development cycles allowing faster product launches and quick response to market demands enabled by streamlined processes and better cost control

**Increased Competitive Advantage**
Reduced waste, lower production costs, and maximized value creation due to efficient use of materials, labor and processes

**Improved Product Lifecycle Management**
Easier upgraded, more sustainable products, and reduced cost over the product lifecycle owing to a focus on cost-effective design early on

## Success Stories

**Aerospace OEM**

We supported the launch of two initiatives- Convergence of design-to-cost processes, Harmonization of structure design processes. Proposed new technology solutions for Design for Re-Use, Design-to-Cost, Design for Manufacturing

**Mountaineering gear provider**

We Implemented the Design to cost methodology on a lead product. Achieved 13% cost reduction with 10+ margin points increase, and identified 100+ redesign levers through Voice of customer analysis and competitor benchmarking exercise

## Your benefits*

- Time-to-Market reduction — Up to **30%**
- Development Cost Reduction — Up to **30%**
- Reduction of Variants — Up to **60%**
- Product Cost Reduction — Up to **30%**

* Numbers based on Capgemini's project experience

* Depends upon the client context and situation

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# Capgemini supported Design-to-Cost and development processes harmonization to achieve direct savings and reduce lead time

## Aerospace OEM

## Design-to-Cost and process optimization

### The Challenge

- RC reduction
- PoC for new tools to achieve target as part of DDMS
- Definition of new optimization methods
- Various structural components of

### The Solution

- Multi-stakeholder approach: Design Office, Manufacturing, Procurement
- Proposal of new technological solutions under consideration of Design for Re-Use, Design-to-Cost, Design-for Manufacturing
- Design proposal, analysis and justification

Multi-disciplinary team and cross-functional experience (design, analysis, manufacturing)

Variety of tools for deployment of studies and tade-offs (e.g. CATIA, 3Djuump, Exalead, SCOOP, DFX)

Proposal of design solutions



 

# Capgemini helped a mountaineering gear provider to implement a Design-to-Cost methodology on a lead product

## The Challenge

- Farming the Lifting/redesign of an existing product using a Design-to Cost Methodology
- Increase control of costs and decrease products' costs to maintain margins and to stay a one step away in the marketplace
- Continue to innovate while designing products that provides more values to the final users
- Identify reduction tracks without calling into the question the industrial scheme, supply nor prices negotiated to date with the various suppliers

## The Solution

12-week approach involving French local team & Malaysian team (for purchasing & industrialization)

- Identification of the products' functions and cost breakdown of each function
- Benchmarking of competing products on technical characteristics
- Realization of a "Voice of Customer" approach with surveys (+300 users) and a focus group
- Identification, selection and validation of redesign levers with cost-reduction perspective

13% cost reduction/ +10 margin points won

7 competing products studied and tested in laboratory

47 functions prioritized & divided into 8 main families

100 redesign levers identified

**Mountaineering gear provider**

**Design-to-Cost and process optimization**



 

6

# Manufacturing & Operations



 

# State-of-the-art Manufacturing Engineering Integration & Virtual Commissioning enables Continuous Manufacturability

## Key Challenges

**Shortened product life cycles**
Shortened product life cycles require companies to adapt quickly, reduce idle times and enable a **continuous manufacturability.**

**Increased product and production complexity**
Keeping production costs down whilst product and production requirements are getting increasingly complex demands a **seamless and traceable interaction** between engineering and manufacturing.

**Enabling a holistic & continuous value proposition**
Development processes need to be reshaped to enable **cross-functional teams** working together toward a continuous value proposition.


## Target Picture

A Co-Design approach that shares information & requirements between engineering and manufacturing to boost efficiency, quality and enable a continuous manufacturability.

Embedding a digital thread throughout the product life cycle with clear trace-links between engineering and manufacturing that reduces idle time, as impacts of changes will become transparent immediately.

Digital commissioning via a shared digital collaboration platforms as the central connector for cross-functional teams work in parallel towards an aligned continuous value proposition - further connecting external partners possible.

