NEM BAM 2025-2

North European Modularization Network

N.E.M.

VOLVO

Welcome – 2025-2 BAM

presentation: 75 persons – 5 nationalities

NEM Member Companies

Atlas Copco
Carl Zeiss SMT ★
Cibes Lift
Coloplast
Danfoss Drives
Delphi Tech
Demant
Electrolux
Körber
Leser
Linak
Sandvik ★
Velux
Vestas
Wärtsilä
Volvo

63

NEM University Partner

DTU
TUHH
Chalmers/Milan Uni
Jönköping University
RISE

5

NEM Partner Consultancy

Modular Management
Configit
Odego

4

NEM Team

3

~54 Companies (Members & Partners)
~418 NEM active individuals

NEM Network – Meetings/Webinars

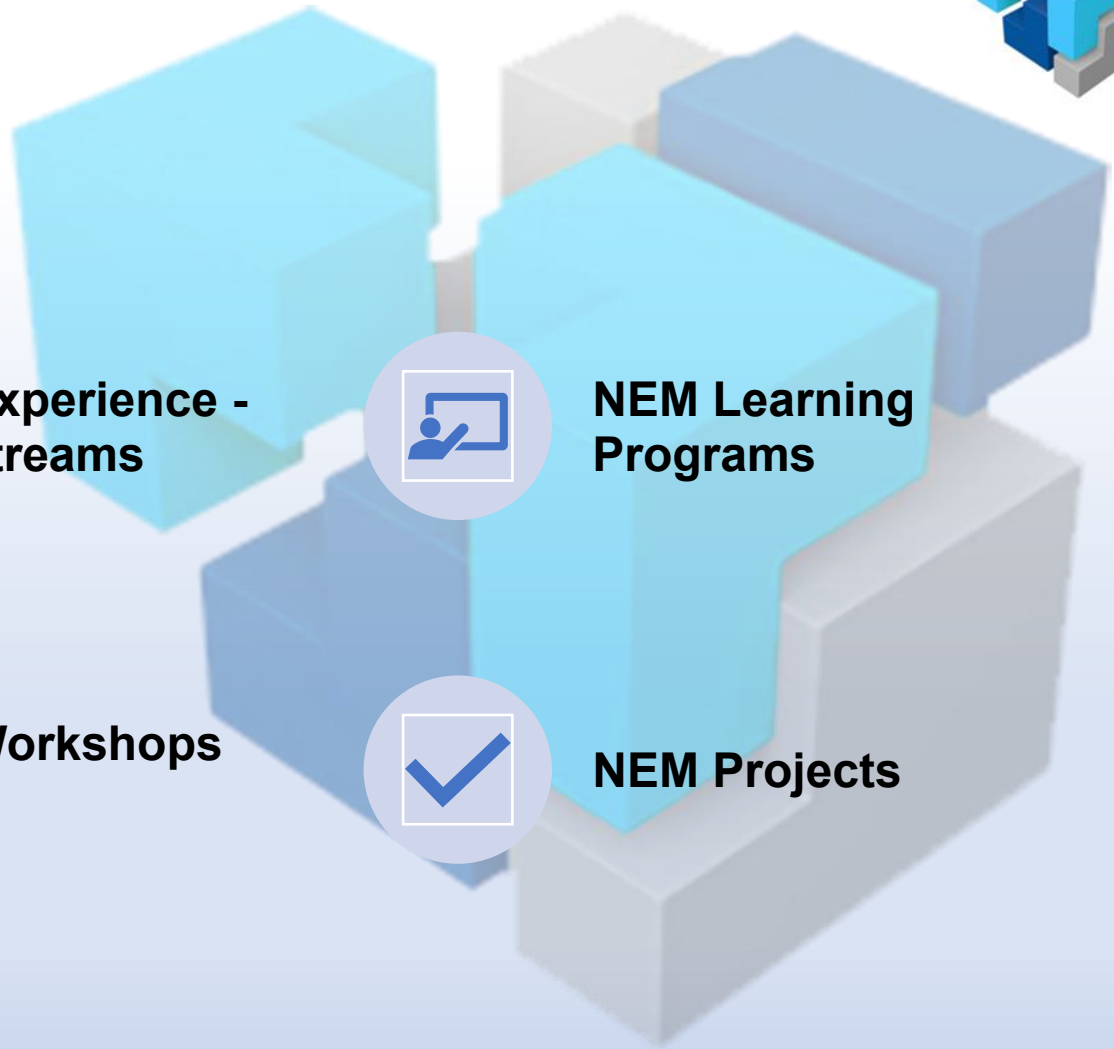
NEM Experience - Workstreams

NEM Learning Programs

NEM Services

NEM Workshops ++

NEM Projects



” We accelerate Modular Strategies ”

Meetings and Network	Experience Sharing	Learning Center	Services and Workshops	Projects

Competence and Experience - Realistic, Pragmatic and Practical

Partner-ships

NEM Partnerships

NEM has established partnerships with universities, industry associations, and consultancy companies, each with their own unique approaches to and experience with modularization.

Through these partnerships, our network gains knowledge and new perspectives, which benefit our members on their respective modularization journeys.

Universities (8)

Consultancy Companies (9)

Day 1

	Tuesday 7 oct(only NEM-member)	
	NEM Day 1 high level Agenda	**Details**
0800		
0830	Coffe	Coffe
0900	NEM Welcome/introduction NEM	Welcome/introduction
0930		
1000	Volvo company introduction	
1030		
1100		Volvo company introduction
1130	Lunch + Transport to manufacturing plant	Lunch
1200		1200-1245 Bus Shuttle to Tuve(7km)
1230		
1300	Manufacturing plant, tour + presentation	Group 1: Tuve Train 1300-1345
1330		Group 2: Fishbone Factory/Mixed Model Assembly
1400		Group 2: Tuve Train 1400-1445
1430		Group 1: Fishbone factory/Mixed Model Assembly
1500	Volvo Modularization journey	Modularization assembly perspectiv(60min)
1530		
1600		
1630	Transport to Volvo Lundby -> World of Volvo	Bus Shuttle till Lundby->World of Volvo
1700	World of Volvo Museum	World of Volvo, Museum from 1700?
1730		
1800	World of Volvo, dinner 1830->	Resturant Ceno OnTop 1830
1830		
1900		
1930		
2000		

Day 2

	Wednesday 8 oct(open day with invited companies)	
	NEM Day2 High level Agenda	**NEM Day2 details**
0800	Introduction/coffee	Introduction/coffee
0830	Volvo Modularization history	Lennart Börjesson/Andreas Lundmark
0900		
0930	Modularization at Volvo Group Trucks Technology	Modularization at GTT(Top Level Modules/Vehicle Module Structure)
1000	Customer perspective	Customer perspective(GTA/TAD)
1030	PDM/PLM ->AVP	Toolchain KOLA from design ->production & visualization
1100		
1130	Modularization examples	Modularization IRL: Mack/Volvo North America
1200		
1230	Lunch	
1300		
1330	NEM Information	NEM Workstream status
1400		NEM Project - AIMO - Artificial Intelligence to support Modular Strategies
1430		NEM Project - CEMO - Modular Circular Economy model.
1500		NEM Partner presentations
1530		Next NEM activities
1600	Wrap up	Wrap up and networking
1630	Closing the conference	Close at 1630
1700		

NEM Agenda – Day 2
13.30-16.00

13.30-14.00	Group session – ”Give/Take”	All	
14.00-14.30	NEM workstream ”status/dialogue”	Peter	
14.30-15.00	NEM project AIMO	Carsten	
15.00-15.15	New Partner presentation	Sandra	Odego
15.15-15.30	New Partner presentation	Lars	Configit
15.30-15.45	NEM-JU project: CfM	Dan & Christian	
15.45-16.00	NEM CEMO & news	Christian	

16.00-16.30	**Wrap-up**	**ALL**	

N.E.M.

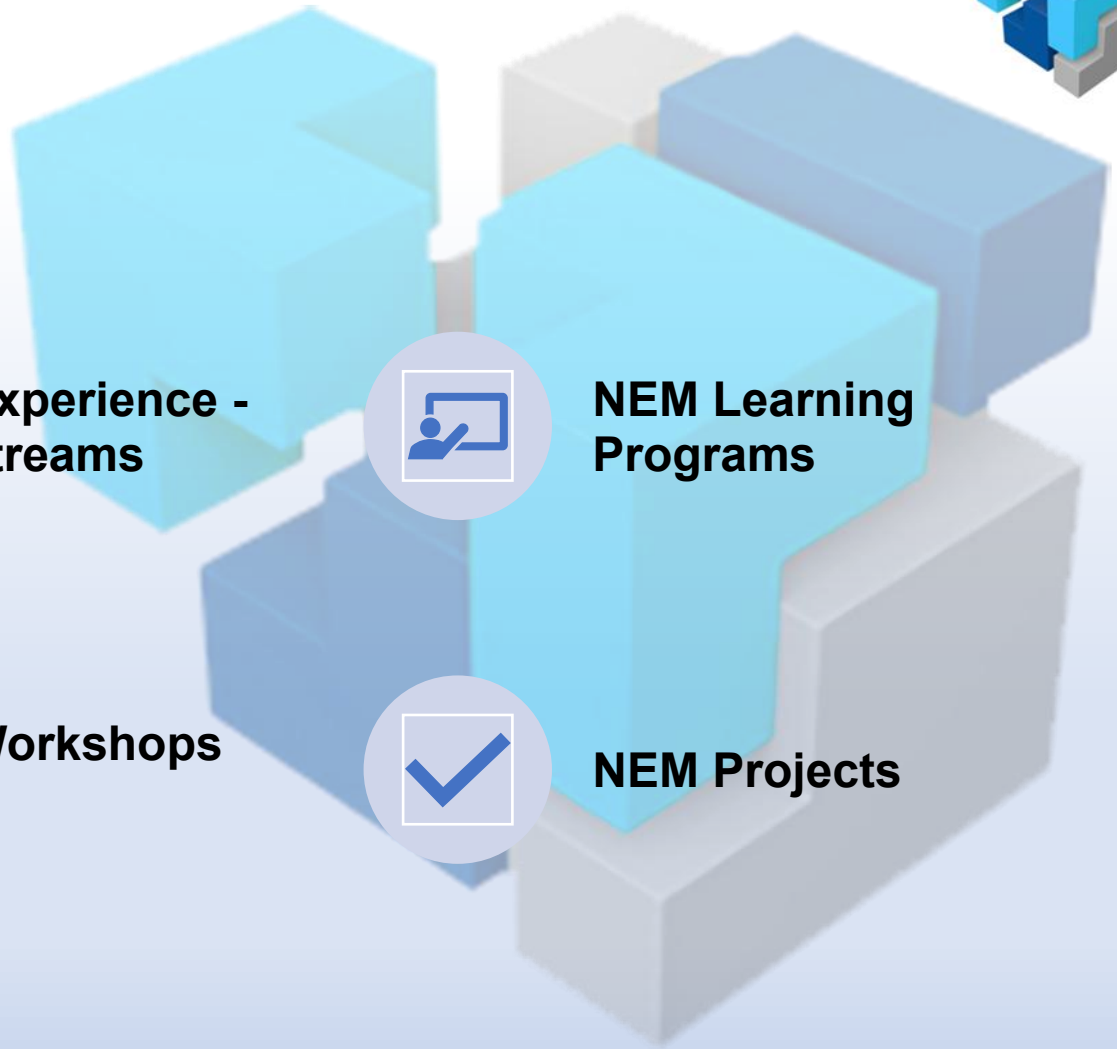
- MODULARIZATION
- GET INSPIRED, GET NEW IDEA's, SHARE EXPERIENCE
- MEET OLD FRIENDS, GET NEW FRIENDS

- HAVE FUN TOGETHER

- ACCELERATE……

" We accelerate Modular Strategies "				
Meetings and Network	Experience Sharing	Learning Center	Services and Workshops	Projects
Competence and Experience - Realistic, Pragmatic and Practical				

N.E.M.



NEM Network – Meetings/Webinars

NEM Experience - Workstreams

NEM Learning Programs

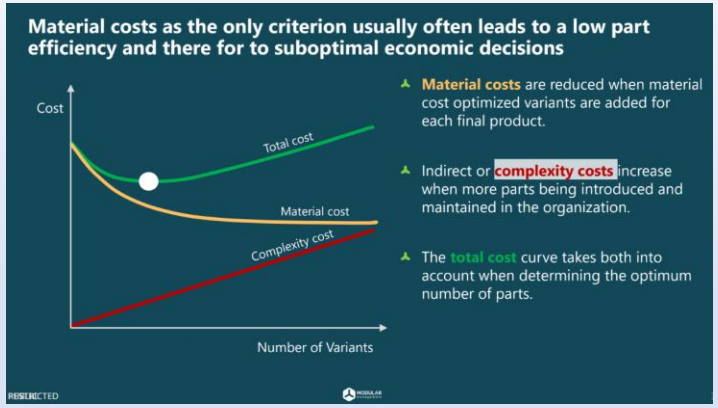
NEM Services

NEM Workshops ++

NEM Projects

NEM Webinars

Frauenhofer
Modular Manufacturing
June



Modular Management
Complexity Cost
June

ICV - NEM
Finance-Modularization
October

Execution model

NEM Workstreams

Industry drive on modularization topics

participation

Finished 2023 & 2024

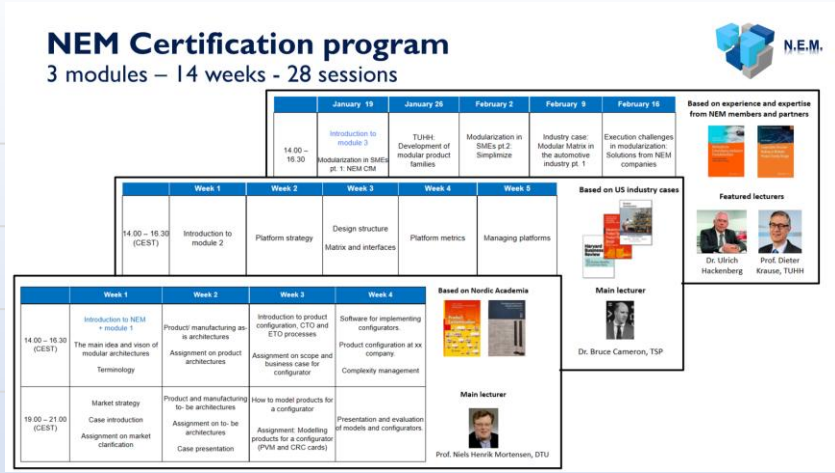
- **Process and Tools** — WS 5
- **Architecture Governance** — WS 6
- **Cost of Complexity** — WS 7
- ***Requirements Engineering Modular Products*** — WS 9

New WS Process running 2024 & 2025

- ***Modular & Circular*** — WS 1
- ***Modular PLM (Digital Thread)*** — WS 10
- ***Modular Manufacturing*** — WS 3
- ***SW & Connectivity*** — WS 2

NEM CERT Program – unique and global

Cancelled 2025/2026 – too few registrations. Will be running again 2026/2027



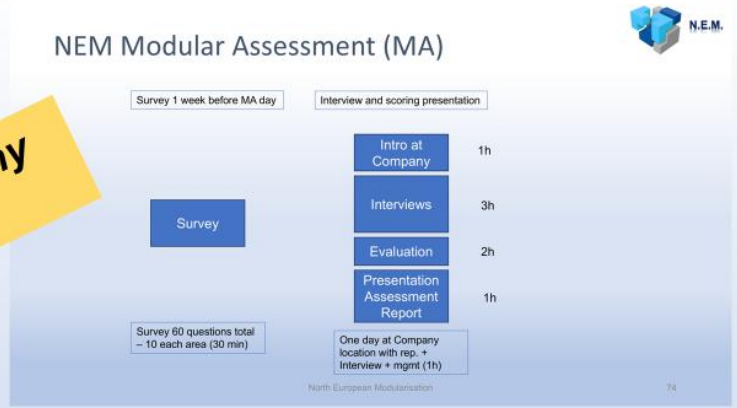
Framework for NEM Assessment

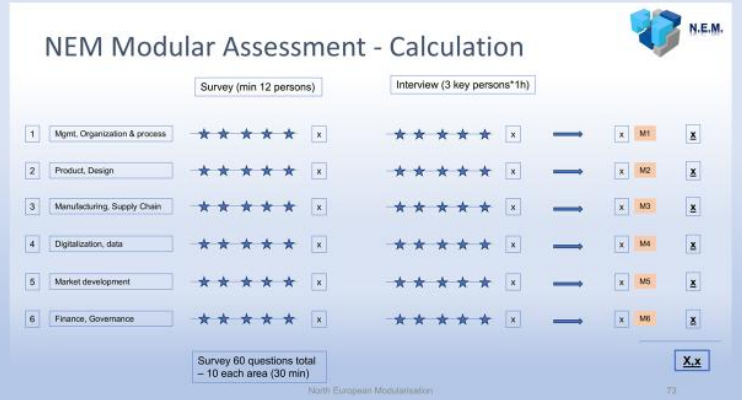
NEM Assessment – 1 day at Company location

- Qustionaire:
  - 1 week before MA day
  - 10 persons selected
  - Whole Value Chain

- Assessment day
  - Interviews
  - 3 persons
  - Assessment results

NEM Member Company Free test in 2025





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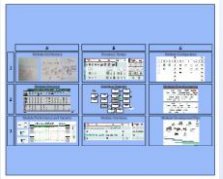
Mandate
execute
modular
Strategy

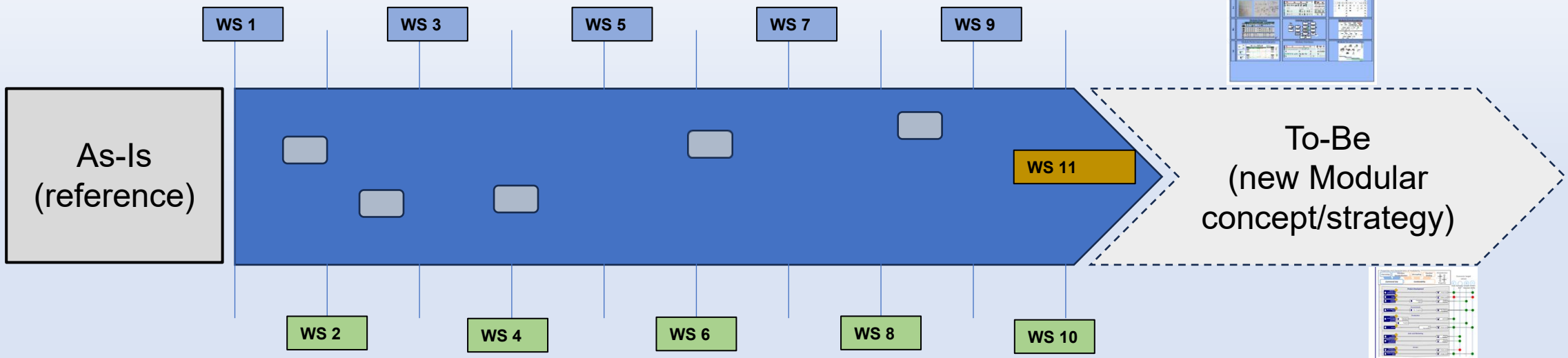
NEM Con Project - Overview

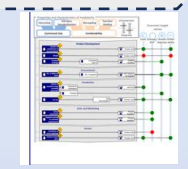
NEM has succesfully supported NEM member Companies in accelerating on a Modular Strategy.
NEM approach to use the NEM network of Companies, Partners and Universities etc to compose a NEM specific team to support the Company team in approx 6 months time with normally 10-11 workshops. This offer is unique and only possible to take advantage of as a NEM member. Each Con project will be developed to accelerate Company strategy and the connected benefits of modularization.

NEM Top-Down Approach - CUBE

End to end valuechain approach to quantify the overall potential and a proposed road-map for execution,..





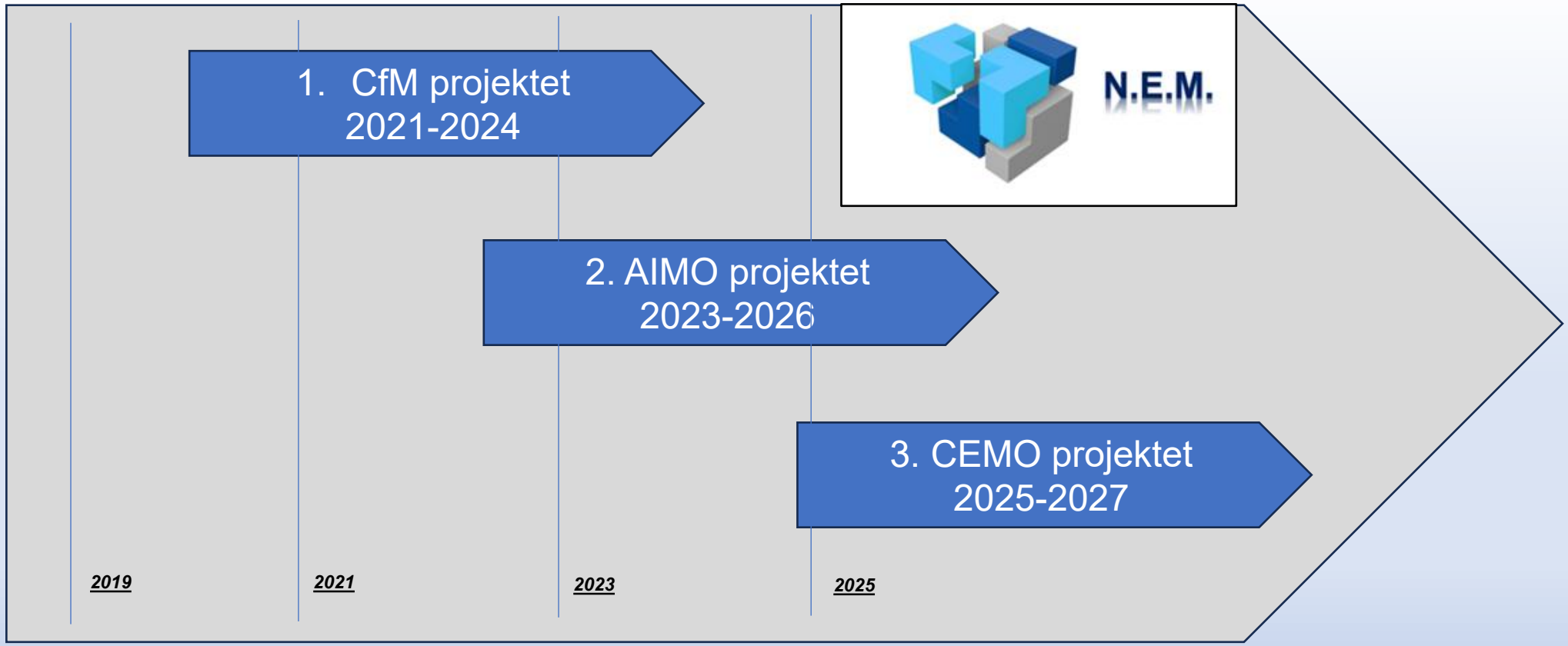


NEM Bottom-up Approach - IMF

Analysis and datamining of existing productportfolio to quantify potential savings linked to complexity reduction, cost of complexity and portfolio optimization,..