## Success Stories

**Automotive OEM**

Integration of multiple Digital Twin software's in a single scene unlocks new capabilities to improve manufacturing and digital engineering

**Automotive OEM**

Capgemini created a real-time 3D digital twin of the entire facility by ingesting CAD models and connecting the application to the client's back-end services.

## Your benefits*

Speed-up **time-to market**
up to 30%

Reduction of **engineering costs & rework**
up to 20%

**Improved process quality**
up to 15%

**Process efficiency increase**
up to 30%

* Numbers based on Capgemini's project experience

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# Capgemini helped an Automotive to implement a Digital Twin into their manufacturing

## Automotive OEM

## Digital Twin Proof-of-Concept

### The Challenge

- Reduce investment, ramp-up and lead time with factory planning
- Lacking infrastructure, data, competences, way-of-working

### The Solution

- Digital Twin show potential for cross-platform integration, cross-functional collaboration and interactive decision making
- Large scene visualization in Omniverse has the potential to improve manufacturing design, optimization and operations

- A single source-of-truth
- Live-sync collaboration
- Improved efficiency
- New capabilities for analytics
- Data availability and quality
- Change management concept
- Interactive decision making
- Prioritized use cases and roadmap

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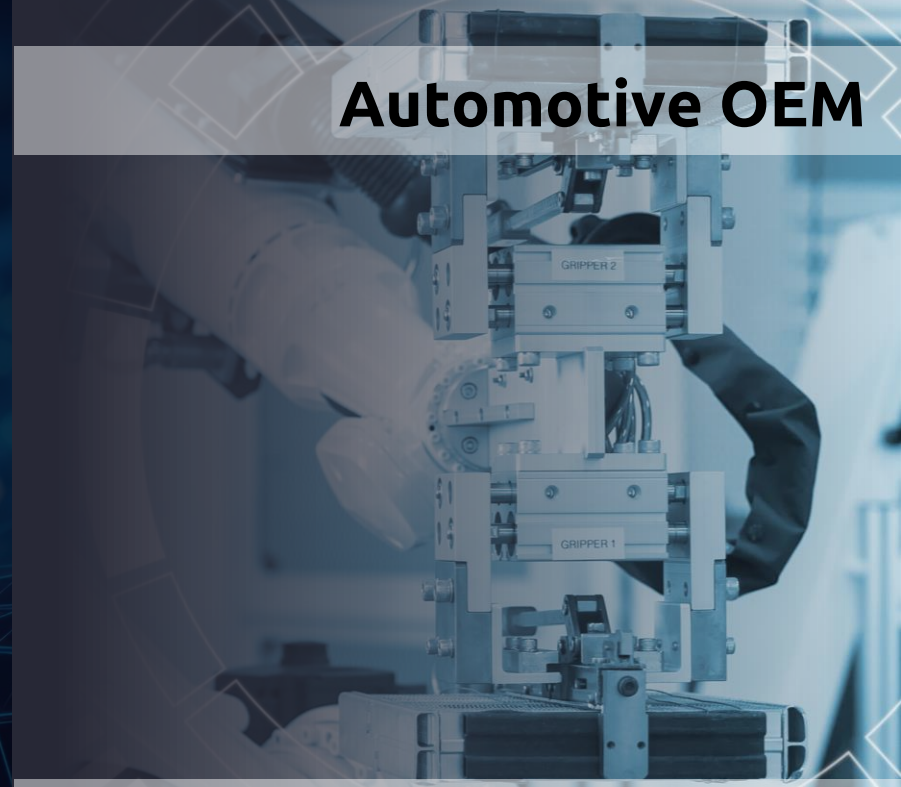
# We supported an OEM with a highly automated production process to remotely monitor, manage, and optimize holistic site operations

## Automotive OEM




## Manufacturing facility of the future

### The Challenge

- Transition from traditional line-based production to cell-based production
- Pervasive automation required a digital twin to help bridge the communication gap between key legacy information systems and bleeding-edge technology applications

### The Solution

- Our team produced a real-time 3D digital twin of the entire facility by ingesting CAD models and connecting the application to client back-end services
- Solution reflects the actual condition of plant in a virtual space, allowing for better planning, monitoring and training

10-fold increase of automation of logistics & assembly

Immaculate quality control with 0 total assembly claims

Operational costs reduced by >30%

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# Continuous verification & validation enabled through a model-based value chain is one key success factor of Digital Continuity

## Key Challenges

**System & product complexity**
With advanced electronics , software & AI the product complexity is continuously rising, involving more and more stakeholders in the related processes. State-of-the art **validation processes consume and generate vast amounts of data** which need to be managed efficiently.