Company specifc Modular activities like projects, programs etc….

NEM Project oveview

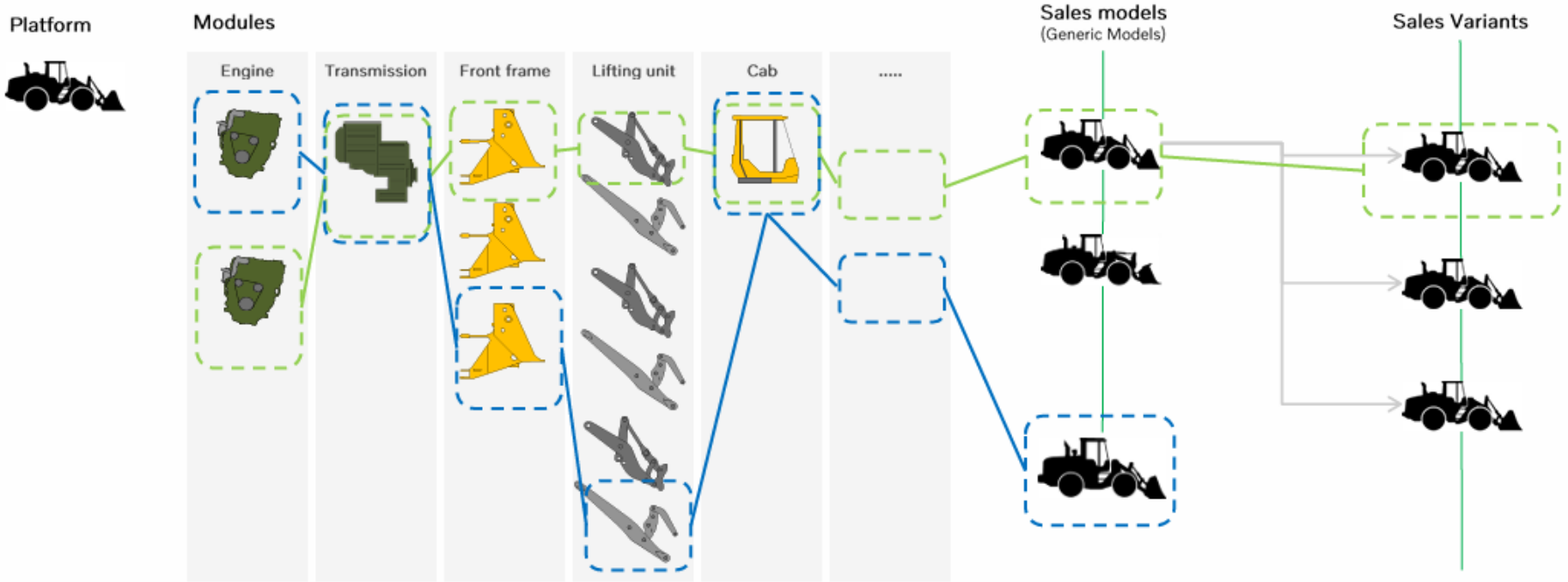


NEM BAM - VOLVO

VOLVO

The benefits of Common Architecture and Shared Technologies CAST

A modular Architecture will optimize the development effort



- The development cost is mainly connected to the large expensive modules
- A modular architecture is therefore crucial to manage this variety
- Development cost is optimized by keeping the modules on a minimum level

- A good architecture generates many sales variants to reach broader market coverage
- Reducing sales variants will only have a limited effect on the development cost

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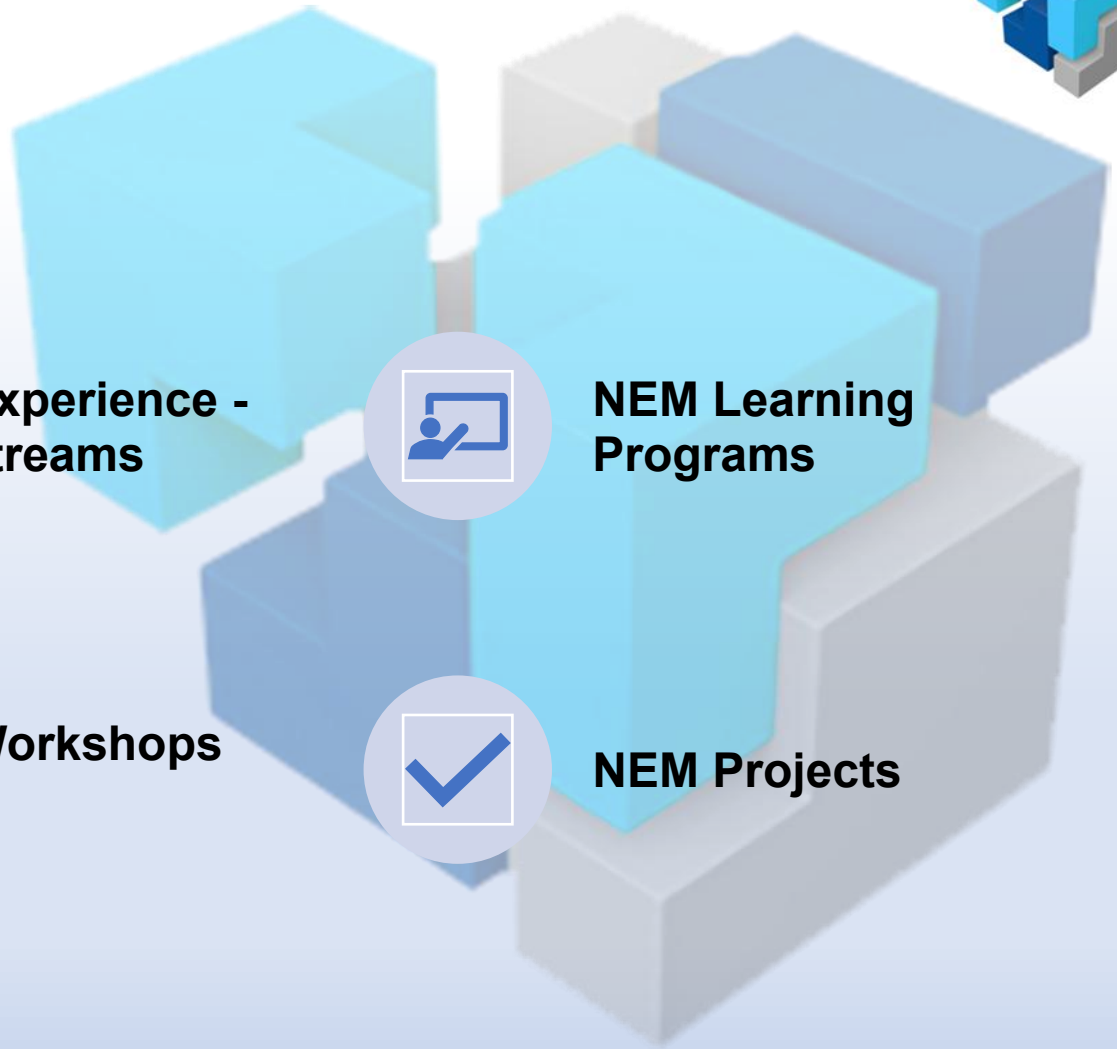

NEM Network – Meetings/Webinars

NEM Experience - Workstreams

NEM Learning Programs

NEM Services

NEM Workshops ++

NEM Projects

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VOLVO

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	Fika		
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NEM Projects

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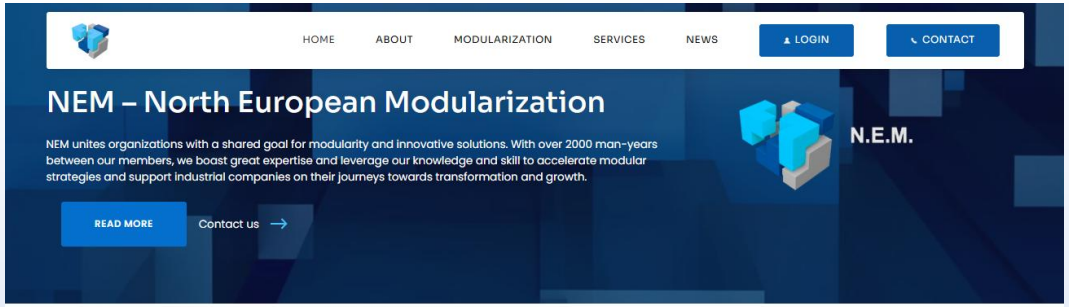
Competence and Experience - Realistic, Pragmatic and Practical

WWW - updates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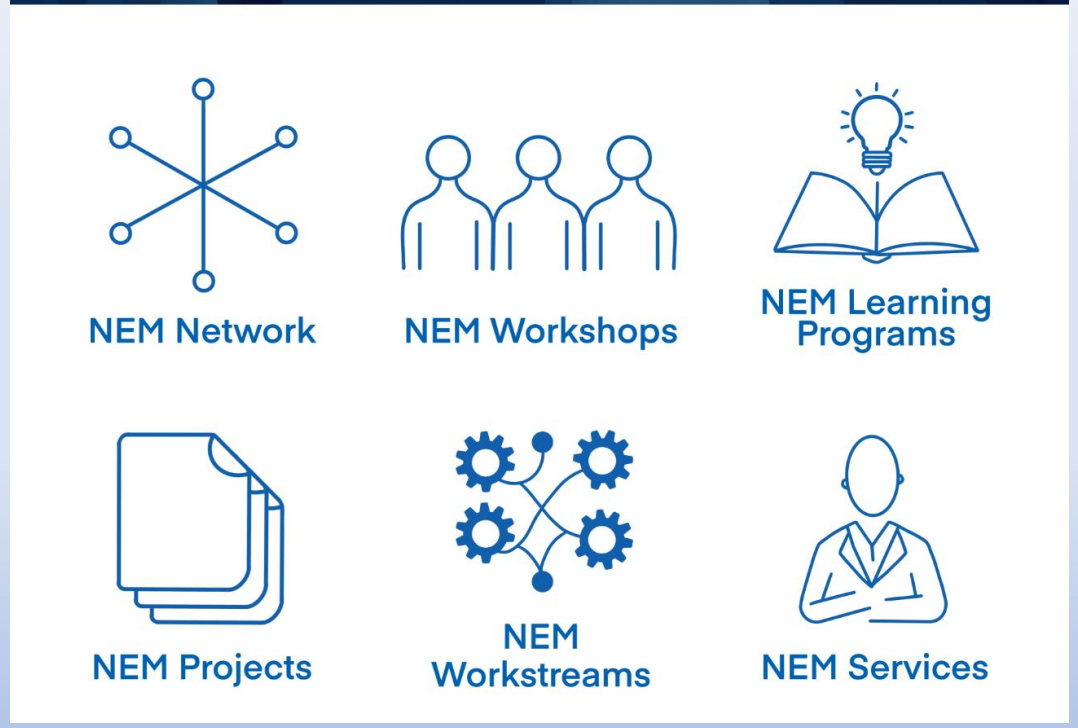
NEM – North European Modularization
NEM unites organizations with a shared goal for modularity and innovative solutions. With over 2000 man-years between our members, we boast great expertise and leverage our knowledge and skill to accelerate modular strategies and support industrial companies on their journeys towards transformation and growth.
READ MORE
Contact us
N.E.M.


NEM Network
NEM Workshops
NEM Learning Programs
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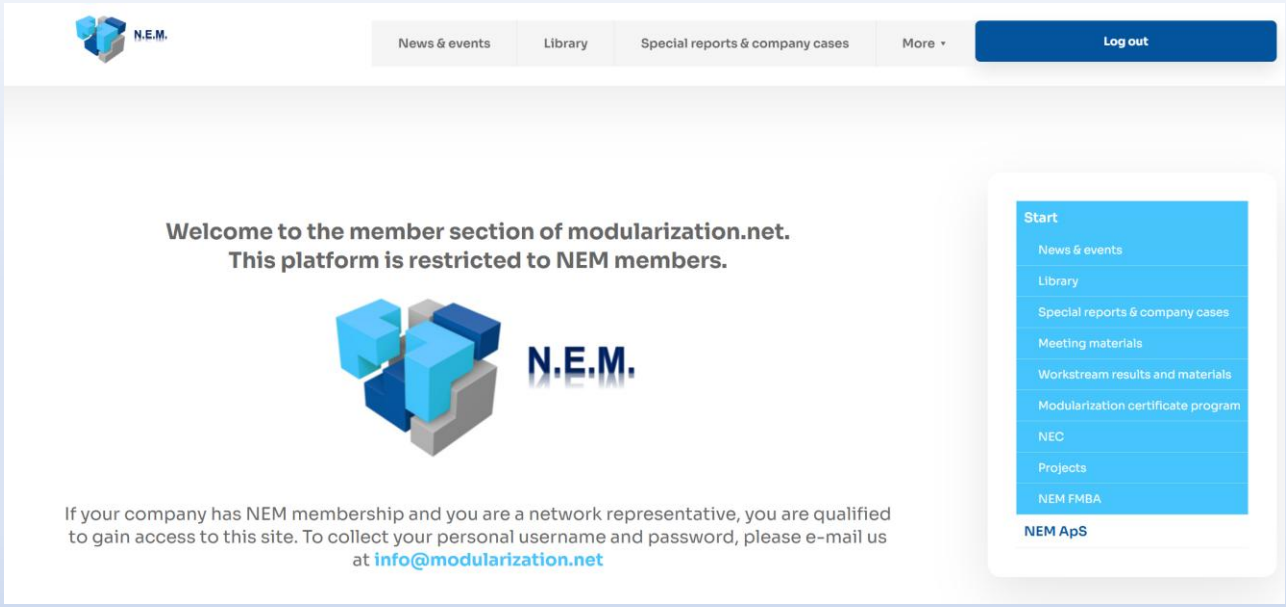
NEM Workstreams
NEM Services


N.E.M.
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More
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Welcome to the member section of modularization.net.
This platform is restricted to NEM members.
N.E.M.
If your company has NEM membership and you are a network representative, you are qualified to gain access to this site. To collect your personal username and password, please e-mail us at info@modularization.net
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Meeting materials
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NEM FMBA
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DTU University

- Hansen, Mortensen & Hvam (2012): Calculation of Complexity Costs – An Approach for Rationalizing a Product Program
- Harlou (2006): Developing product families based on architectures
- Hansen (2013): On the identification of architectures for product programs
- Ghosh et al. (2019): Reusing components across multiple configurators
- Mortensen, Hvam & Haug (2010): Modelling Product Families for Product Configuration Systems with Product VariantMaster
- Mortensen et al. (2010): Making Product Customization Profitable
- Askhøj (2021): Implementing modular product architectures in mid-sized companies
- Christensen (2021): Developing Modular Product and Process Architectures in Engineer To Order Companies
- Løkkegaard et. al (2018): Assessing increased product line commonality's effect on assembly productivity and product quality
- Joergensen, Hvilshøj, Madsen (2012): Designing modular manufacturing systems using mass customisation theories and methods
- Askhøj et. al (2021): Cross domain modularization tool: Mechanics, electronics, and software
- Lomholt Bruun (2015): PLM support to architecture based development
- Bonev (2015): Enabling Mass Costumization in Engineer-To-Order Industries

KTH University

- Williamson (2021): On integrated modularization in heavy-duty truck architecting
- Henriksson, von Yxkull (2017): Controlling product complexity over time in a modular product architecture

MIT University

- Simpson, Siddique, Jiao (2005): Product Platform and Product Family Design: Methods and Applications
- Cameron et. al (2017) Management levers for product platforms
- Cameron, Crawley (2013): Crafting Platform Strategy based on Anticipated Benefits and Costs

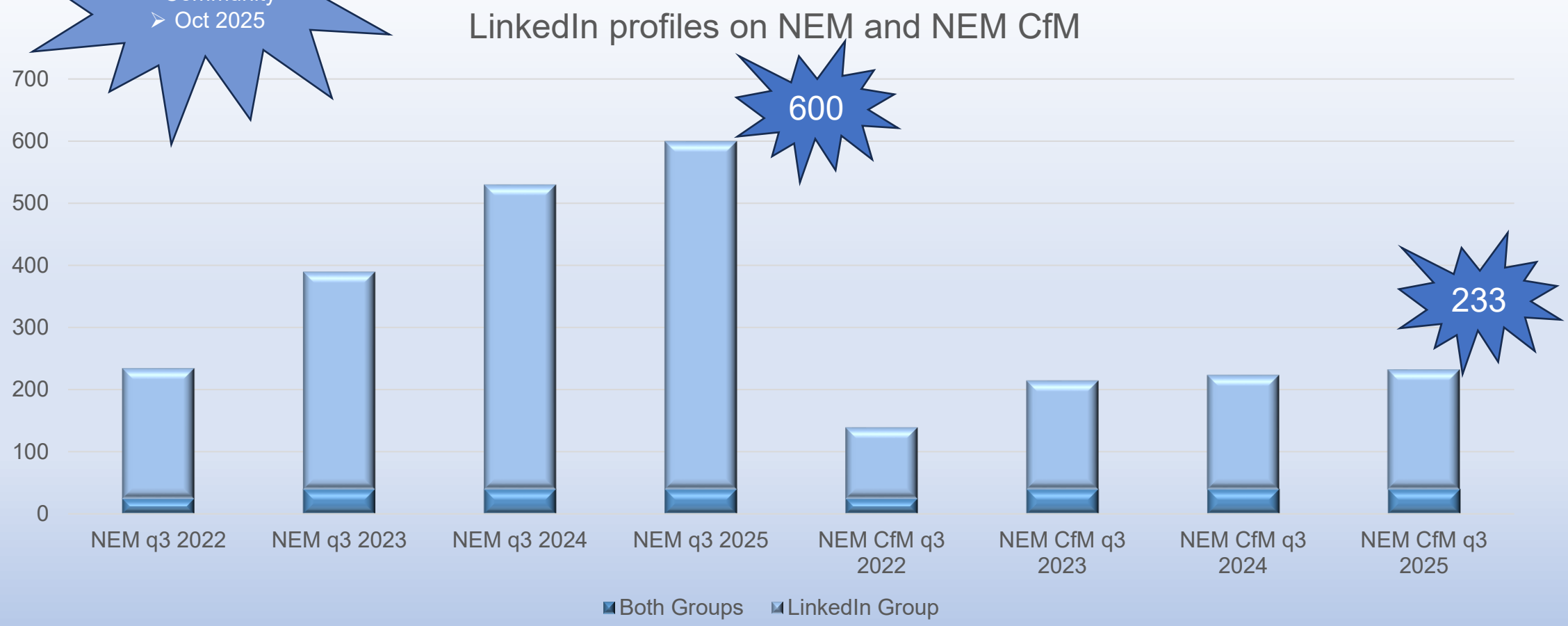
Pennsylvania State University

- Chiu, Okudan (2011): An Investigation of Product Modularity and Supply Chain Performance at the Product Design Stage

SDU University

Good Progress – Profiles on our on LinkedIn sites

- 833 Community
- Oct 2025



Frequent activity on LinkedIn.

NEM - North European Modularization Network
584 followers
5d • Edited •

🚀 Driving Innovation in Production: Partnership with Fraunhofer IPA 🚀
We are thrilled to announce our collaboration with the Fraunhofer Institute for Production, Technology, and Automation (IPA), a global leader in modular ...more

Fraunhofer IPA & N.E.M.

NEM - North European Modularization Network
584 followers
2w • Edited •

🚀 Is your business ready to turn sustainability into a competitive edge?

Join a conference organized by North European Modularization and Jönköping University (Sept 22–23) where we dive into how modularization can boost both profitability and sustainability. 🍸📈

Rethinking your development and manufacturing processes - this event offers:

🔍 Real business cases: from small and midsized companies
🧠 Expert insights and strategies
🛠️ Mini-workshops tailored to your business
🤝 Peer exchange with fellow manufacturers
👥 Perfect for small and medium-sized manufacturing companies ready to take th
next step in the green transition – without compromising on business value.

✓ The conference is free of charge
✓ Dinner is paid separately by participants at cost price

📍 Jönköping University | 🗓️ Sept 22–23

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🗓️ Mark your calendars: NEM Biannual Meeting – October 7–8, 2025
📍 Volvo Facilities, Gothenburg, Sweden ...more

NEM - North European Modu...
600 followers
2w •

🚀 Exciting News from NEM!

We are thrilled to welcome LESER GmbH & Cc ...more

LESER The Safety Valve.com & N.E.M.