**Scalability of verification**
As systems scale up in size and complexity, component types and interoperability, physical testing and even virtual manual testing become **impractical and cost-intensive**.

**Safety and compliance**
Ensuring safety with **stricter standards and expanding scope of compliance regulations** considering emerging technologies, complexity and amount of testing scenarios increases.


## Target Picture

Increased processing capacity for parallel testing of large-scale systems. Flexible and quick adaptive verification of product variations and customizations with increased scenario coverage.

Data analytics, AI and machine learning leverage testing quality. Continuous and automated improvement of verification approaches, scenario definition and accuracy of root cause analysis.

Expanded use of simulation and automation for system validation. Seamless access to intelligent model-based product data through a master data backbone.

## Success Stories

**Automotive OEM**

Capgemini supports an automotive OEM in agilizing EE development according to SAFe, resulting in reduced complexity and improved efficiency.

**Construction machinery OEM**

Capgemini supported a construction machinery OEM in setting up a global PLM transformation program, addressing challenges from mergers and acquisitions, and implementing an agile, commercial off-the-shelf solution to achieve significant annual savings.

## Your benefits*

Increase of **product quality & compliance**
up to 20%

Reduction of **errors and rework (process robustness)**
up to 15%

Shorten overall **time-to-market**
up to 30%

**Process compliance & standardization** increase
up to 100%

* Numbers based on Capgemini's project experience



 

# Capgemini supports an automotive OEM in the agilization of an EE development according to SAFe


## The Challenge

- Speed of new market requirements (shorter development cycles, higher customer orientation)
- Continuous increase of software shares in the vehicle (paradigm shift SW>HW)
- Integration and safeguarding of SW composite releases and overall SW composites in the portfolio (portfolio, vehicle, domain, function)
- Provision of new functionalities in the course of the product lifecycle

## The Solution

- Agilization of EE development at the function, domain and composite level
- Agilization of the way of working according to SAFe from demand and requirements management to final validation and release in the vehicle
- SAFe model in the domain, overarching agile control
- Control of individual releases with focus on product increments
- Tool definition and introduction along the development processes

Mastering EE complexity through the incremental agile approach.

Earlier verification & validation of the scopes in the vehicle

Reduction of effort for requirement specification (complexity reduction)

Reaction to project and scope changes are controllable and plannable

Reduction of technical changes



 

# We supported a construction machinery OEM in setting up a global PLM transformation program

## The Challenge

- The client grew through M&A and operated three different PLM solutions
- Several improvement programs had been started but were lacking software support
- To leverage synergies from one single PLM solution, the client tried to adapt and enhance the its-own PLM solution
- This first PLM program did not deliver as expected and was finally stopped
- The client made the decision to implement a commercial off-the-shelf
- Capgemini was selected to support and moderate the setup phase

## The Solution

- Capgemini conducted the preparation of the implementation phase
- Future to-be processes were designed and merged with best practice E2E processes and industry know-how
- The scope of the software functionality was set using workshops and a gap analysis of the clients architecture
- Capgemini ensured constant buy-in
- The setup phase ended with a successful ASE and a go for implementation phase

Enablement to set a clear and feasible objective for their common PLM program

The expected scenario will result in an average yearly annual saving of 264 MSEK with a total NPV of 507 MSEK

The program is backed through a solid and tangible business case




 

# Service & Performance



 

# Optimizing Asset Utilization and Enhancing Service Revenues through Effective Installed Base Management

## Key Challenges

**Increasingly customized products**
Customers require products that are adapted to their needs which leads to to more product variants

**Exploding volume & complexity of product data**
Product variants increase data volume while all functions are gathering more and more data soiling data leading to low transparency.