NEM - North European Modu...
600 followers
3w •

🚀 Exciting News from NEM!

We are delighted to welcome Nidec Global ...more

Nidec & N.E.M.

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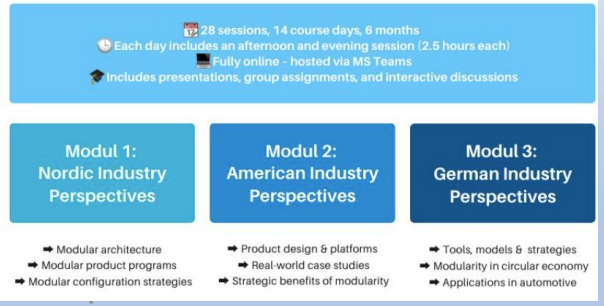
🕒 Last chance to sign up for the NEM Modularization Certificate Program 2025–2026! ...more



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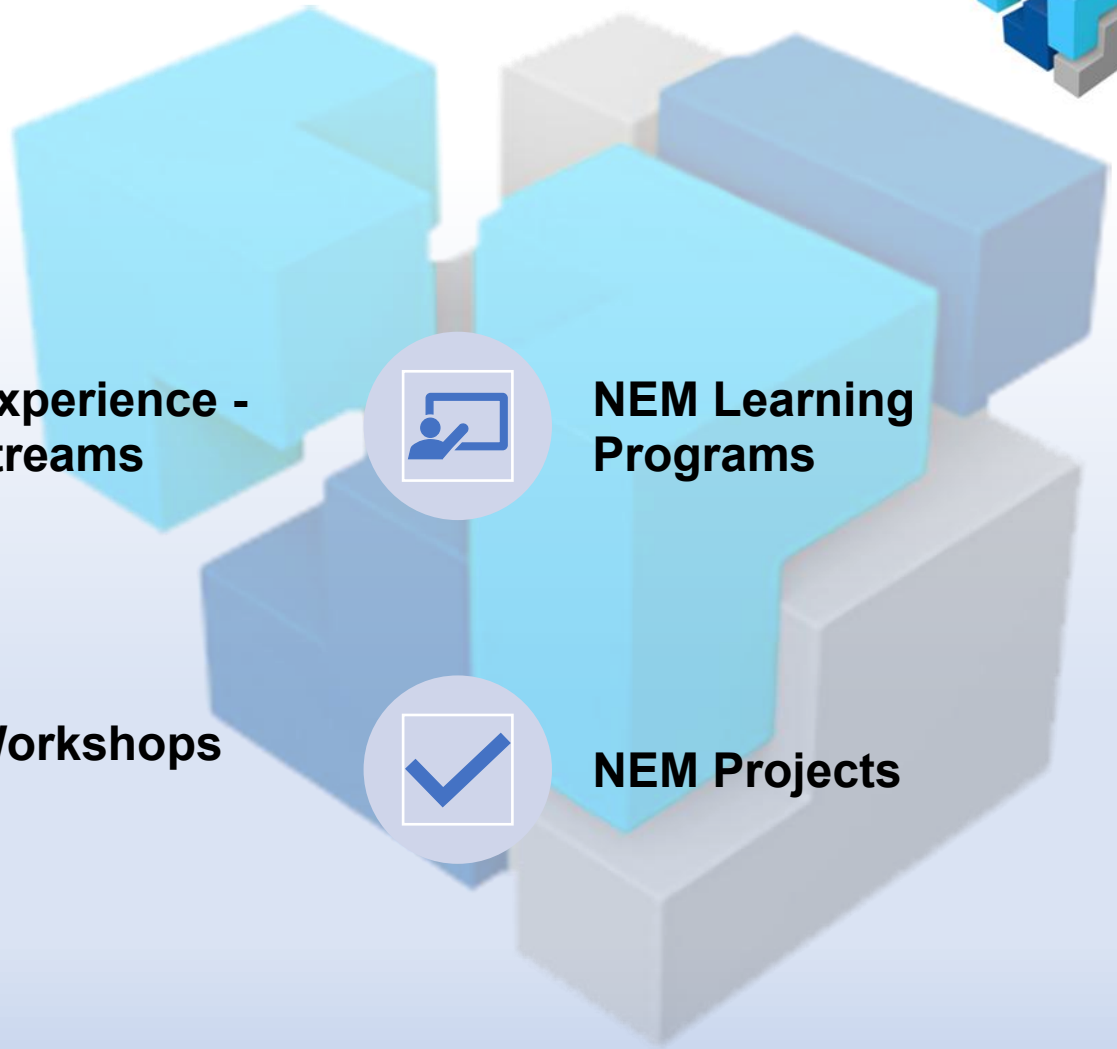

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Welcome to the Volvo Group

Time plan

08.30 Networking

09.00 NEM welcome/introduction

10.00 Fika

10.30 Volvo Company introduction

11.30 Lunch

12.15 Bus transfer to Tuve Plant

13.00 Manufacturing plant, tour & presentation

15.00 Fika

15.30 Modularization, assembly perspective

16.30 Bus transfer to World of Volvo via Campus Lundby

17.30 World of Volvo/Volvo Museum

18.30 Dinner World of Volvo, Resturant Ceno on Top

08.00 Networking

08.30 Volvo Modularization Journey with Lennart Börjesson

09.30 Fika

10.00 Modularization at Volvo Group Trucks Technology

12.00 or 1230? Lunch

13.30 NEM information, Aimo/new company introduction

15.00 Fika

15.30 NEM information/Wrap up

16.30 Close

Introduction

Joakim Bursell

Chief Engineer – Platform and Architecture
Volvo Group Trucks Technology

Andreas Lundmark

Director, Platform Architecture, AE & Studies
Volvo Group Trucks Technology

Erik Carresjö

Maria Siiskonen

Emil Arvidsson

Cecilia Linner

Robin Persson

Some reminders:

Emergency exit

No foods or beverages in the room

Phones on silent

Welcome to the Volvo Group

Time plan

08.30 Networking	08.00 Networking
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15.30 Modularization, assembly perspective	
16.30 Bus transfer to World of Volvo via Campus Lundby	16.30 Close
17.30 World of Volvo/Volvo Museum	
18.30 Dinner World of Volvo, Resturant Ceno on Top	

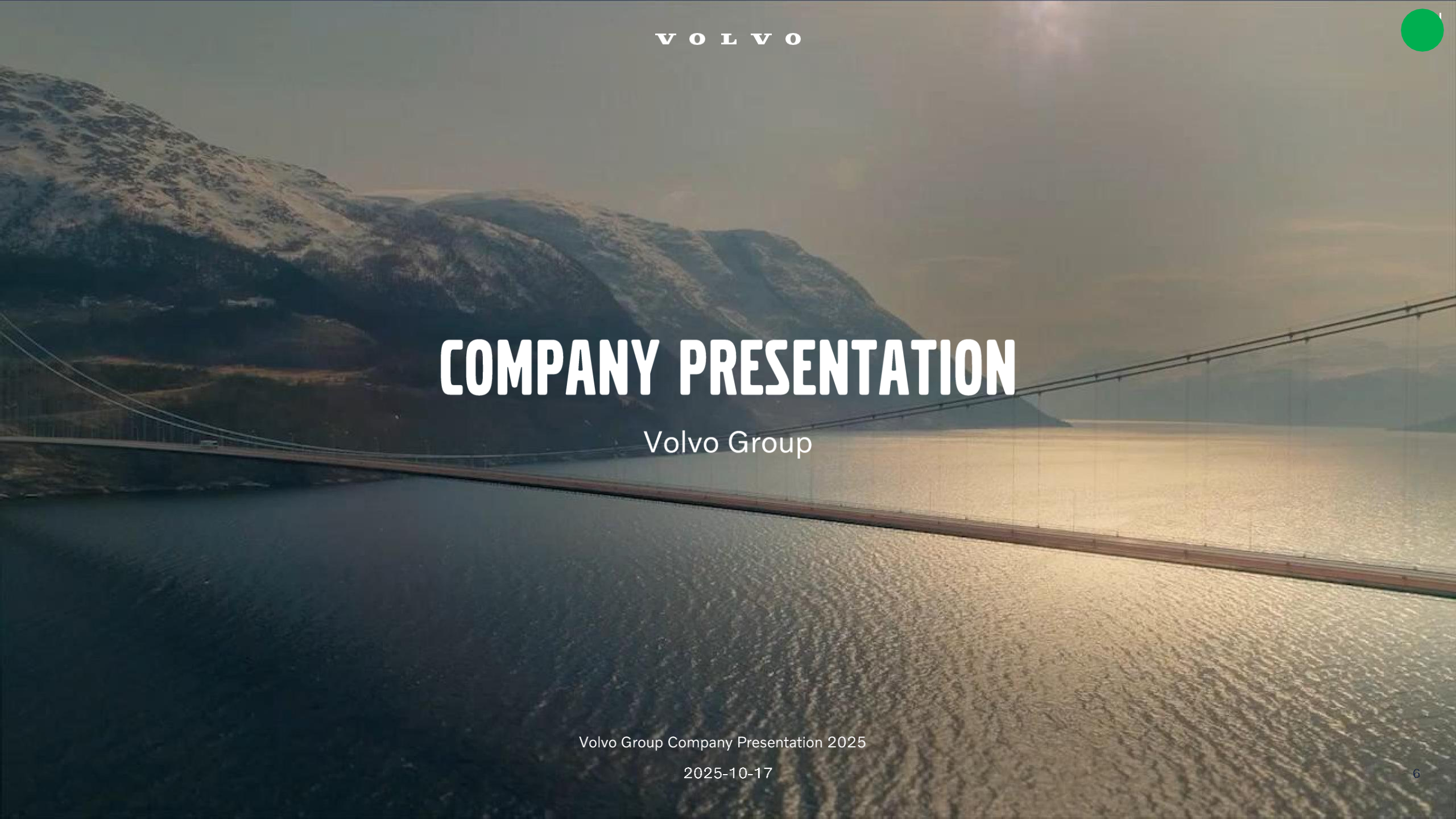
VOLVO

Questions to reflect upon based on what is presented during the two days.

1. How can organizations effectively finance modular platform projects while **balancing short-term** ROI with **long-term** strategic value?

2. What practical strategies can teams use to actively **manage complexity in modular systems**—across architecture, governance, and operations?

3. How can a modular platform support **multiple brands** without compromising brand identity, customer experience, or operational efficiency?



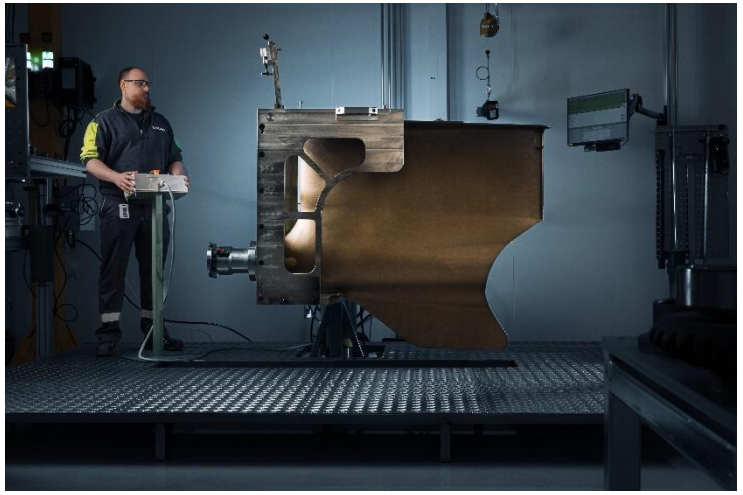
COMPANY PRESENTATION

Volvo Group

What we do

Volvo Group offers trucks, buses, construction equipment, power solutions for marine and industrial applications, financing and services that increase our customers' uptime and productivity.

We develop and offer electrified and autonomous solutions for the benefit of customers, society and for the environment.

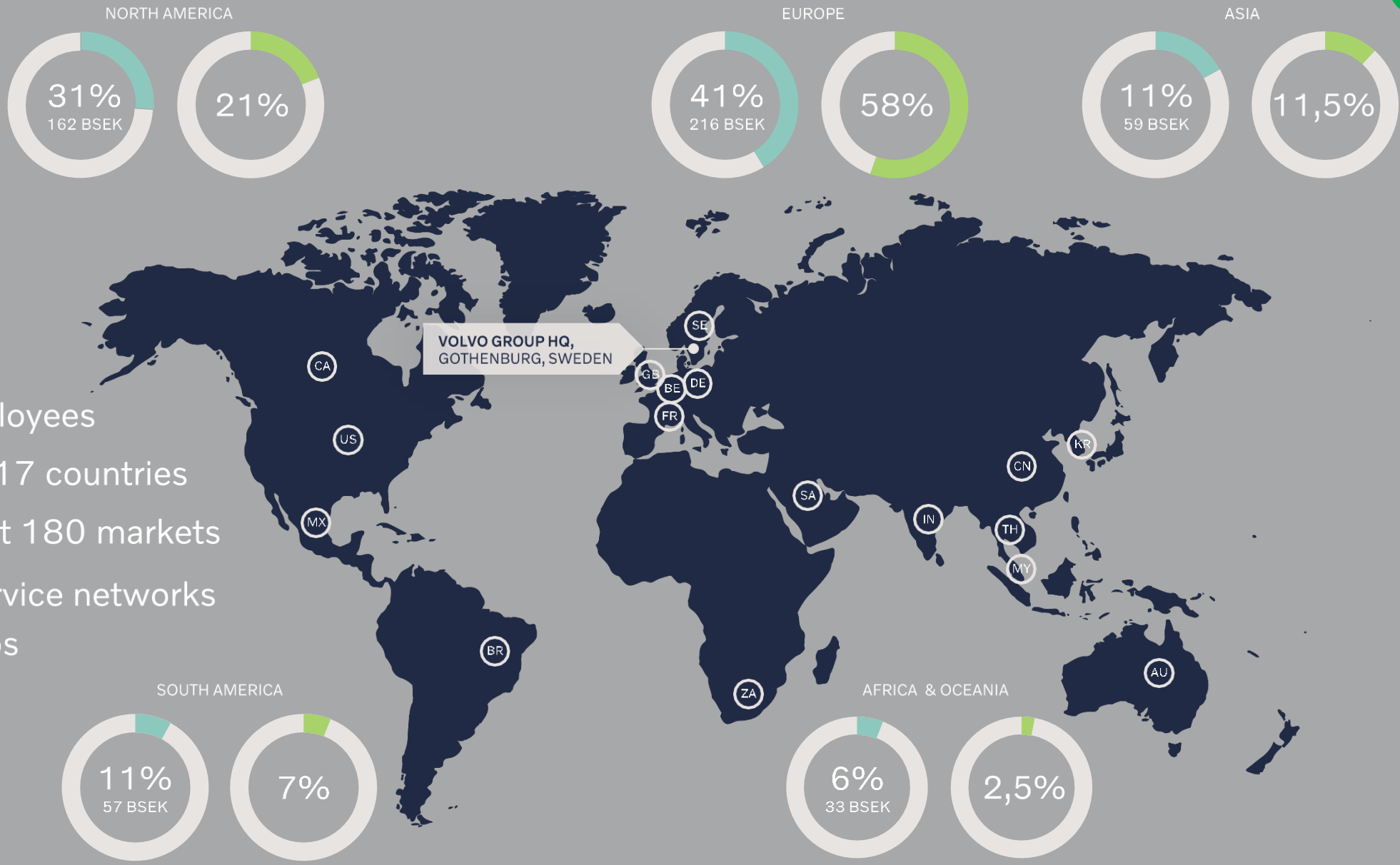


Our brands

Volvo Group’s brand portfolio consists of several distinct brands, targeting a variety of customers and segments.

Global presence

- → 102,000 employees
- → Production in 17 countries
- → Sales in almost 180 markets
- → Worldwide service networks and dealerships



Share of net sales by market (2024) · Share of total employees (2024) · Countries with Volvo Group production

Innovative since 1927

Snapshots of a history of innovation and sustainability focus.

1927
Safety is put in focus in the very first year of Volvo's history.

1959
The three-point safety belt is invented.

1966
The world's first articulated hauler sees the light of day.

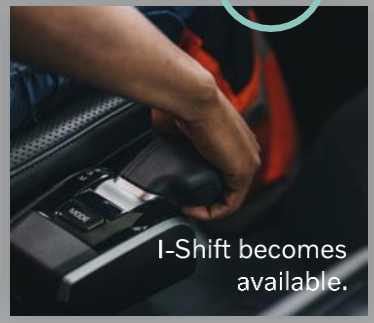
1972
Environmental care becomes a core value for Volvo.

1976
The Lambda Sond is presented.

1990
The Volvo Environment Prize is incepted.

1995
Volvo Trucks introduces driver airbags in heavy-duty trucks as a world first.

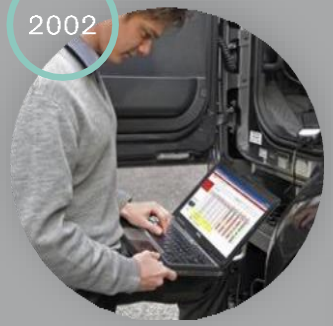
2001
I-Shift becomes available.



2004

Volvo Penta's revolutionary IPS system is revealed.

2002



Infomax from Renault Trucks premieres.

2005

V-Eagle – Volvo Group's LGBTQ+ network is established.

2007

The world's first carbon neutral vehicle manufacturing plant opens in Ghent.

2010

Volvo Group joins WWF's Climate Savers program.

2015

The ElectriCity project takes place in Gothenburg

2013

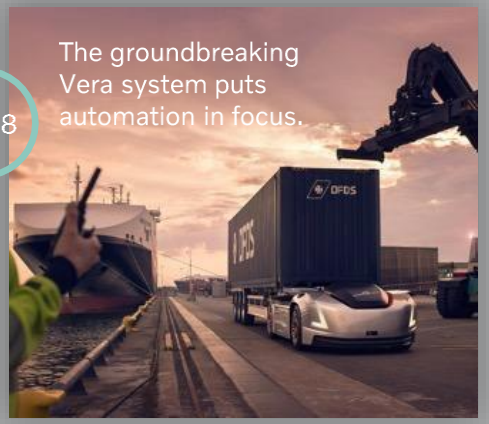
Launch of Volvo Dynamic Steering.

2018

Results from the Electric Site research project shows a 98% reduction in CO_2 emissions.

2018

The groundbreaking Vera system puts automation in focus.



2020

Volvo Group commits to the goals of the Paris Agreement.

2022

Volvo Group starts series production of electric heavy-duty trucks – completing the range.

Expanding portfolio since 1915

1915

Volvo trademark started by SKF ball-bearing company

AB Volvo started as the first car was built.

1927

Volvo acquired White trucks

1981

1928

First truck was built.

2001

Renault trucks and Mack trucks becomes part of AB Volvo.

2007

Nissan diesel (later UD trucks)

2008

EICHER

VE Commercial Vehicles. 50% Joint venture with Eicher

2013

Dongfeng Commercial Vehicle. 45% joint venture with Dongfeng Motor Corporation

DONGFENG Trucks

2021 - 2025

Partnerships

cellcentric

cespira

coretura

BUSINESS AREAS

Volvo Trucks | Renault Trucks | Mack Trucks | Volvo Construction Equipment | Volvo Buses | Volvo Penta | Volvo Energy | Volvo Autonomous Solutions | Volvo Financial Services

Volvo Trucks

One of the largest premium truck brands in the world.

→ Medium and heavy-duty trucks.

→ Main production in Sweden, Belgium, Brazil and the USA.

Volvo FE Electric

Volvo FMX Electric

Volvo FH Aero

Volvo VNL

Renault Trucks

One of the world leaders in heavy goods vehicles. (Internal Combustion Engine and Battery Electric)

→ Light, medium and heavy-duty trucks.

→ Main production in France.

Renault Trucks E-Tech D Wide

Renault Trucks E-Tech T

Renault Trucks Master

Mack Trucks

One of North America's largest truck manufacturers.

→ Heavy-duty trucks, engines, transmissions and axles.

→ Medium-duty trucks.

→ Main production in the USA.

Mack Anthem

Mack LR Electric

Mack MD

Volvo Construction Equipment

A leading provider of construction equipment and innovative solutions.

→ Brands: Volvo, Rokbak.

→ Rigid & articulated haulers, wheel loaders, excavators & road equipment.

→ Main production in Sweden, Germany, South Korea and China.

Volvo A60H

Volvo ECR 25 Electric

Rokbak RA40 RA30

Volvo Buses

Leader in the development of sustainable transport solutions for public transport.

→ Premium city- and intercity buses, coaches and chassis.

→ Brands: Volvo and Prevost.

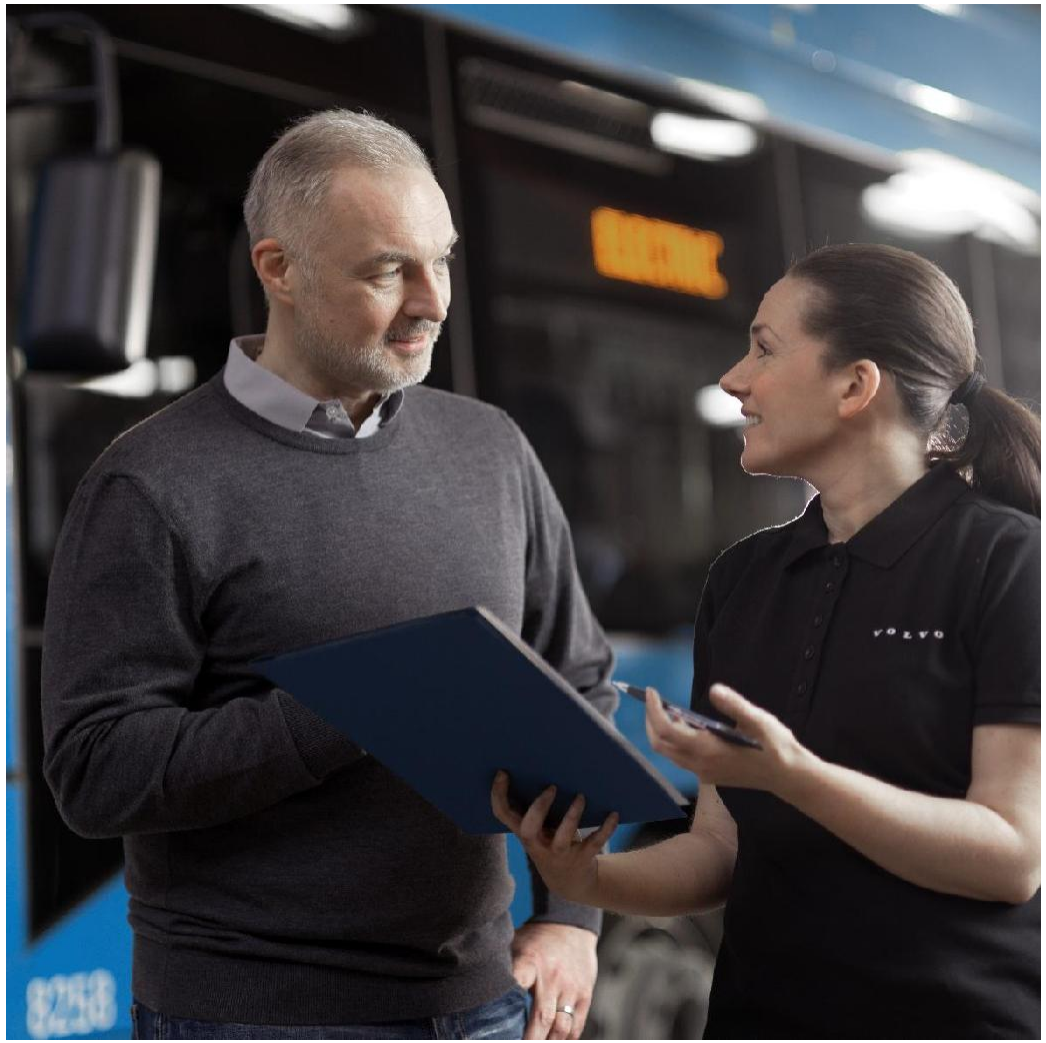
→ Main production in Sweden, Mexico, Brazil and Canada.

Volvo 7900 Electric

Volvo 9800

Volvo BZL Electric

Prevost X3-45



Volvo Penta

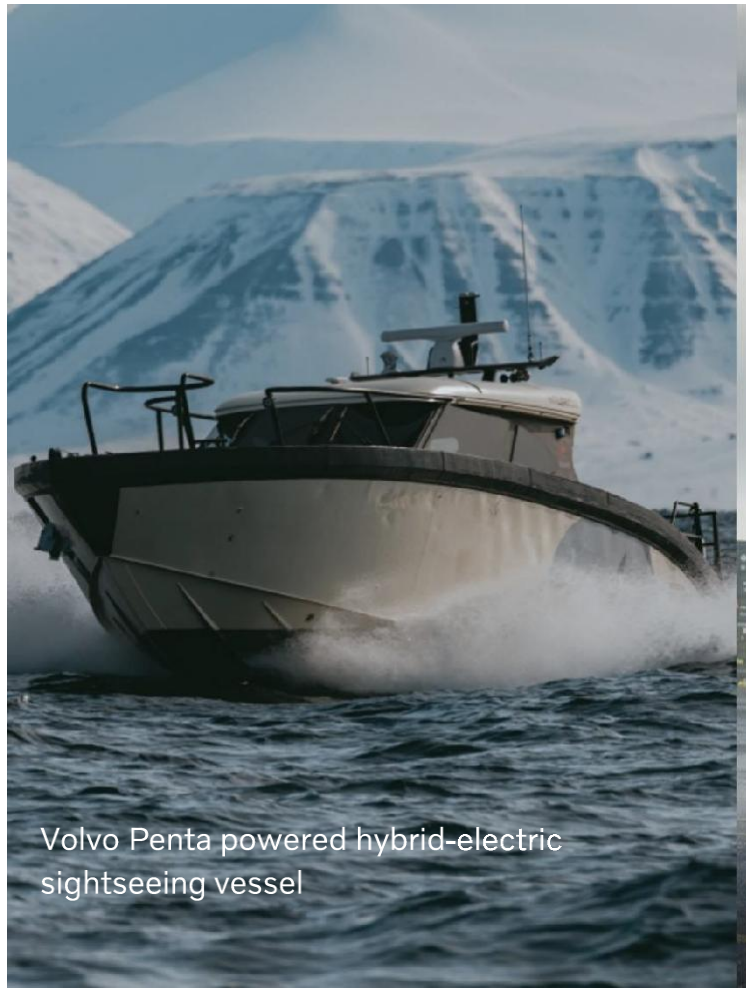
World-leading supplier of power solutions to marine and industrial applications.

→ Engine- and power systems for marine and industrial applications.

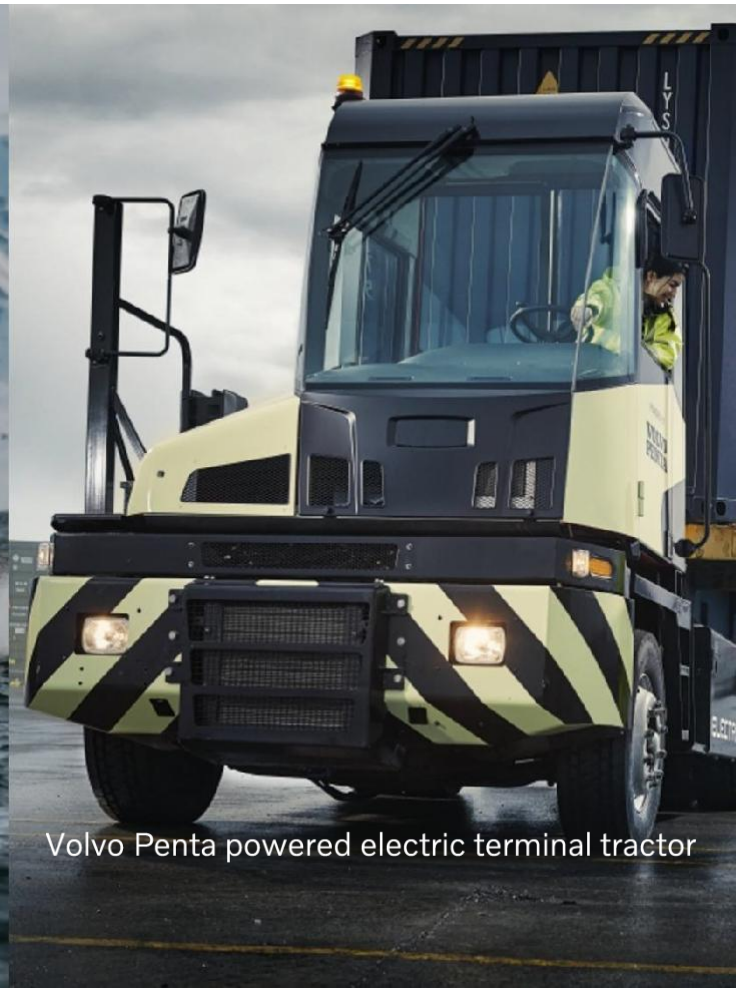
→ Production in Sweden and in USA.

D16 engine

Volvo Penta IPS



Volvo Penta powered hybrid-electric sightseeing vessel

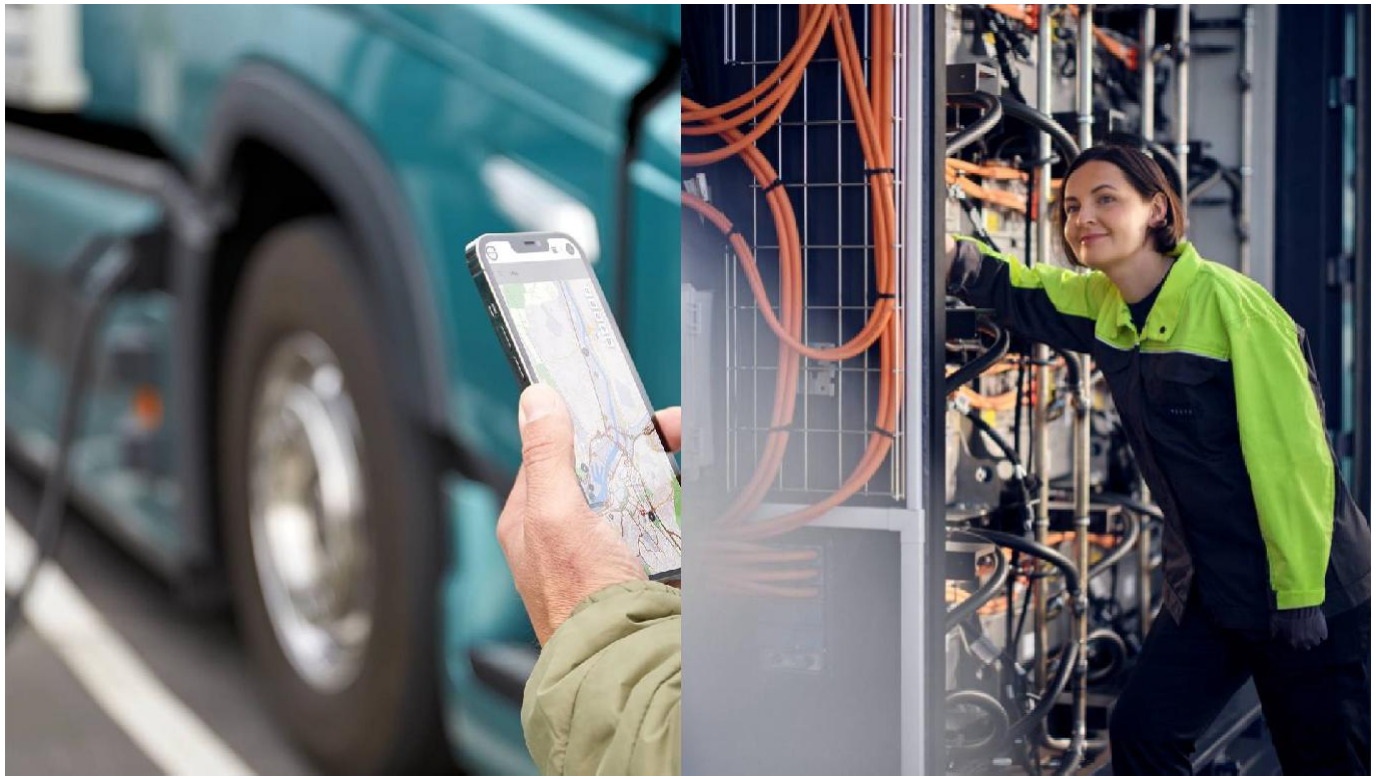


Volvo Penta powered electric terminal tractor

Volvo Energy

Volvo Energy is dedicated to accelerate electrification and drive circularity for a better tomorrow through:

- Charging value chain: ensure reliable access to charging, by supporting the Volvo Group brands' sales and services of electrified vehicles and machines.
- Battery value chain: capture Battery Energy Storage System (BESS) market potential, with an attractive and sustainable circular business model for both first and second-life batteries.
- Enabling and accelerating the Volvo Group's overall sustainability ambitions.



Volvo Autonomous Solutions

Volvo Autonomous Solutions is transforming the movement of goods through efficient, sustainable, and safe autonomous transport solutions within selected industry verticals.

- → Industry verticals: Hub-to-Hub highway trucking and Quarries and Mining
- → Complete Autonomous Transport Solution based on Transport-as-a-Service (TaaS)
- → In-house developed full-stack solution for confined areas, industry-leading partners for Hub-to-Hub
- → Current deployments in Norway, Sweden and the United States

Volvo VNL Autonomous

Autonomous Volvo FH

Volvo Financial Services

Volvo Group's captive finance provider committed to customer success

→ Works collaboratively with all Volvo Group brands and business areas as an integral part of Volvo Group's total offer

→ A full range of financing, rental, insurance and other services and solutions for the truck, construction equipment, bus and marine and industrial engine markets

→ Accelerating sustainable solutions for customers

THE STRENGTH OF THE VOLVO GROUP

Creating synergies

Harnessing shared resources

Volvo Group has global organizations for product development, manufacturing and purchasing. This is one of the ways in which we can create synergies and utilize Volvo Group’s extensive and shared resources in the best possible way.

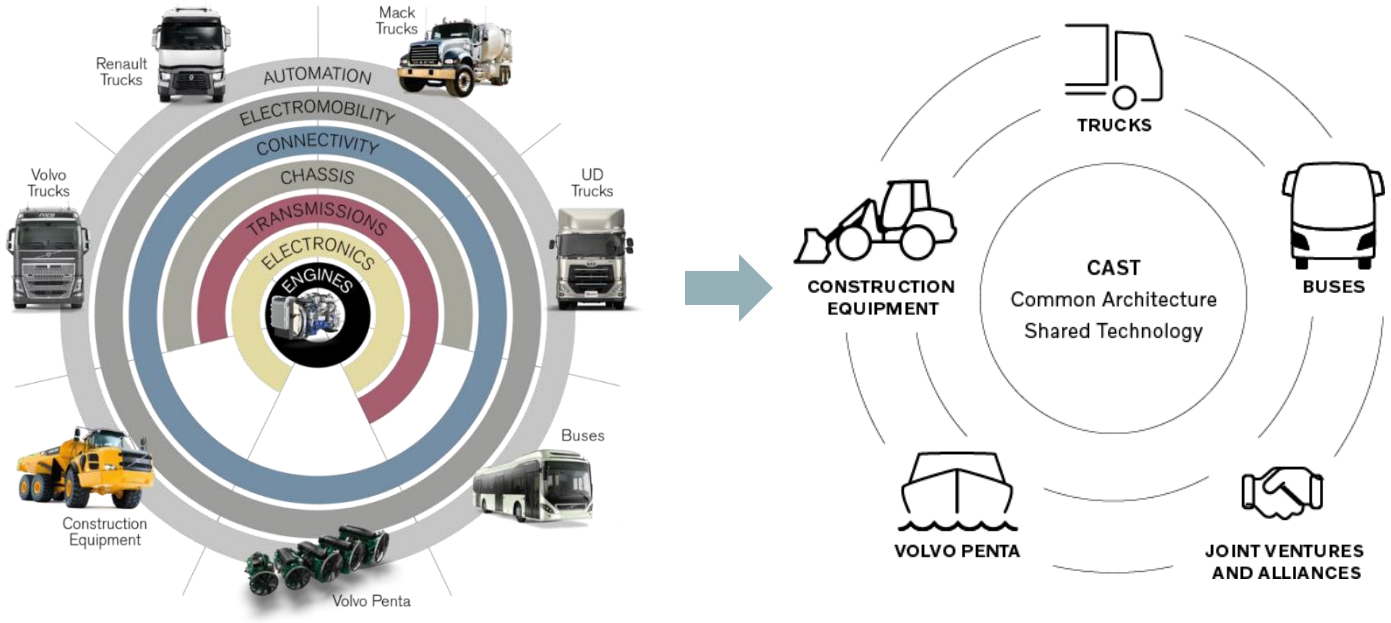
PURCHASING

OPERATIONS

TECHNOLOGY

CAST – Common Architecture & Shared Technology

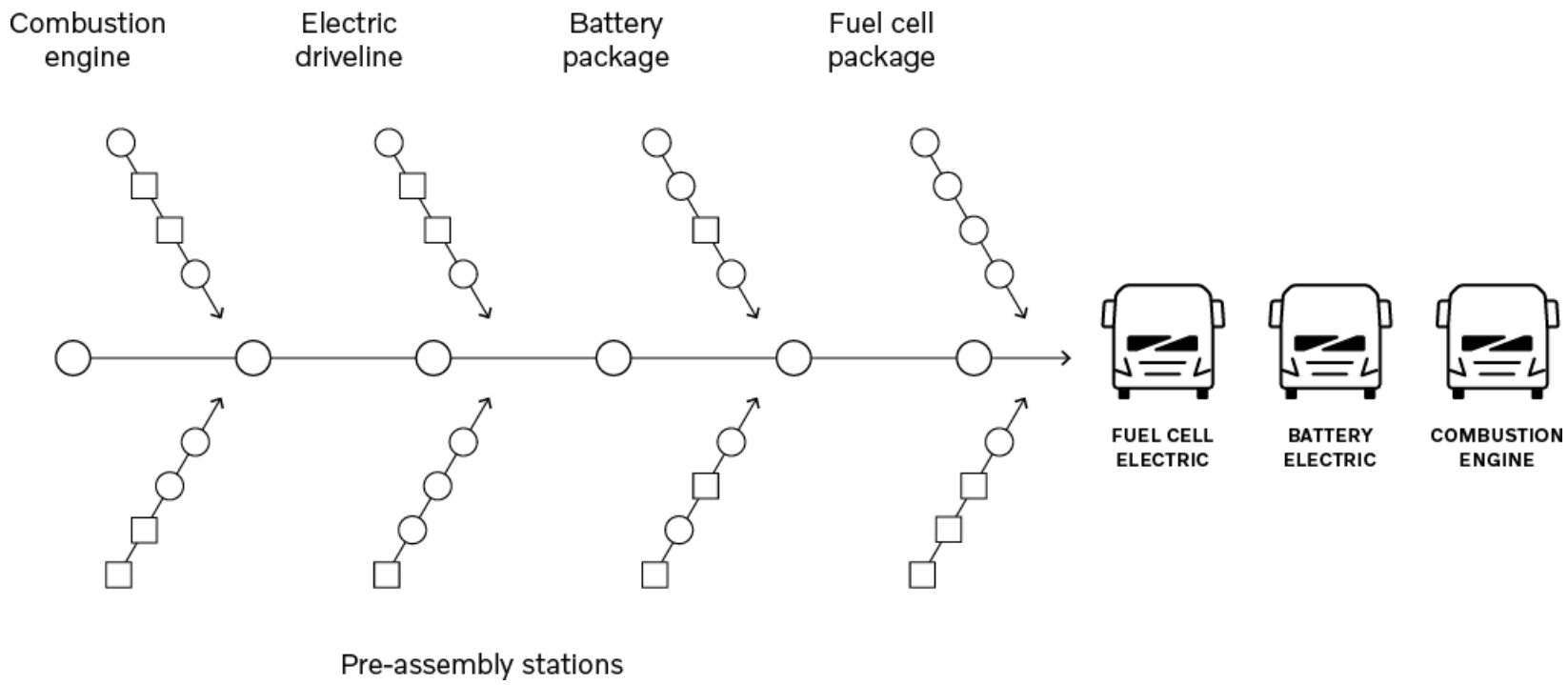
A modular approach that benefits all business areas



- Volvo Group and its partners can benefit from the Group's modular platform: Common Architecture & Shared Technology (CAST).
- The ambition with CAST is to develop a competitive set of modular products and services that are easy to integrate, that meet future legal, market and society needs, and that exceed customer expectations.
- This modular approach enables Volvo Group to share technology for engines, electronics, transmissions, chassis, connectivity, electromobility and automation among its business areas.

Mixed model assembly

Volvo produces electric trucks on the same lines as its conventional trucks, which gives high production flexibility and efficiency gains.



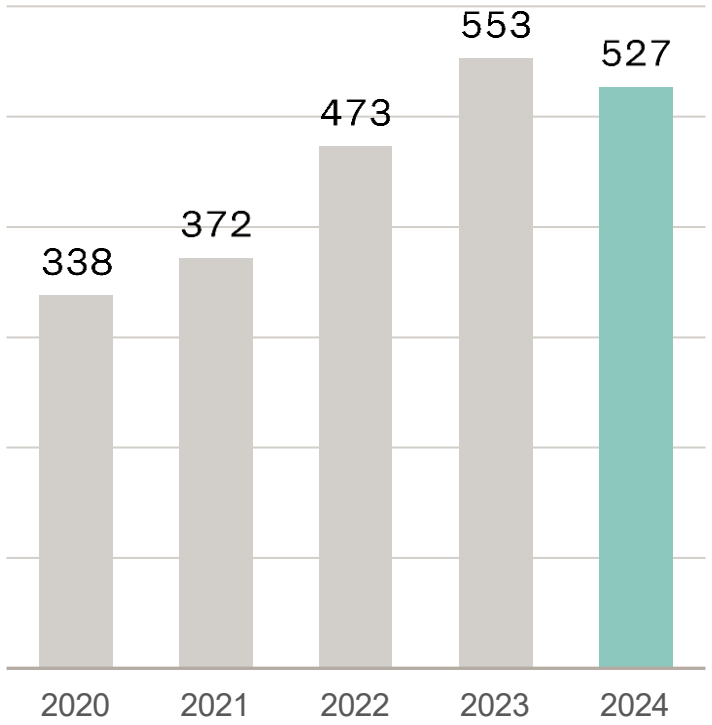
Partnership is the new leadership

Keeping up with the latest development is an essential part of staying successful – and one which is impossible to do on your own. So, Volvo Group engages in numerous collaborations and partnerships.