**Complex PLM IT system landscape**
IT system landscapes are becoming more complex and characterised by a high number of IT systems and applications which leads to breaks within the process flow.

**Lack of integration from Engineering to Service**
Product defining data is not forwarded continuously along the product lifecycle. This leads to a higher manual effort

## Target Picture

**Harmonized Configuration Mgmt.**
A harmonized management of data will serve to optimize essential service business scenarios

**Service is fully enabled**
access technical information about the machines but also about related commercial and logistical information (Fleet, Product, As-Is Configuration, Spare parts ..)

**A Global Data Model**
The data structures aligned to a common, scalable data model (Industry standard); The model

## Success Stories

### Wind power manufacturer

Capgemini supported a wind power manufacturer from the initial design of a harmonized configuration management to the go live of the different implementation stages. We have designed and implemented a harmonized E2E Configuration Management Solution managing components of a power plant

### Machinery & equipment

Capgemini Created an analytics pilot for leveraging Predictive Maintenance service potentials defined. We built the corresponding data model and analysed the vast amount of data under consideration of hypothesis-related constraints using various analytics techniques.

## Your benefits

- Improved asset utilization and efficiency
- Increased service revenues
- Improved service efficiency and **customer satisfaction**



 

# Capgemini helped a wind energy manufacturer to establish a world class supply chain operation in their service business

## The Challenge

- The client is a global leading manufacturer of Wind energy systems
- The client Service is challenged to deliver spare parts for maintenance in an efficient way and create high level of customer satisfaction
- The SCM processes are scattered using different systems for operations and lacking transparency and efficiency in supply chain management at project start

## The Solution

- Establish a global, digital SCM environment with harmonized processes across all global business units
- Implement highly automated operations processes from customer quotation, materials planning, order management to operations efficiency
- Enable a transparency for customer order progress
- Reduce operational costs and increase on time in full delivery

Implement a digital, highly automated and integrated quotation and order management process based on SAP

Select and implement a materials planning solution that ensure availability at lowest possible inventory level

Develop an order management control tower solution to create full transparency regarding order progress

Analyze and recommend a new warehouse set-up meeting the demands of global customers