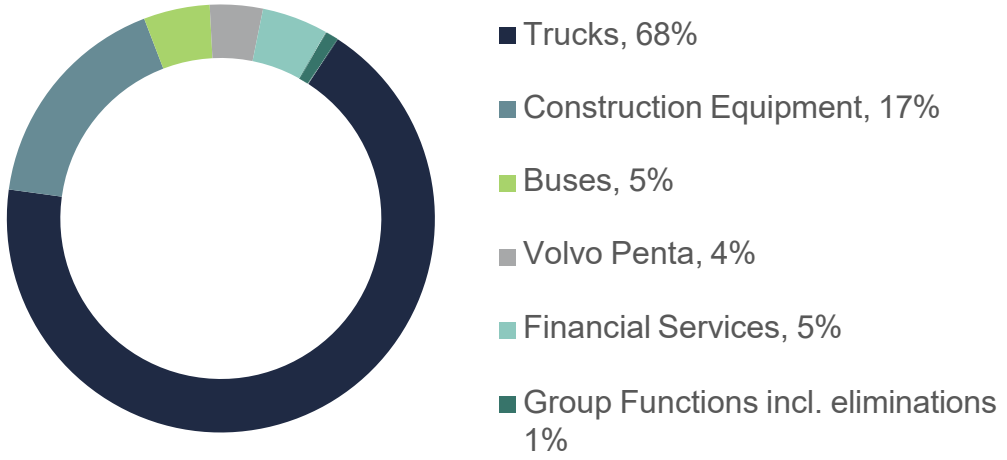
FINANCIAL PERFORMANCE

Net sales

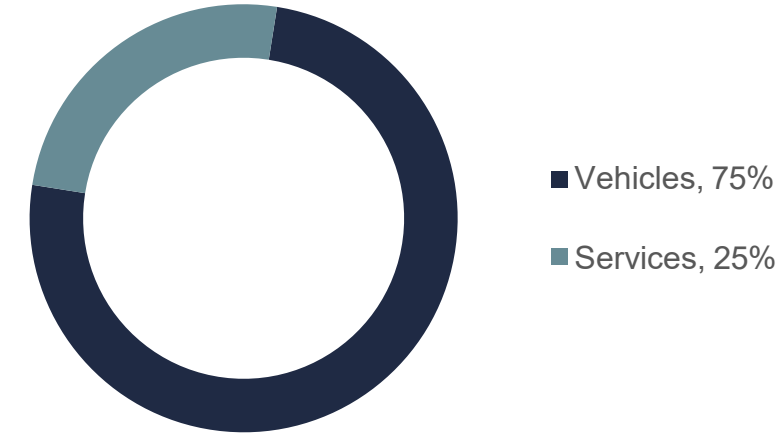
Volvo Group's net sales 2020-2024, BSEK.



Share of net sales by segment

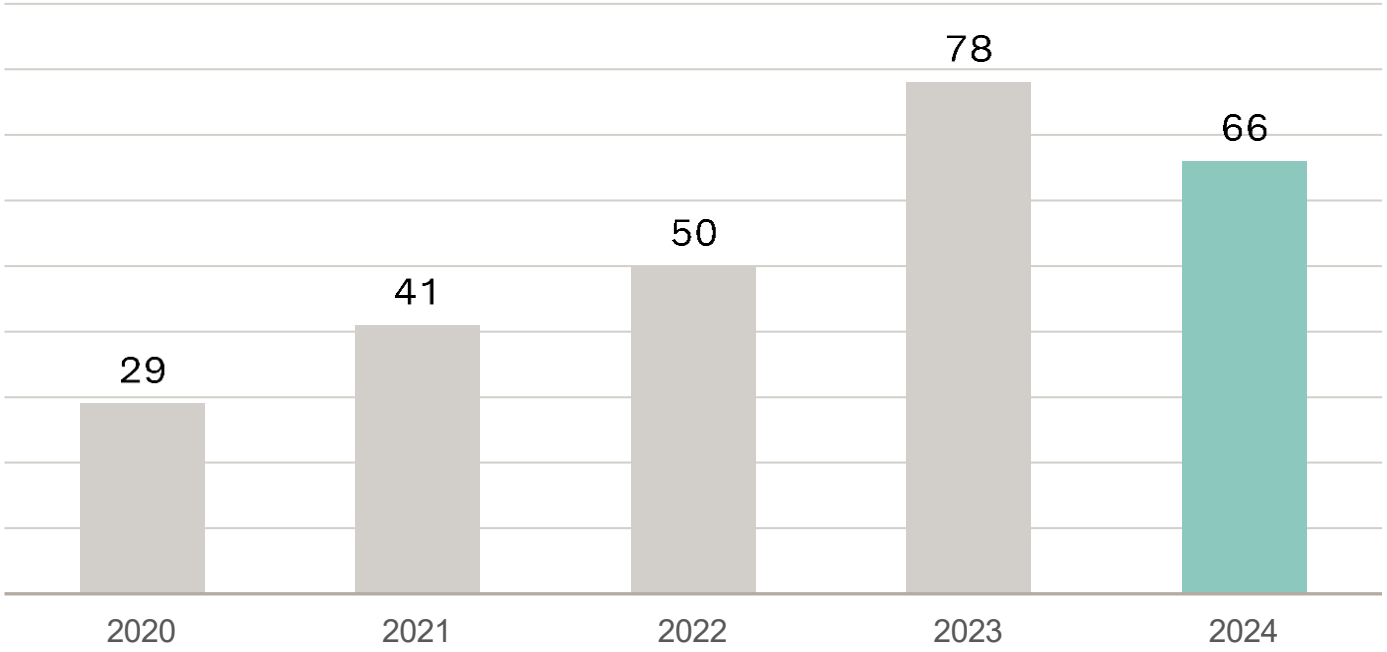


Share of net sales by revenue type



Adjusted operating income

Volvo Group's adjusted operating income 2020–2024, BSEK.



Adjusted operating margin:

2024: 12.5%

2023: 14.0%

2022: 10.7%

2021: 11.0%

2020: 8.4%

Volvo Group

102,000 employees | 180 markets

9 business areas | 15 brands

Sharing resources

Safer | Cleaner | More efficient

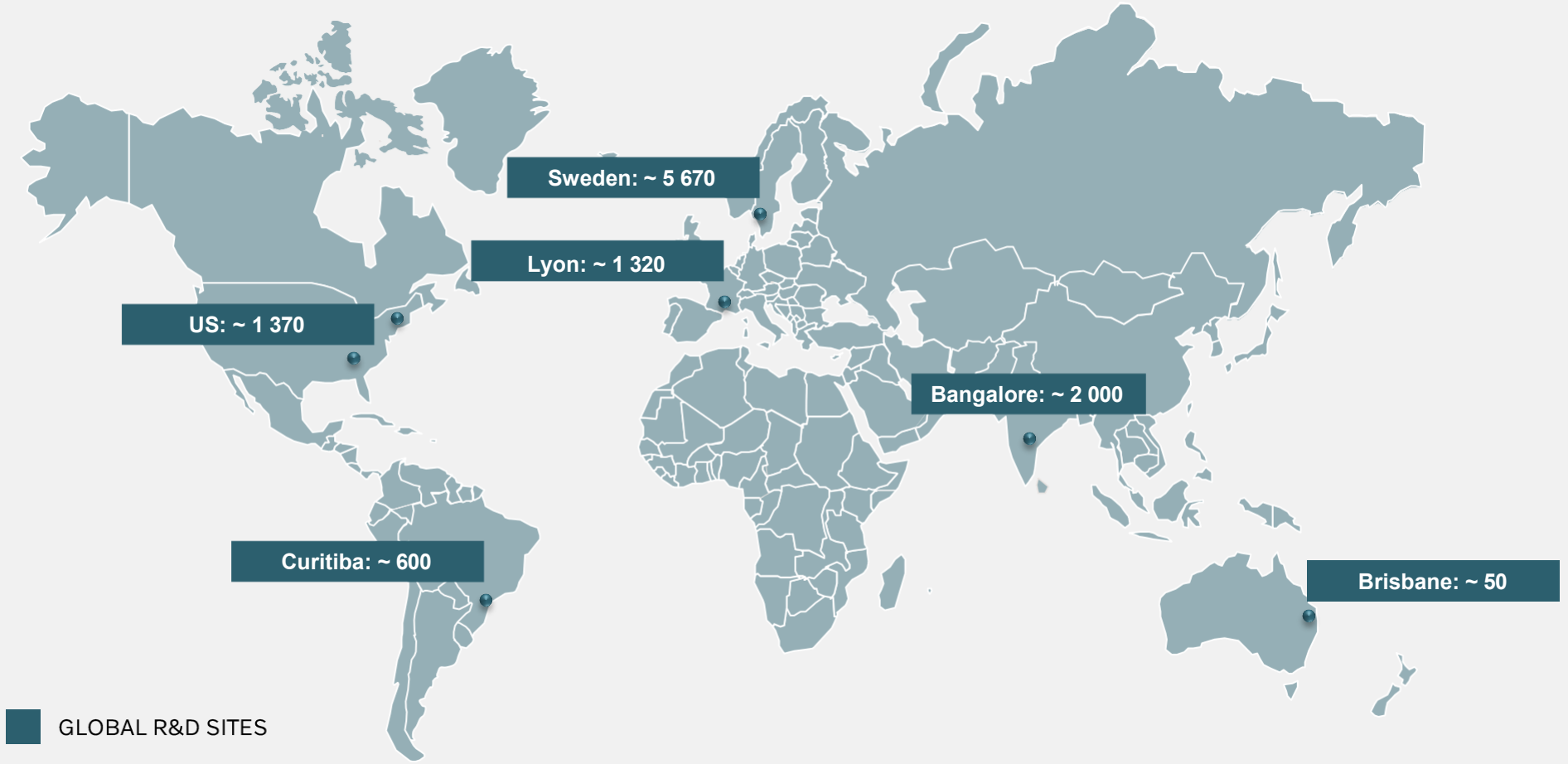

VOLVO
GROUP TRUCKS TECHNOLOGY

Group Trucks Technology

- We maximize the output from the Volvo Group R&D investment. We do this by balancing common and brand unique solutions and by mastering both well-known and new technologies.
- We provide state-of-the-art research, engineering, product planning and project execution to final delivery of complete products and support the products in the aftermarket.
- We assure product leadership for all Volvo Group brands. By offering technologies for different brands, we address many different customer and market segments in mature as well as growth markets.
- Empowerment, accountability and simplicity are key principles guiding us in our daily work.

Global cooperation in our R&D system – every day

~11,000 GTT PROFESSIONALS



State-of-the-art facilities and labs

ACROSS THE GLOBE

06 | **GLOBAL R&D SITES**

Research and development sites around the world and in close cooperation

06 | **PROVING GROUNDS**

GTT has six proving grounds where intensive tests are carried out for all products

Over 18 | **STATE-OF-THE-ART LABORATORIES**

Our engineers concentrate on innovation, our state-of-the-art facilities allow them to do just that

04 | **DESIGN STUDIOS**

Volvo Group product and services design is carried out in studios by a diverse team of highly skilled professionals

Over 22 | **WORKSHOPS**

Professionals with deep customer knowledge at workshop focus on complete products, cross-collaboration, continuous improvements, verification and validation and bring hands-on truck experience