**Wind power manufacturer**

**Supply Chain Excellence**

**Order Management & Quotation Automation**

**Spare Parts Planning**

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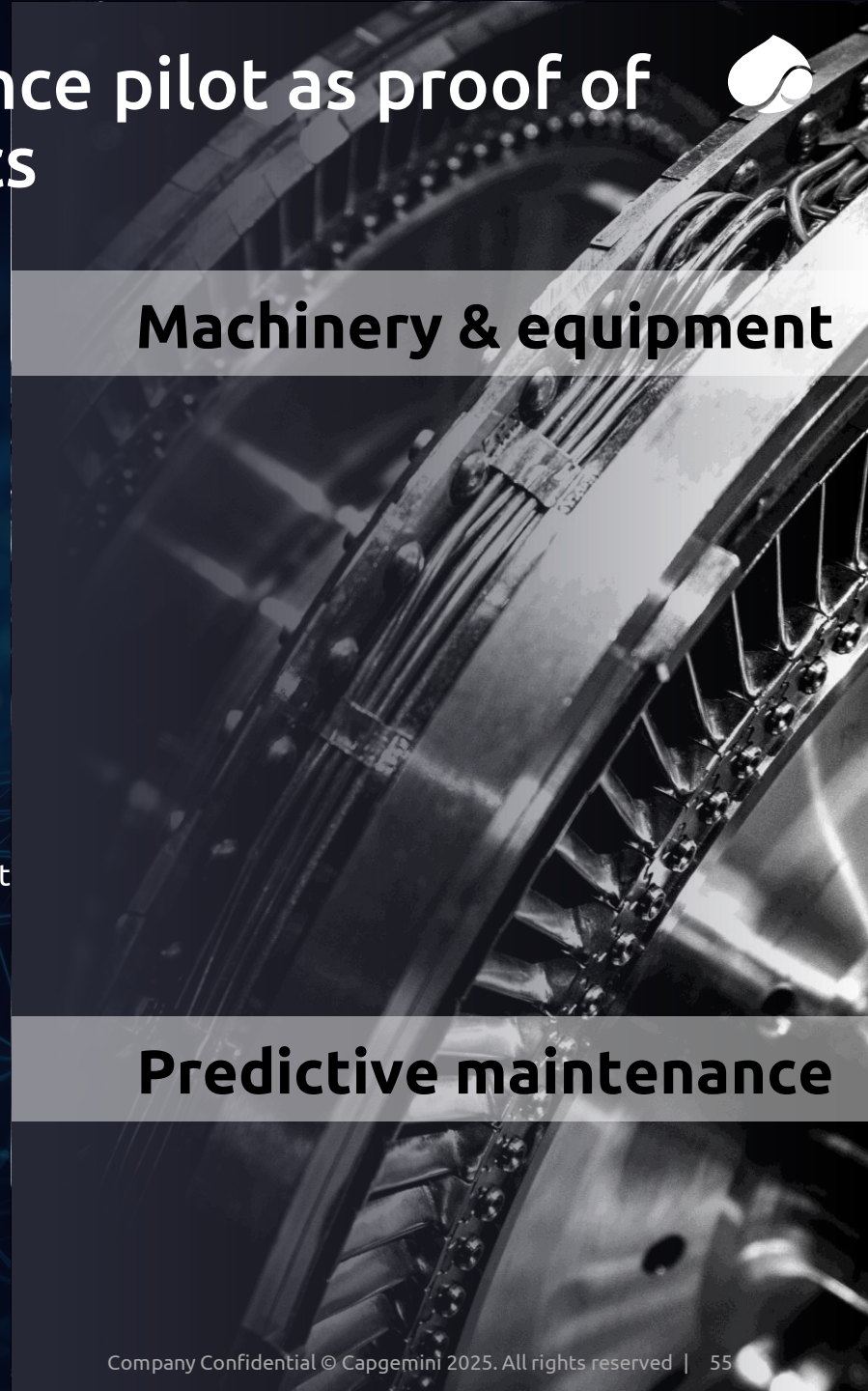
# Capgemini conducted a predictive maintenance pilot as proof of concept for a new business based on analytics




## The Challenge

- The client is a world-class leader in providing cutting-edge milling machines and services
- Machines are equipped with sensors and respective data and machine conditions are available for recording
- The client wants to launch analytic-driven services to improve their solution portfolio and optimize their clients' business
- The client requested a definition and implementation predictive maintenance pilot at a given subset of client's machines and corresponding ERP service data
- The Capgemini PoC for analytics was considered for giving impulses on new business development

## The Solution

- Definition of problem-related hypothesis with biggest beneficial impact on improving service cost and time
- Analysis of disjoint data sources with interdependencies for each hypothesis, in general service data and machine data
- Aggregation and development of an integrated data model for analytic investigation (reports, conditions, sensors)
- Application of text analytics and time series analysis on specific subsets of the common data model, using IBM SPSS

Identification of analytic business potential

Diagnostics and monitoring possible right now



# Achieving Service and Closed-loop Excellence in Digital Continuity to maximize synergies and reuse of products

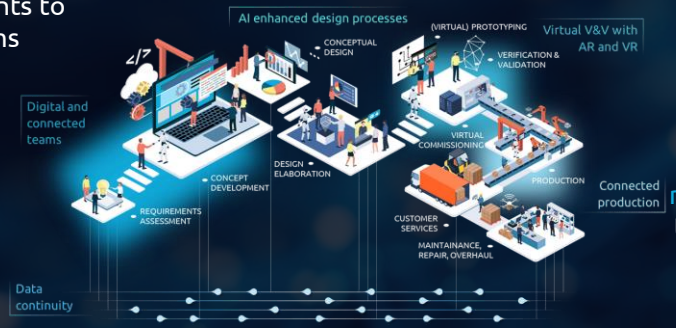
## Key Challenges

**Data Management**
Managing data continuity and traceability from requirements to validation in complex systems

**Automated Toolchain**
Integrating model-based design, simulation and automated testing into the toolchain

**Regulatory Process**
Managing regulations along the development process and ensure compliance of the entire system

## Target Picture




**Requirement Engineering**
Requirement driven product specification, ensuring requirement and solution consistency

**Traceability**
Improved requirements management and increased traceability throughout the development process

**Product synergies**
Maximize synergies and reuse of products and product variants within the product portfolio

## Success Stories

**Flying Fuel Cell**

We analyzed existing systems engineering concepts and tool landscapes and prepared the scaling of the initial concepts for the entire development department.

**Energy & Utilities**

Replacing drawings and documents with the MBVC as E2E digital process where model-based definitions are the process authority through the entire product lifecycle (focus design and manufacturing).

## Your benefits

Elimination of process redundancies and time waste with data and system breaks

Introduces exchangeable and traceable information up to the level of a single dimension

Supports specialists in handling increasing complexity and amount of information

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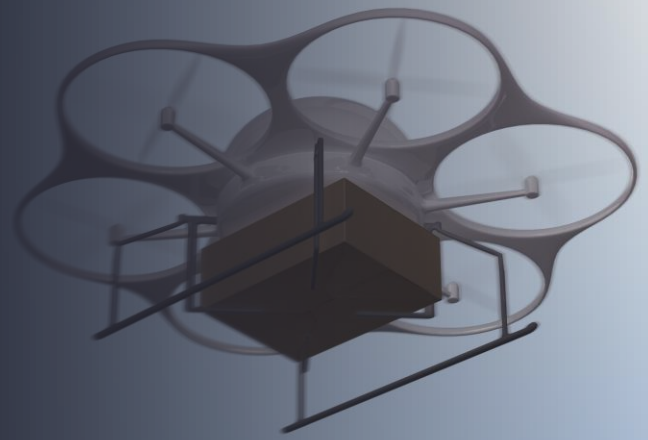
# Wie supported an Aerospace Supplier to implement an end-to-end configuration management from Engineering to Service

## Aerospace Supplier



## Integration of MBSE Environment into PLM-Backbone

### The Challenge

- The client uses a Model-based Systems Engineering Approach (MBSE) to handle the complexity of fuel cell development.
- The MBSE environment is currently independent from other tools.
- The current situation sees a lack of integration from Engineering to Service, a complex PLM IT system landscape and a wide organization with diverse cultural elements

### The Solution

- The solution involved a structured approach using "spikes," which are time-bound, cross-functional teams, to address risks and uncertainties
- Based on a simplified process, five work packages (features) were identified for implementation
- An agile working mode was adopted to develop concepts and recommendations
- The identified features to be implemented enable users to perform affected process steps of the MBSE value stream

The implemented features enable users to perform affected process steps of the MBSE value stream

Providing a release workflow in Teamcenter for MBSE-specific objects and structures

The integration aims to provide traceability between SE-specific objects and downstream processes in Teamcenter



# We supported an energy client to implement an end-to-end configuration management from Engineering to Service

## Energy & Utilities

## Installed base management

### The Challenge

- The client is positioned as a total plant solution provider delivering plants, components and service, Providing turn-key solutions, components (Steam, Gas, Geno), parts, service, repair, field service, LTP to O&M, power diagnostics, etc.
- The organization is structured in several business units around product lines and value chain stages (turn-key, products, service)
- The current situation sees a lack of integration from Engineering to Service, a complex PLM IT system landscape and a wide organization with diverse cultural elements

### The Solution

- Capgemini supported the client from the initial design of a harmonized configuration management to the go live of the different implementation stages:
- The conceptual design phase of the project led to an overall design for configuration management incl. business case and roadmap
- The design phase of the project detailed the rough concept of the conceptual design down to a functional specification level
- The first implementation stage focused on the implementation of a harmonized installed base management “from site to turbine level”

A harmonized SAP-centric product configuration management “from plant to part level“

Portal for Installed Base Management

Global Data Model & System Landscape

New and enablement-oriented Roles & responsibilities



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