TRUCK PRODUCTS

Volvo trucks

Volvo FH16 Aero

Volvo FH Aero

Volvo FH16

Volvo FH

Volvo FMX

Volvo FM

Volvo FE

Volvo FL

Volvo trucks

North America

Volvo VNL

Volvo VNR

Volvo VNX

Volvo VHD

Volvo VAH

Renault trucks

Renault Trucks T High

Renault Trucks T

Renault Trucks K

Renault Trucks C

Renault Trucks D Wide

Renault Trucks D

Mack trucks

Mack Anthem®

Mack Pioneer™

Mack® Pinnacle™

Mack® TerraPro®

Mack® MD Series

Mack® Granite®

Mack® LR

All truck products

VOLVO

Volvo trucks

VOLVO

Renault trucks

VOLVO

Volvo trucks

North America


Volvo VNL


Volvo VNR


Volvo VNX


Volvo VHD


Volvo VAH

VOLVO

Mack trucks


Mack Anthem


Mack Pioneer


Mack Pinnacle

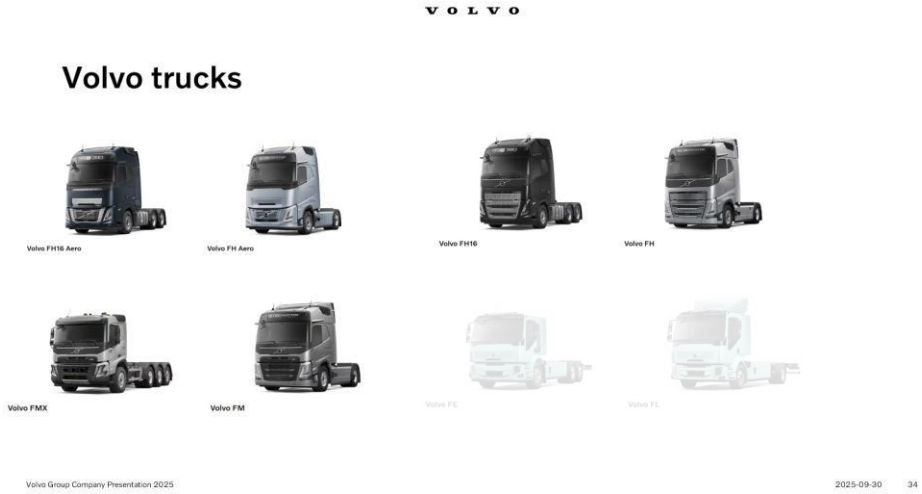
Mack TerraPro

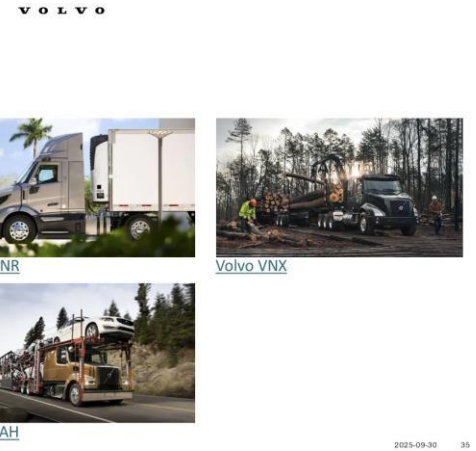

Mack MD Series

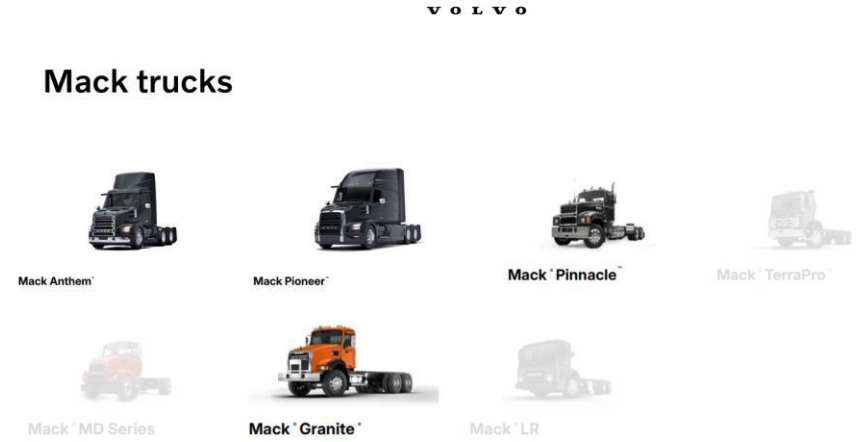

Mack Granite


Mack LR

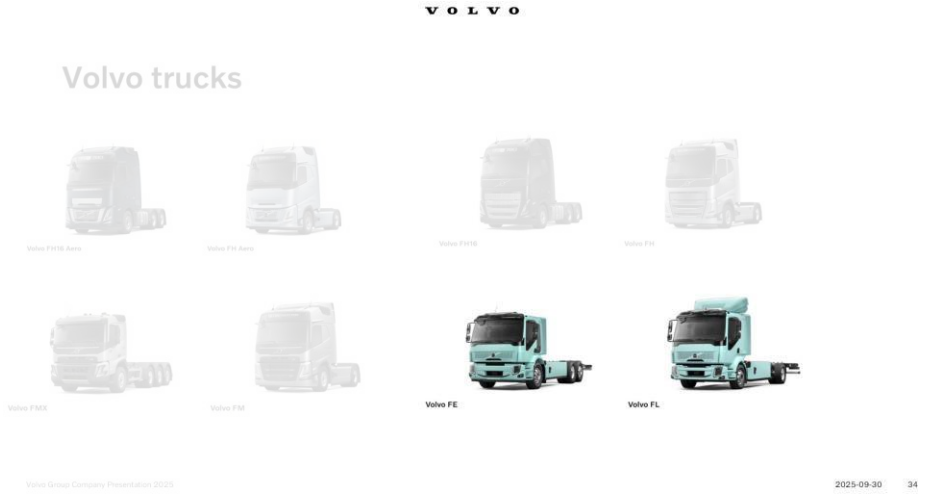
Heavy duty platform



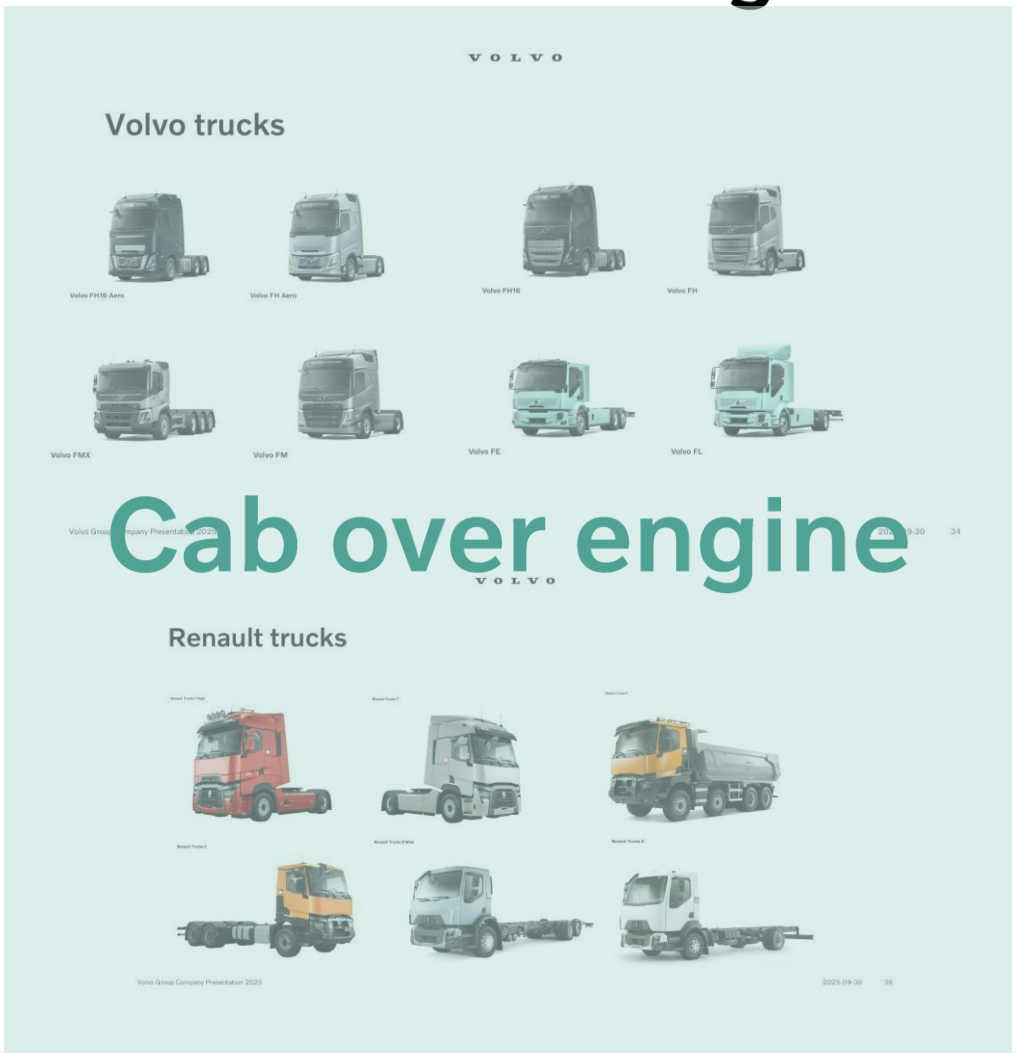


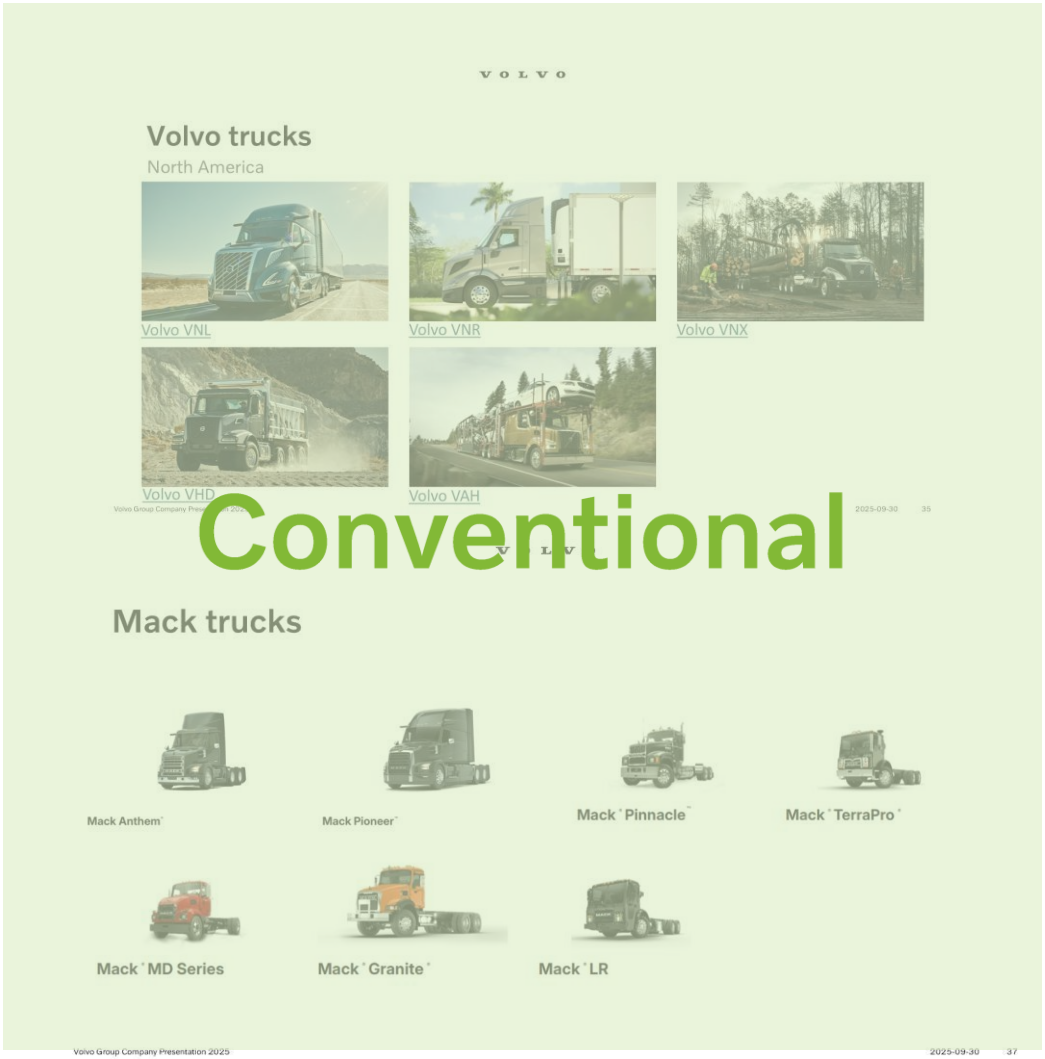


Medium duty platform



Two different ranges

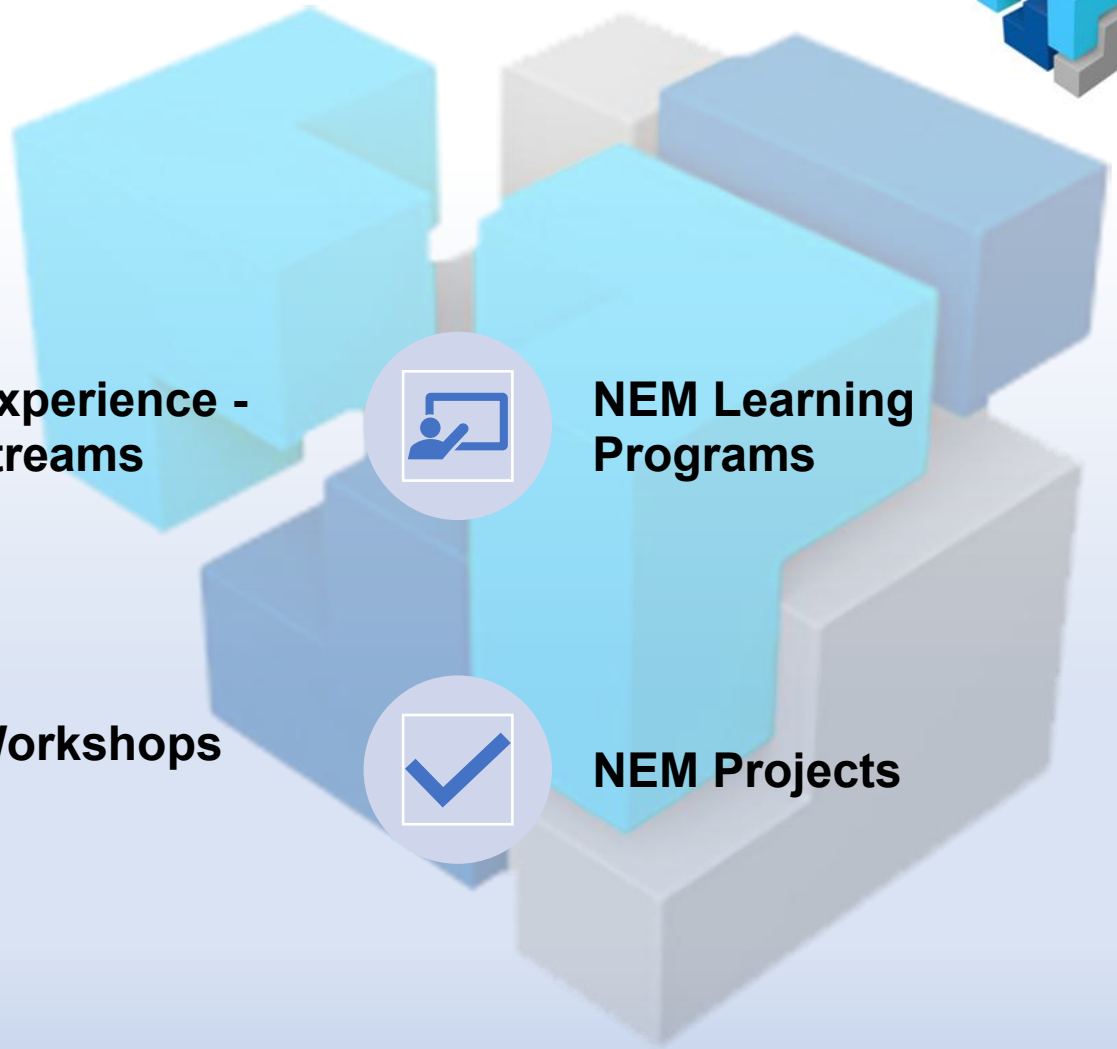




Agenda/time plan

08.30 Networking	08.00 Networking
09.00 NEM welcome/introduction	08.30 Volvo Modularization Journey with Lennart Börjesson
10.00 Fika	09.30 Fika
10.30 Volvo Company introduction	10.00 Modularization at Volvo Group Trucks Technology
11.30 Lunch	12.00 or 1230? Lunch
12.15 Bus transfer to Tuve Plant	13.30 NEM information, Aimo/new company introduction
13.00 Manufacturing plant, tour & presentation	15.00 Fika
15.00 Fika	15.30 NEM information/Wrap up
15.30 Modularization, assembly perspective	
16.30 Bus transfer to World of Volvo via Campus Lundby	16.30 Close
17.30 World of Volvo/Volvo Museum	
18.30 Dinner World of Volvo, Resturant Ceno on Top	

N.E.M.



NEM Network – Meetings/Webinars

NEM Experience - Workstreams

NEM Learning Programs

NEM Services

NEM Workshops ++

NEM Projects

Give and take results

Take

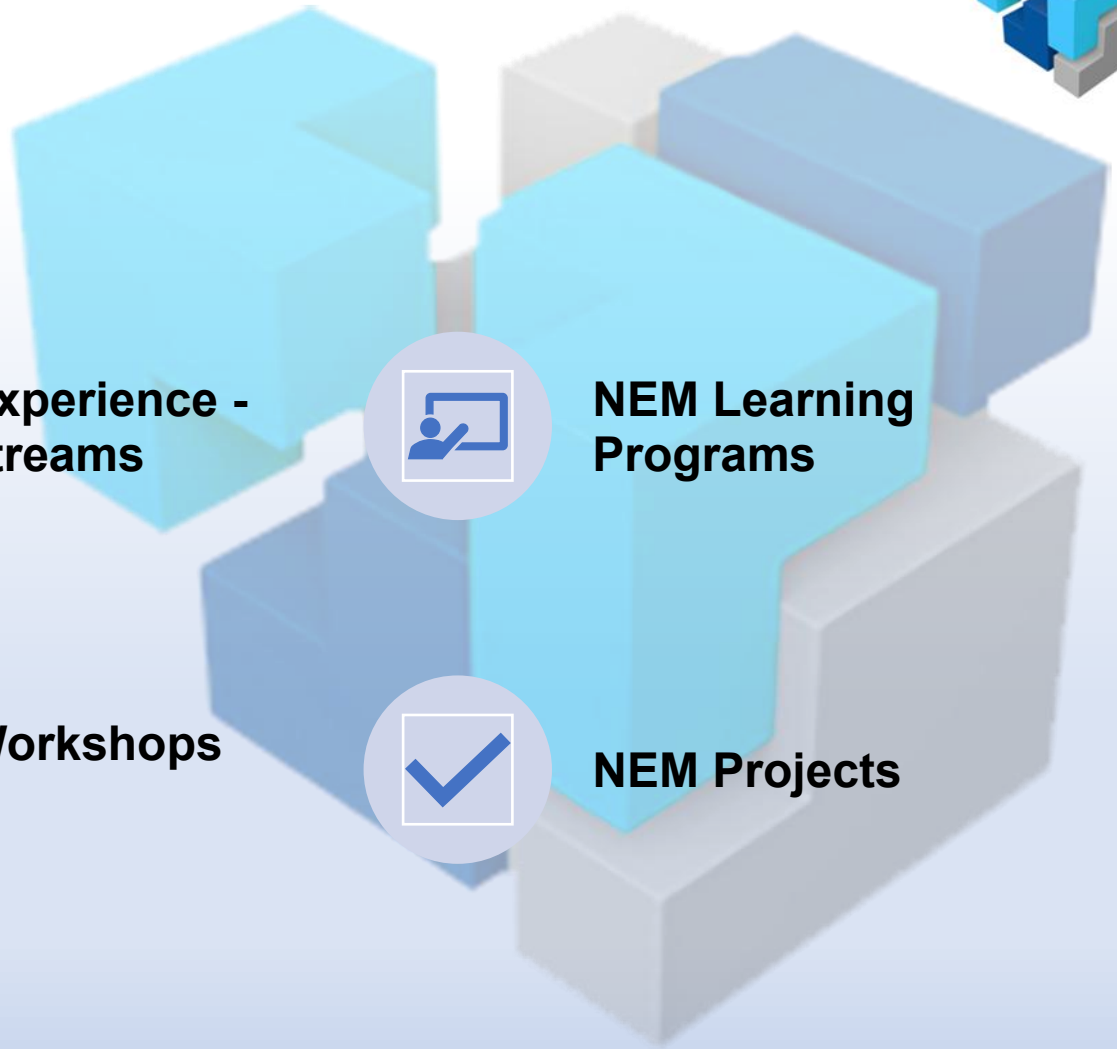
- Long term program – don‘t expect to have things done within 4-5 years
- Common framework is key, common reference
- Tailored system is impressive
- Repeated training is key
- Top down and bottom up approach both important for buy in
- Horizontal line – cross functional – important to serve the customer
- Architecture organisation – long term platform development
- Very clear definition of interfaces
- Spend time to engage in CAST and exchanged knowledge
- CAST is in the anual report - indicates commitment on management level
- PLM system integration
- Organization level is balanced
- Competition enables and motivates new developments
- Production: quiet and without stress, special solution organization, fishbone, advantage of same size product, solve problems in the modular area, production line used for many years
- Variation management close to customer

Give and take results

Give

- Community can help in further organization
- Check if complexity reduction is an option
- Learn something from software modularization in the network
- PLM to be consolidated taking in modular level
- Balancing short term gains vs long term strategies - further input needed
- Brand distinction – input needed
- Commercial variance needed for customer needed – outsource software

N.E.M.



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Workstream 7 – Cost of Complexity

Understanding the balance in creating variance

”When the value of creating variance exceeds the cost of creating and maintaining it”

Table of content

Executive Summary

In a complex organization and in complex end to end processes the practice shows that a „one model fits all“ approach for cost of complexity is not possible as the complexity may differ significantly from the product or service category one considers.

One approach to understand the cost of complexity is to first understand the value chain end-to-end in the process of a company to generate value for customers and consumers.

In each of the value chain steps one defines the cost drivers and their exposure and sensitivity to complexity or the changes in the complexity, first on a rather high level.

This allows to focus on the most important process steps and cost positions. Further detailed evaluations will then lead to cost of complexity with an accuracy and granularity precise enough to take decisions or calculate the cost reductions and impacts for all cases like if complexity is reduced, both directly tangible or intangible, if one wants to select between alternative modular product structures, the effect of new modular structures compared to current integrated structures, impact of variant generation and what the cost of complexity are per product or part.

This is shown in several practical examples.

A summary of potentials by introduction of modular product structures considering the complete value chain is shown. The potential is estimated to be minimum 2% of cost of goods sold, compared to an integrated non modular product structure.

Table of content

Introduction

What is the cost of complexity that comes with added variance? This was the question we asked ourself and a question which permanently appears when companies deal with complex organizations and complex product structures. This is also the question when companies go from integrated product structures to modular product structures: Beside the direct effects e.g. in direct material and direct labour, are there potentials in cost and revenue due to streamlined and simplified processes ? How can this effect in reduced complexity be calculated and used in business cases ? Is there a generic “one model fits all” or is it necessary to go case by case ?

As inspiration we took outset in article from TUHH ‘Impact of Modularity Decisions on a Firm’s Economic Objectives’ to map the life phase affects that have the biggest impact on complexity cost. We took also a look into the publication of Ripperda, Krause et. al. “Cost Effects of Modular Product Structure Concepts“ which looks into a similar question and compared to the result of our investigations of various concepts and used cases in NEM member companies and the cases in our workstream.

In the following outline of our work you will find a lot of answers to the questions above. We will guide you through the important step of value stream mapping which sets the base for the calculation of complexity cost. The value stream mapping is a good exercise to assess the areas where complexity creates over-proportional cost and should be avoided. We also believe that you will be able use the value stream mapping to create a usable model if financial data is available in the right configuration and quality. Based on this mapping you will see how to identify the major complexity drivers, the processes which are impacted by complexity most and which steps you take in order to calculate the financial impacts of complexity changes You will find examples for various applications of those principles. As a result, we believe that we are able to deliver to you a very good guideline to approach your individual situation and application field and how to gain the knowledge to do the right decisions regarding variant generation and product structures.

However, you will also see through the various examples that it became clear that a generic model to calculate the cost complexity as a “one formula fits all” will be close to impossible to build as it is very dependent on the business model and the product. As an example, the model would look very much different in a Make to Stock (MTS) setup than in an Engineered To Order (ETO) setup. Based on this learning we started to map the value stream per product line where the boundary conditions were constant (e.g. MTS, high volume, same significant life phase effects etc).

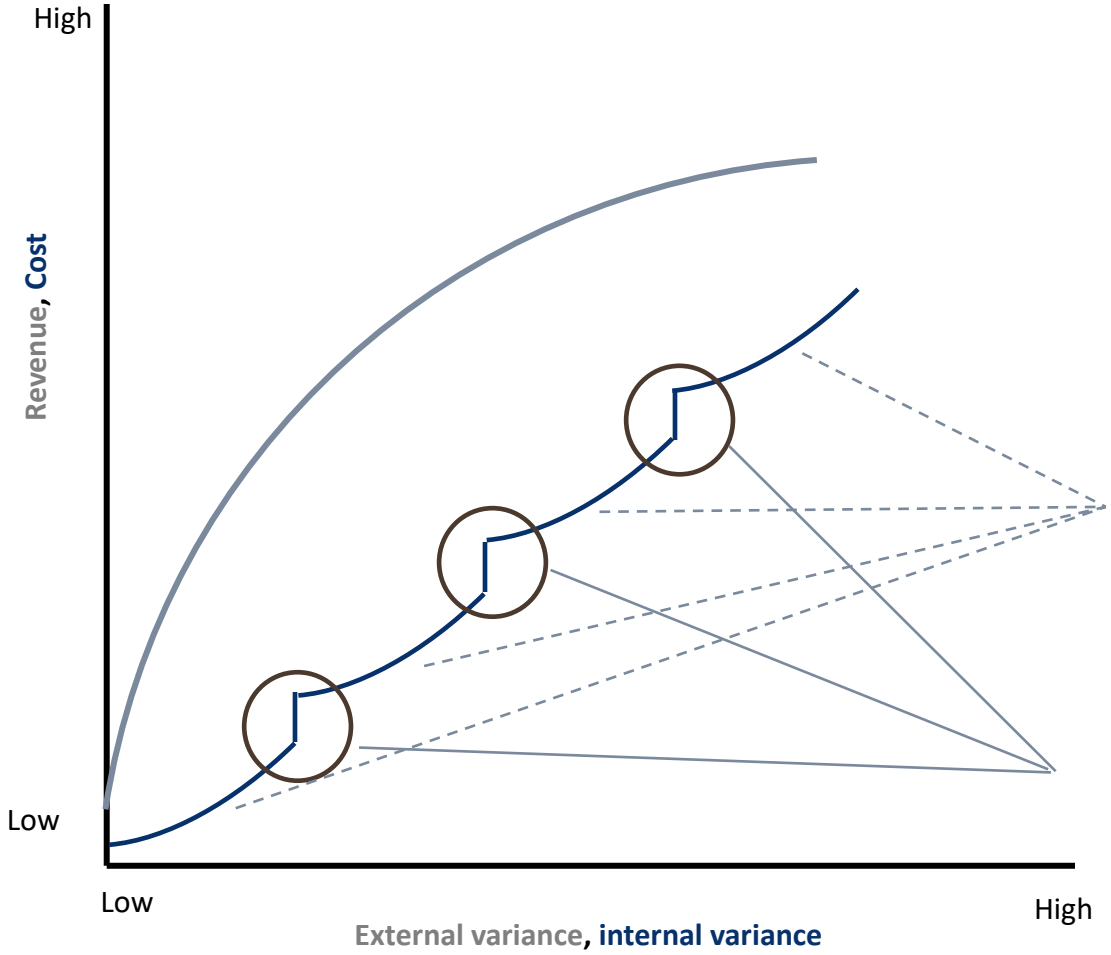
Finally, we can tell a rough range of cost savings which you can expect when working on complexity reduction or introducing modular structures, based on used cases. The exact value will depend on the individual situation, business you are in, product segment, product line, processes and how far you have already come in the way to modularization

Complexity cost play an important role in the P&L of variant generation

The complexity impacts external variance and internal variance

External variance is defined by the products with its different features and functions, delivered to the market

Internal variance is defined by the number of parts or modules in the product generation and connected processes



The vertical axes shows schematically the revenue increase which is created by the increase of product variants (external variances) due to a better offer to the market (with a certain leveling if the number of variants is too big, grey curve)

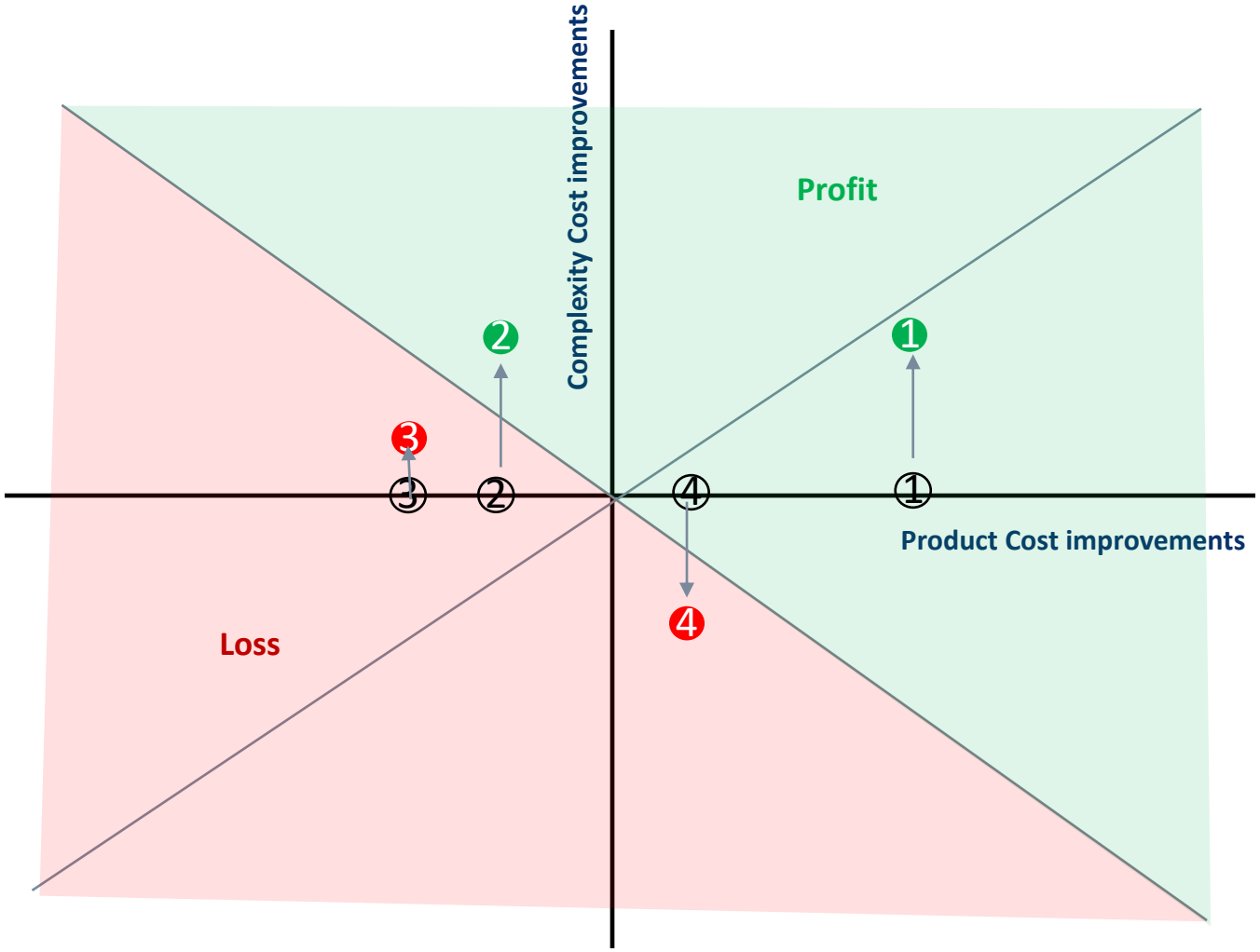
You find in the same graph the cost development with the increase of internal variances (black curve), by the increase of parts, production structure and and more complex processes in the value chain connected with the increase in external variances.

Complexity Cost appear as part of the continuous increases in variable cost (material and labour) due to the increases in internal variants ……

….. and as step changes in the structural cost (R&D, production, procurement, logistics, sales, marketing) to manage the increased number of variants in products and parts

Source: Ripperda S., Krause , D.: „Cost Effects of Modular Product Structure Concepts“, Proceedings of the 20th International Conference on Industrial Design, Mailand, 2015

Business cases and profitability of variant generation needs to consider complexity cost additional to product cost



1. New modular structure or take out of internal variants with improvements of products cost and reduction of complexity
2. New product structure increases product cost but leads to higher improvement of complexity cost
3. New product structure increases product cost more than gains in complexity reduction
4. New variant reduces product cost but increases complexity to a much higher extend

↑ Additional consideration of complexity cost

Source: Krause D., Rennpferdt C, Wehrend S.: „Decision Making and Impact Model for Modularization“, NEM Conference April 2023, Hamburg

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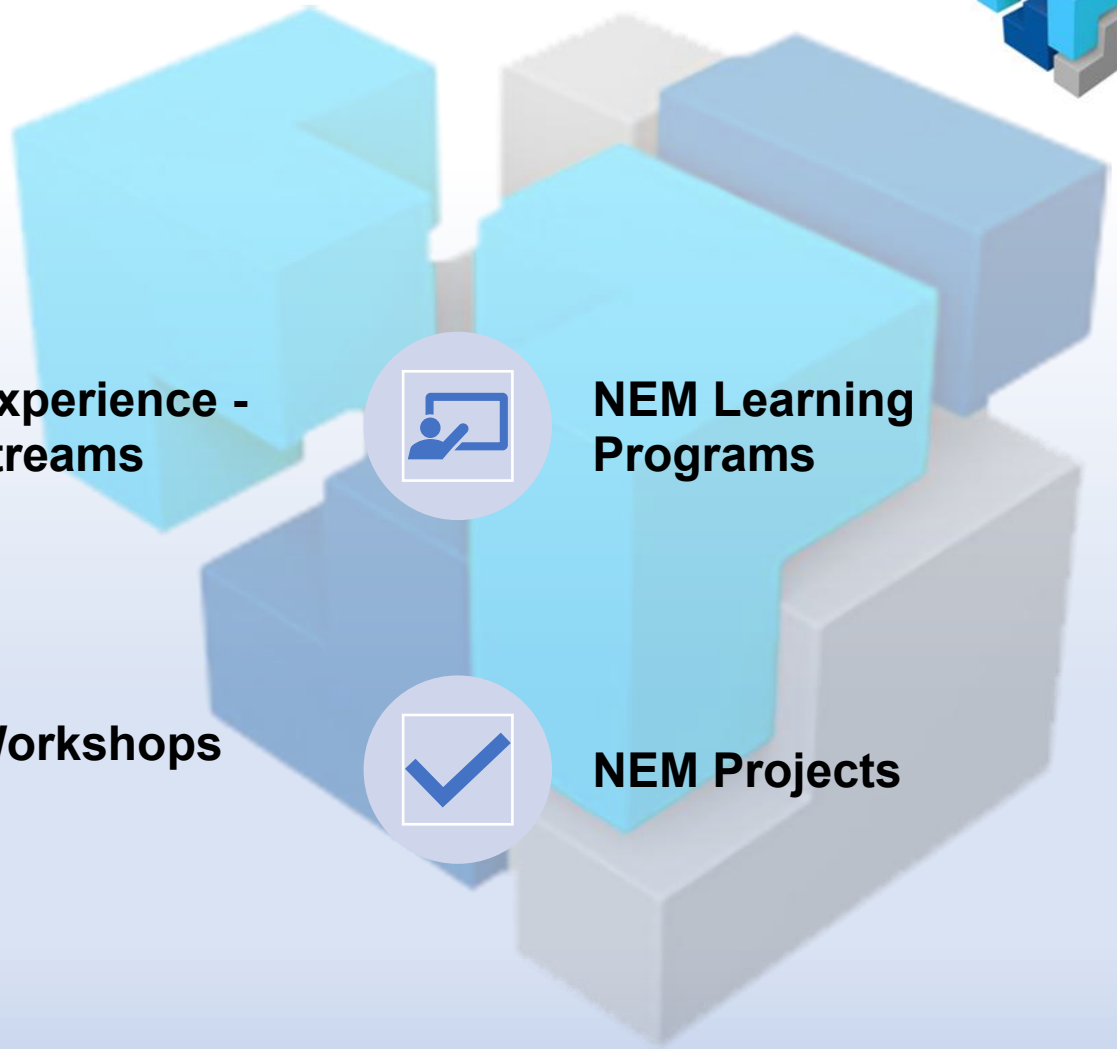

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NEM Services

NEM Workshops ++

NEM Projects

Modelling flexibility and value of modular architectures

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Division of Production Development, Industrial and Materials Science
Research Group Lead, Co-Director of Area of Advance Production
Chalmers University of Technology, Gothenburg, Sweden
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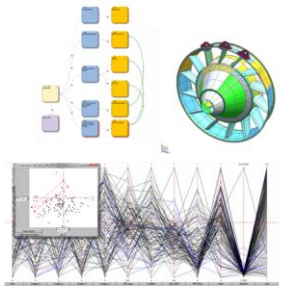
Massimo Panarotto – Associate professor in Mechanical Engineering
Politechnico di Milano, Italy. And *guest researcher at Chalmers
Massimo.panarotto@polimi.it

Systems Engineering Design

Take a Systems Approach to Engineering Design

Systems Design Methodology

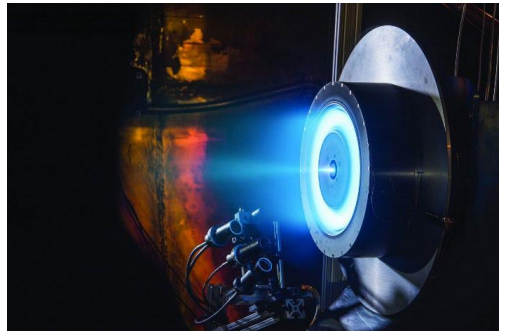
Systems Engineering Design Methods and tools



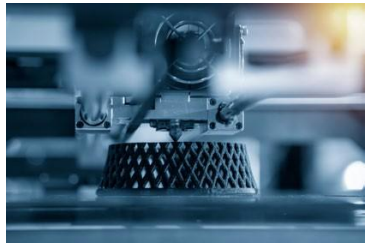
Design to make system level impact

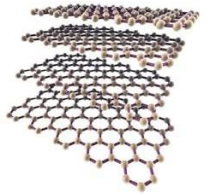
Systems

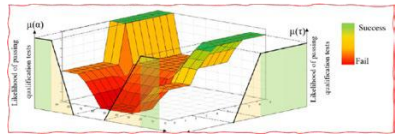
Product



Technology







https://www.chalmers.se/en/departments/ims/research/product-development/systems-engineering-design/

wingquist LABORATORY

Outline

Methods to design and analyse modular architectures Exa

Message What is next

Methods to design and analyse modular architectures

Examples

Message

What is next

What issues do we need to address?

COMPLEXITY increases

Drive cost, time and quality challenge exponentially vs degree of complexity

SPEED is expected to adapt to abrupt changes in conditions

New expectations, constraints, market priorities, availability of resources and material,

..

PLATFORMS have focused to ensure efficient, configurable, products and production systems

Need for increasingly flexible, adaptable, resilient platforms

TECHNOLOGY accelerated impact

New – primarily digital – technologies evolve more rapidly than physical technologies

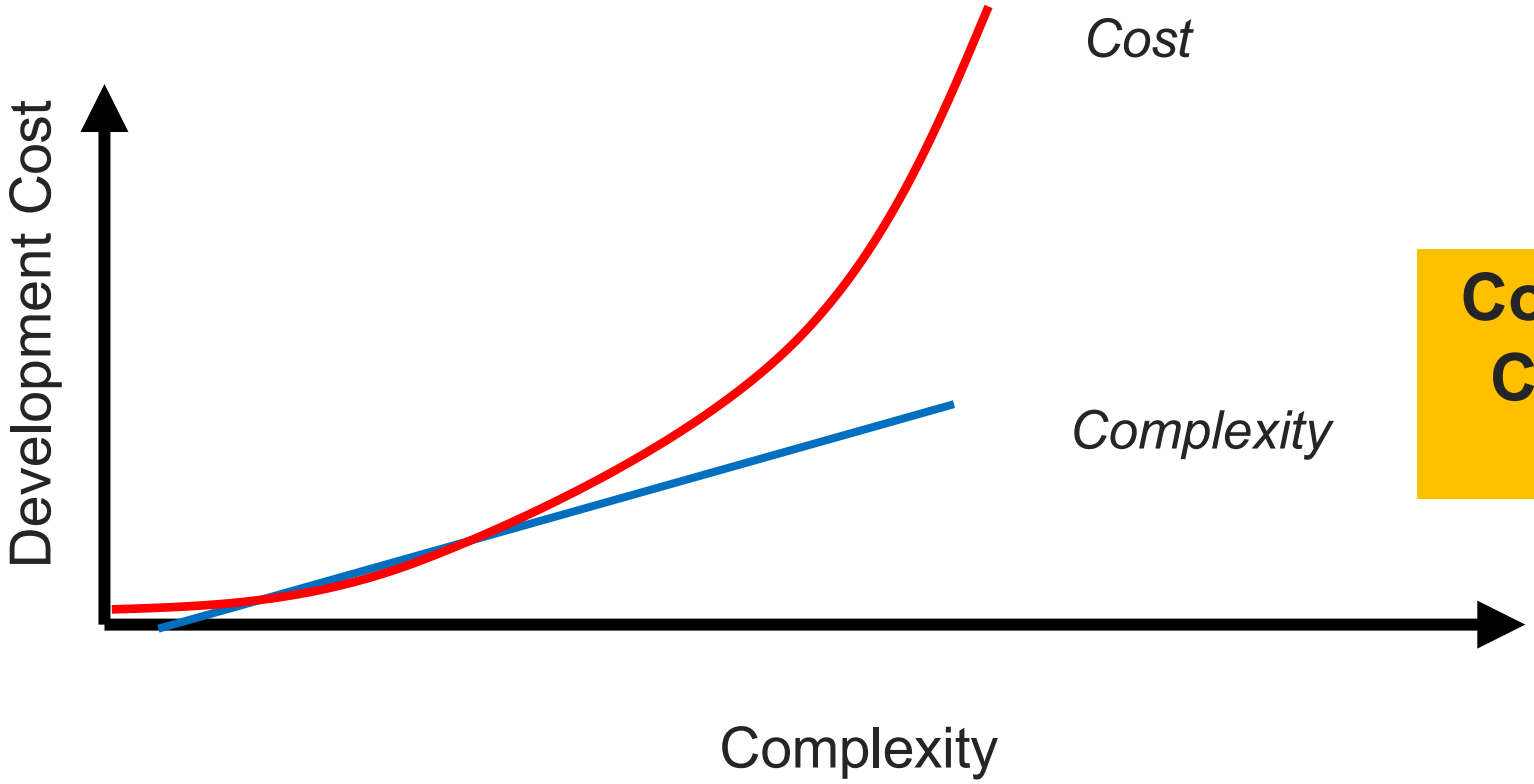
MODULARISATION is one of few proven strategies to manage complexity

MODULARISATION enable automation, (re)allocation, configuration, adaption. Generative methods allow generation and evaluation of many alternatives.

MODULARISATION is an enable to ensure commonality and configurability of products and industrial systems

Platforms are **multitechnological**, and modularisation need to support more diciplines and aspects – while technology **cycles are fast and different in nature**

Complexity of Products Affect Development Cost



Complexity => Exponential Cost Increase to develop and realise

SINHA, K. & DE WECK, O. L. 2016. Empirical Validation of Structural Complexity Metric and Complexity Management for Engineering Systems. *Systems Engineering, 19, **193-206.***

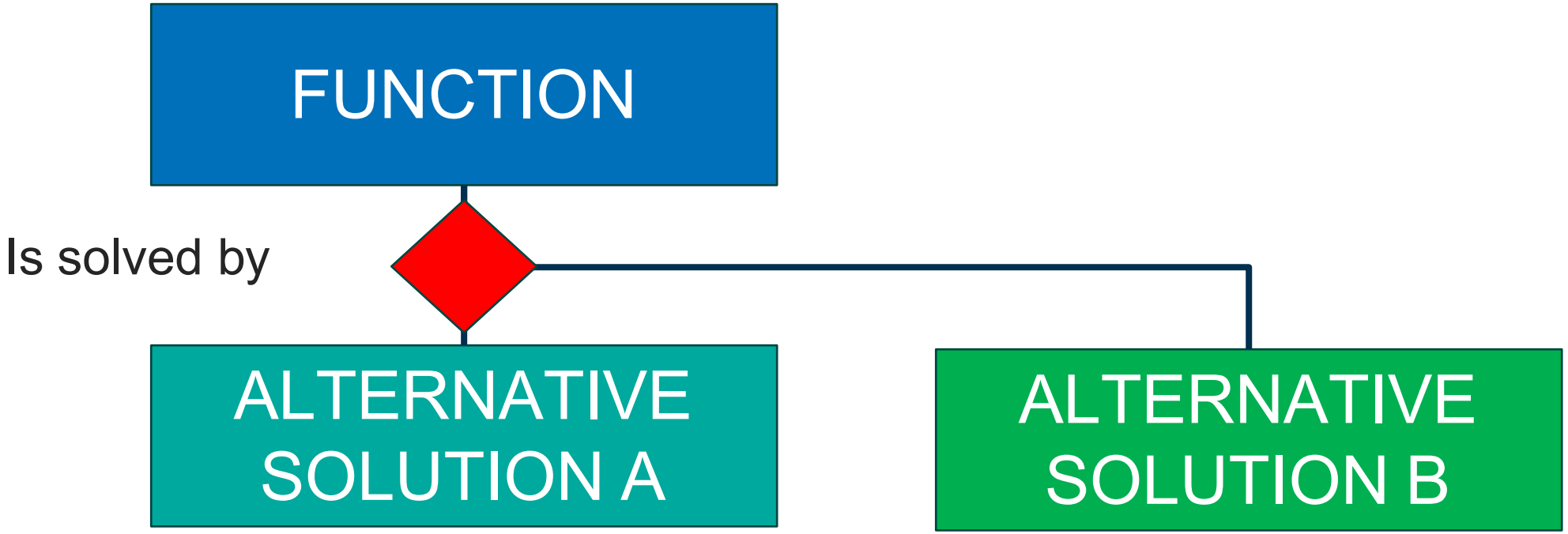
Functionally defined architectures

Separating

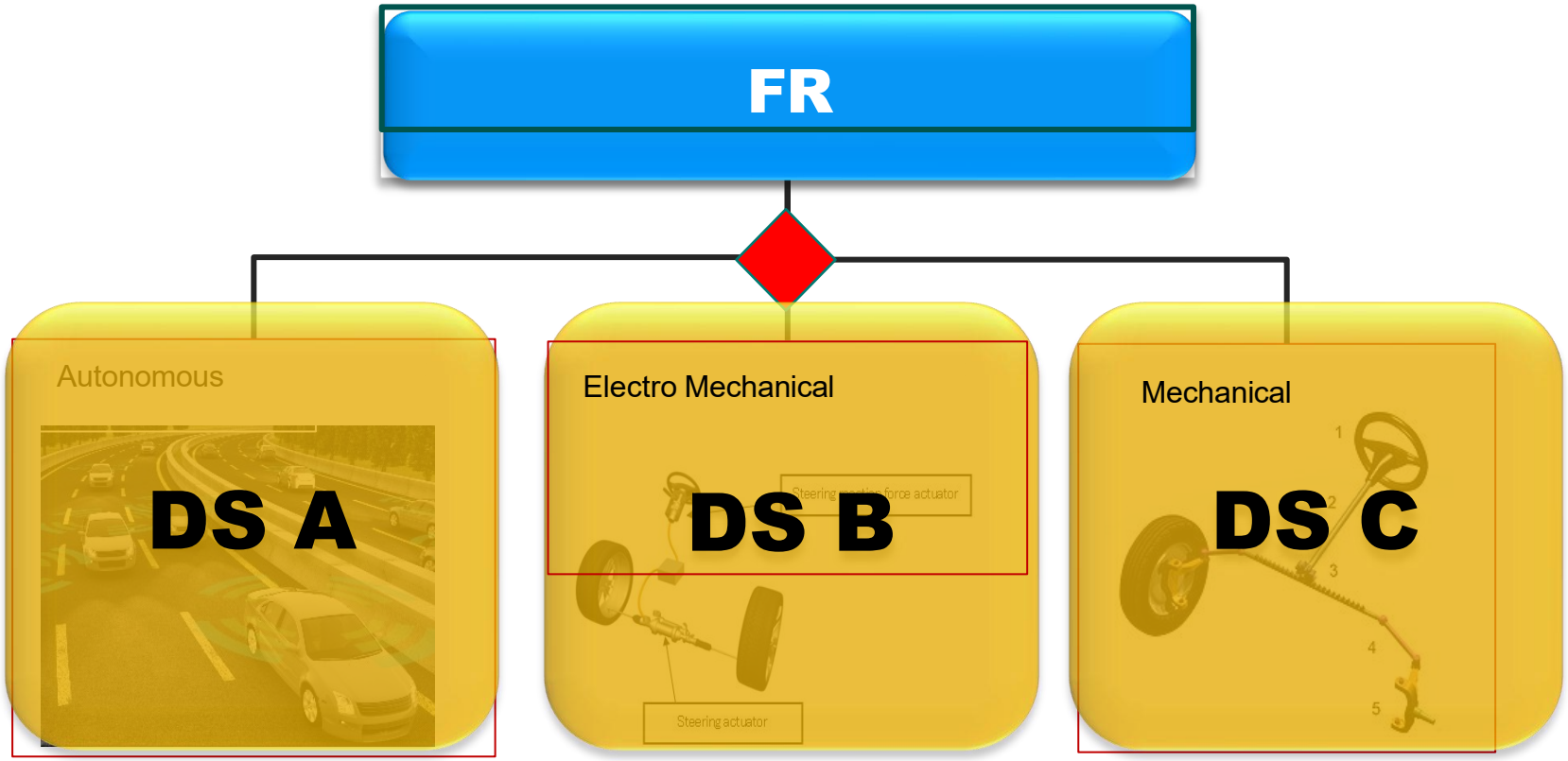
- WHAT the product does (FUNCTION) from
- HOW it solves the function (MEANS; or SOLUTIONS)

Note: Enables representation of multi-technological modular architecture

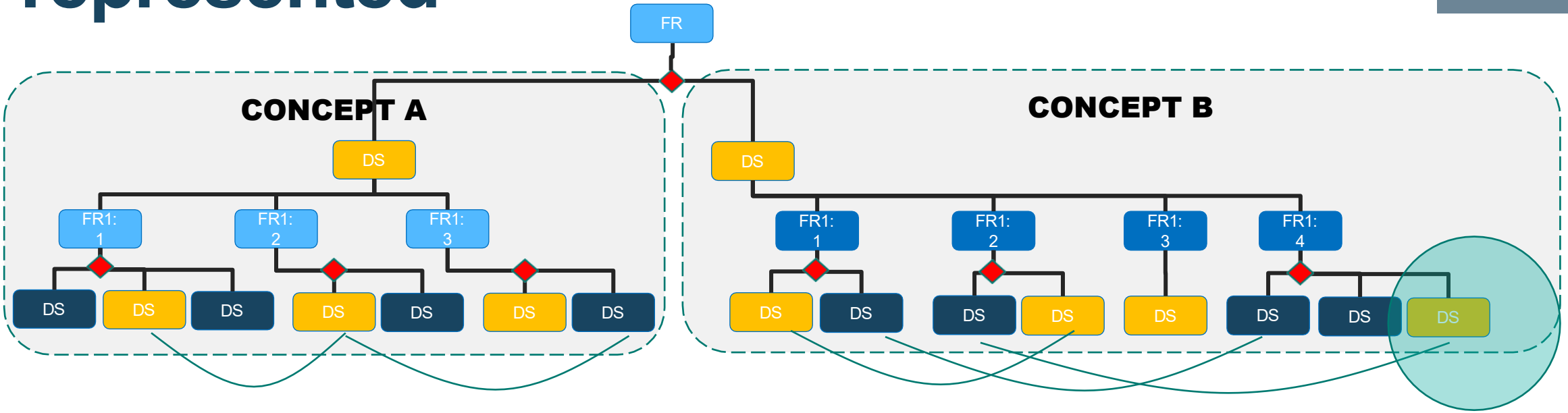
A function can be met by alternative solutions (~concepts)



A modelling approach



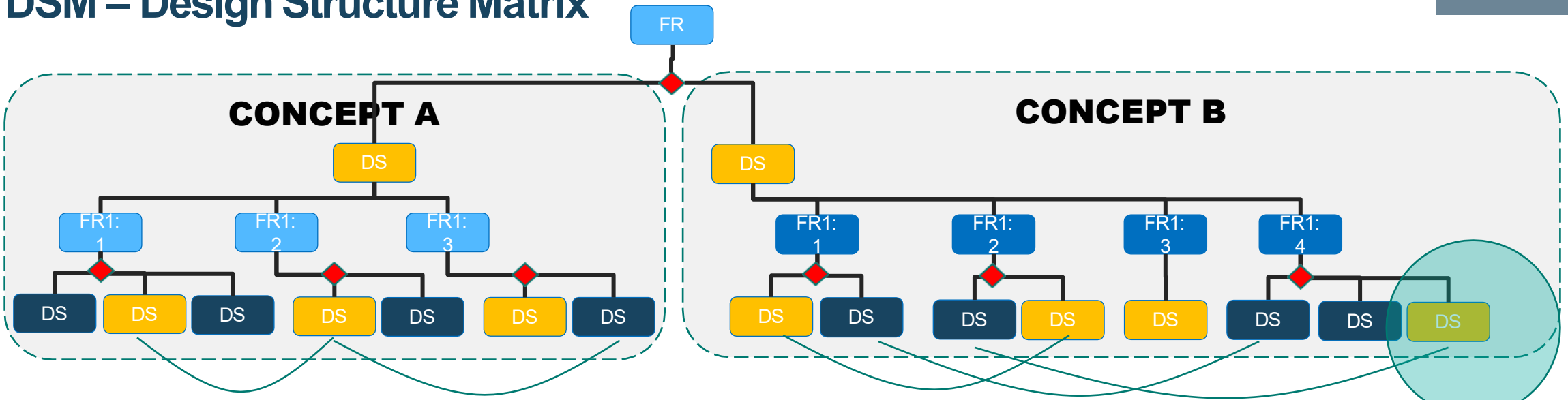
Alternative architectures can be represented

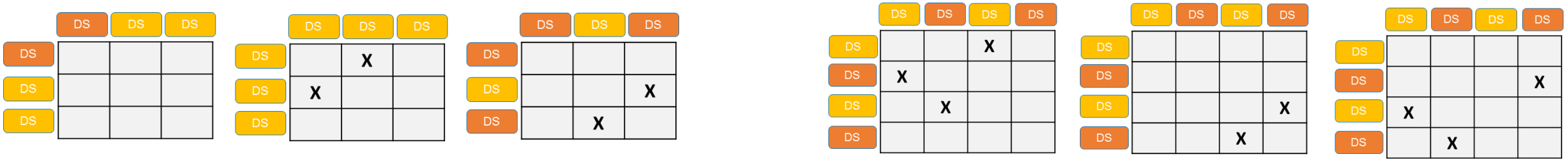


Capture how sub-solutions interact

Dependencies can be captured in matrices (e.g. DSM's)

DSM – Design Structure Matrix



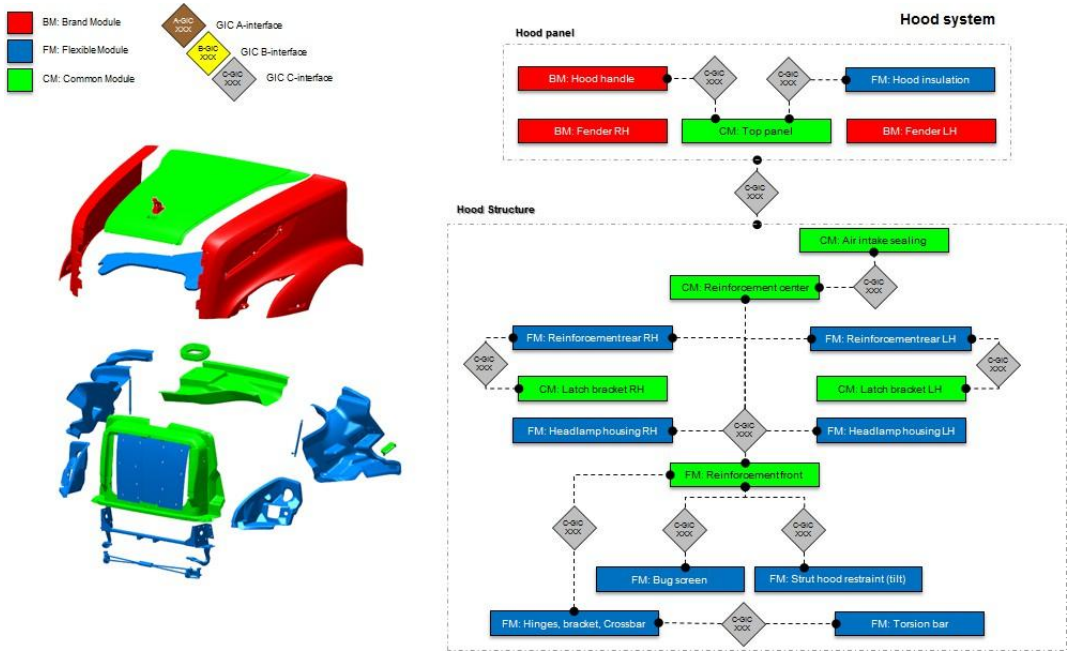


Modelling dependencies allow the use of matrix based analysis methods (e.g. DSM)

Example – Functionally defined Modular Architecture @ Volvo GTT

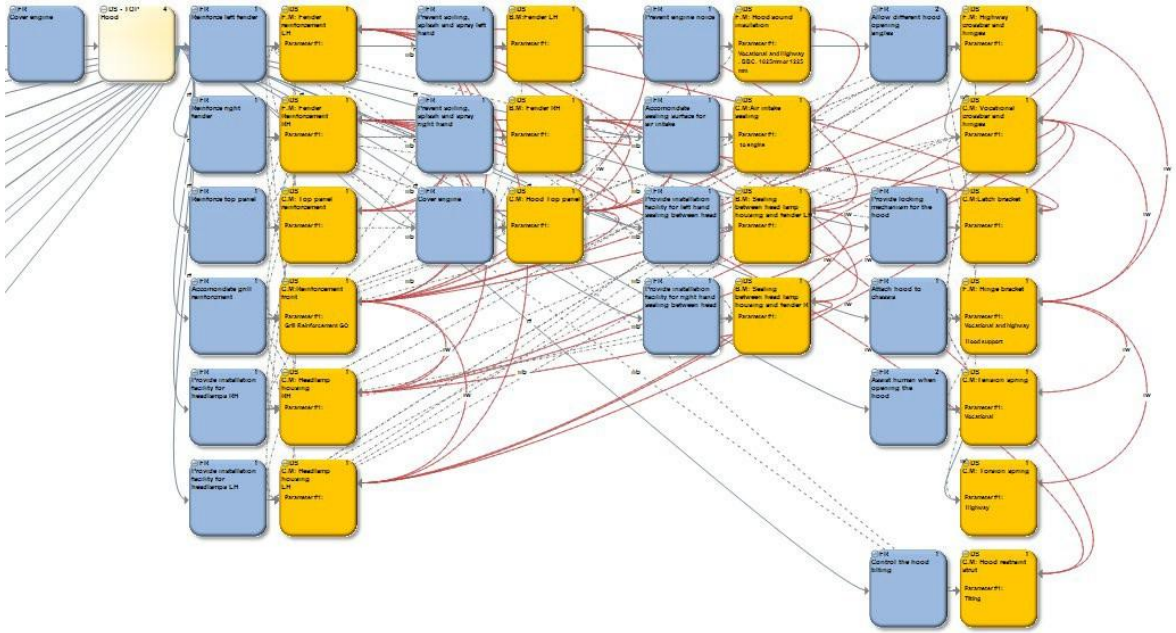
Scope

- 50 modularized systems
- 1300 Modules
- 3500 Components



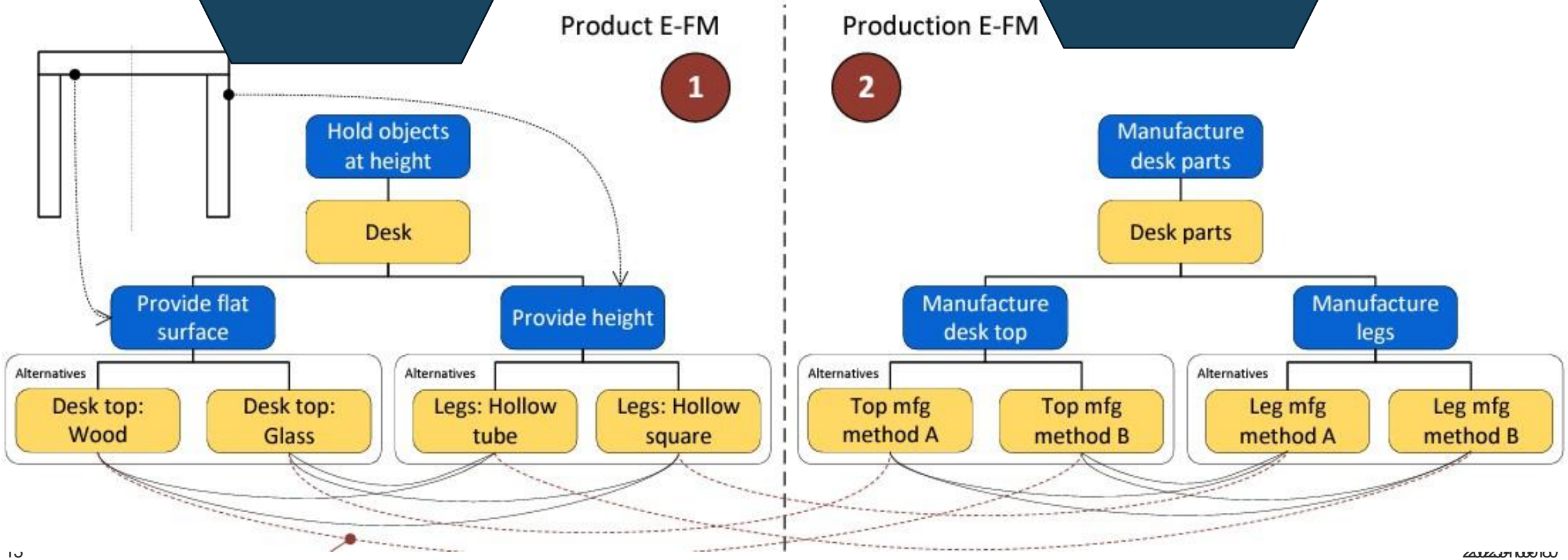
Proven benefits

- Understanding of requirement connection to modules
- Cost saving
- Assessing cost of customer requirement

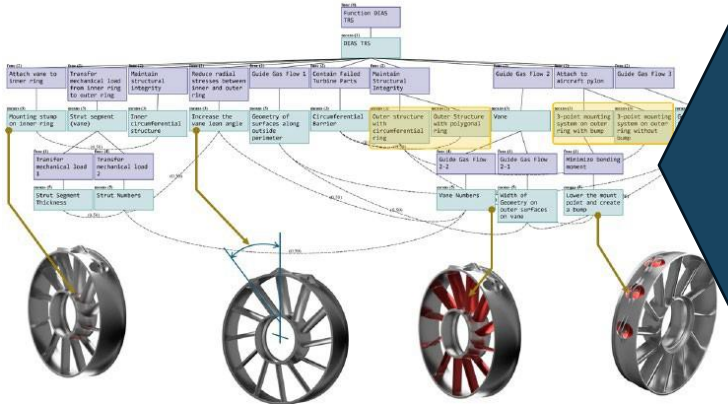


FUNCTIONAL ARCHITECTURE

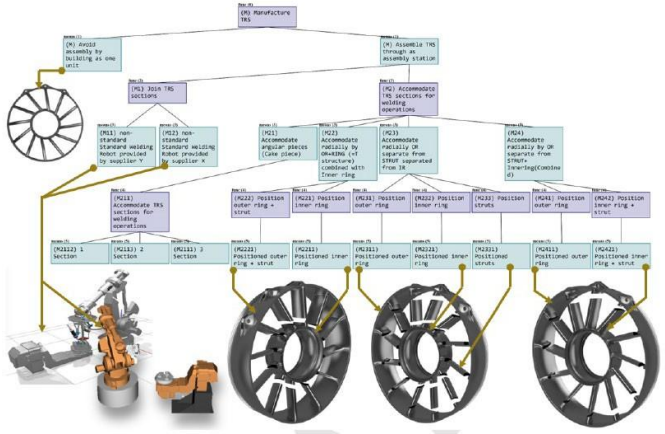
MANUFACTURING ARCHITECTURE



Example from GKN Aerospace



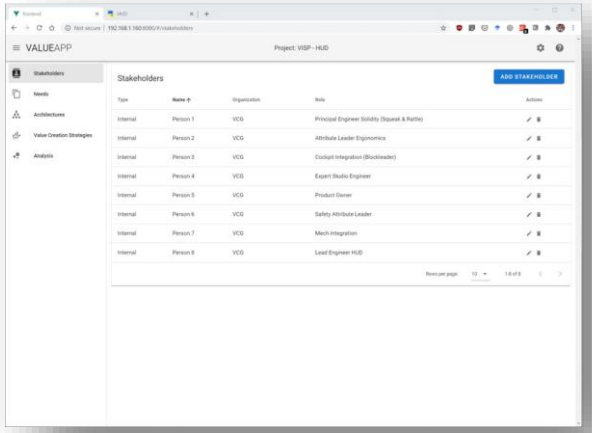
FUNCTIONAL ARCHITECTURE

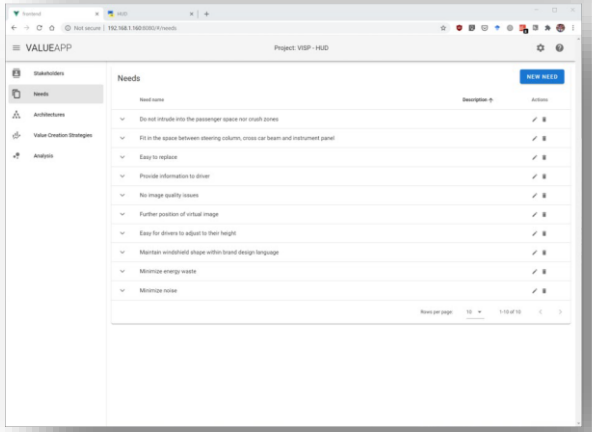


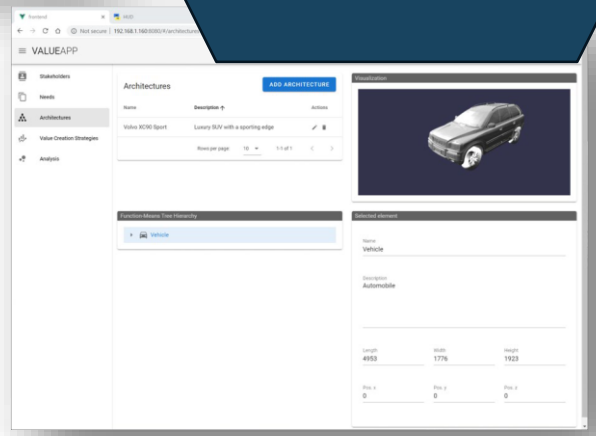
MANUFACTURING ARCHITECTURE

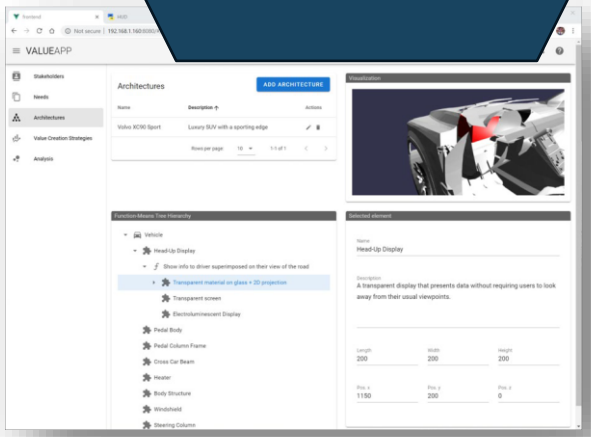
A DSM ”Fingerprint” of the connected system

Lowest level means	A	B	C	D	E	F	G	H	I	J	K	L	M	AA	AB	AC	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
A: Circumferential Barrier	A		0.7	0.7													1								0.1	0.2		0.5
			0.7	0.7													0.75								0.19	0.51		0.97
B: Geometry of surfaces along outside perimeter		B					0.3							0.5			1											
							0.3							0.5			0.75											
C: (E1) Outer structure with circumferential ring	0.7		C							0.3	0.3						1			0.5	0.7	0.3			0.1	0.2		0.5
	0.7									0.3	0.3						0.75			0.75	0.91	0.51			0.19	0.51		0.97
D: (E2) Outer Structure with polygonal ring	0.7			D													1			0.5	0.7	0.3			0.1	0.2		0.5
	0.7																0.75			0.75	0.91	0.51			0.19	0.51		0.97
E: Increase the vane lean angle					E			0.7	0.7								1											
								0.7	0.7								0.75											
F: Inner circumferential structure						F							0.5				1			0.5	0.7	0.3	0.1	0.2	0.5			
													0.5				0.75			0.75	0.91	0.51	0.19	0.51	0.97			
G: Width of Geometry on outer surfaces on vane		0.3					G							0.5			1								0.5	0.1		0.2	
		0.3												0.5			0.75								0.97	0.19		0.44	
H: Vane Numbers					0.7			H	1								1								0.5	0.1		0.2	
					0.7				1								0.75								0.97	0.19		0.44	
					0.7			1	I	0.5			0.3		0.5		1								0.5	0.1		0.2	
					0.7			1		0.5			0.3		0.5		0.75								0.97	0.19		0.44	
									0.5	J			0.3		0.5		1								0.5	0.1		0.2	
									0.5				0.5		0.5		0.75								0.97	0.19		0.44	
		0.3									K						1											
												L					1											
													M				0.75											
					0.5			0.3	0.3														0.1	0.2				
					0.5			0.3	0.5														0.19	0.51				
							0.5							AA			0.5											
							0.5										0.5											
									0.5	0.5					AB		0.5										0.5		0.5
									0.5	0.5					0.5		0.5										0.5		0.5
															0.5	AC	0.5	0.5		0.5	0.5	0.5					0.5		0.5
															0.5		0.5			0.5	0.5	0.5					0.5		0.5
			1	1	1	1	1	1	1	1	1	1	0.5		0.5		N												
			0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.5		0.5			O		0.5	0.7	0.3	0.1	0.2	0.5	0.1	0.2	0.2	0.5
																				0.75	0.91	0.51	0.19	0.51	0.97	0.19	0.51	0.44	0.97
																			P	0.5	0.7	0.3	0.1	0.2	0.5	0.1	0.2	0.2	0.5
																				0.75	0.91	0.51	0.19	0.51	0.97	0.19	0.51	0.44	0.97
Q: (M2113) 2 Section			0.5	0.5		0.5										0.5		0.5	0.5	Q									
			0.75	0.75		0.75										0.5		0.75	0.75										
R: (M2112) 1 Section			0.7	0.7		0.7										0.5		0.7	0.7		R								
			0.91	0.91		0.91										0.5		0.91	0.91										
S: (M2111) 3 Section			0.3	0.3		0.3										0.5		0.3	0.3			S							
			0.51	0.51		0.51										0.5		0.51	0.51										
T: (M2211) Positioned inner ring						0.1							0.1					0.1	0.1				T			0.1			
						0.19							0.19					0.19	0.19							0.19			
U: (M2321) Positioned inner ring						0.2							0.2					0.2	0.2					U				0.2	
						0.51							0.51					0.51	0.51									0.44	
V: (M2421) Positioned inner ring + strut						0.97	0.5	0.5	0.5	0.5								0.5	0.5						V				0.5
						0.97	0.97	0.97	0.97	0.97								0.97	0.97										0.97
W: (M2221) Positioned outer ring + strut	0.1		0.1	0.1			0.1	0.1	0.1	0.1						0.5		0.1	0.1				0.1			W			
	0.19		0.19	0.19			0.19	0.19	0.19	0.19						0.5		0.19	0.19				0.19						
X: (M2311) Positioned outer ring	0.2		0.2	0.2										0.5	0.5			0.2	0.2								X	0.2	
	0.51		0.51	0.51										0.5	0.5			0.51	0.51									0.44	
Y: (M2331) Positioned struts							0.2	0.2	0.2	0.2								0.2	0.2					0.2			0.2	Y	
							0.44	0.44	0.44	0.44								0.44	0.44					0.44			0.44		
Z: (M2411) Positioned outer ring	0.5		0.5	0.5									0.5		0.5			0.5	0.5						0.5				Z
	0.97		0.97	0.97									0.5		0.5			0.97	0.97						0.97				


VALUEAPP
Stakeholders
ADD STAKEHOLDER


VALUEAPP
Needs
NEW NEED


VALUEAPP
Architectures
ADD ARCHITECTURE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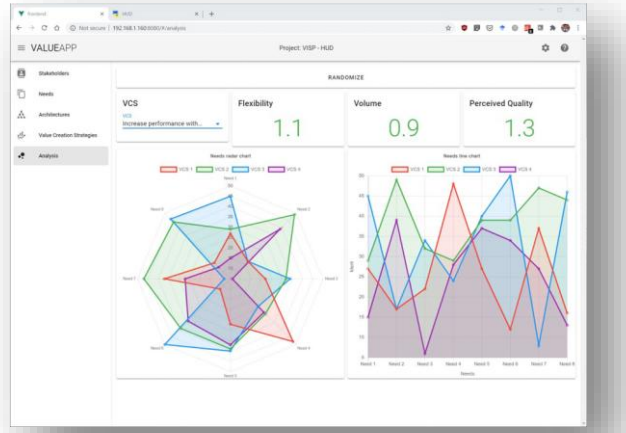
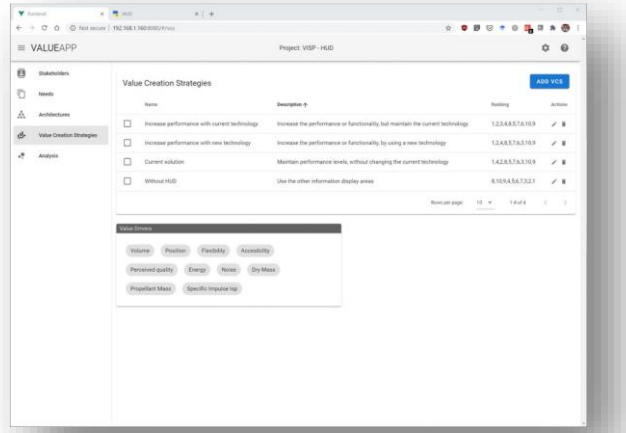
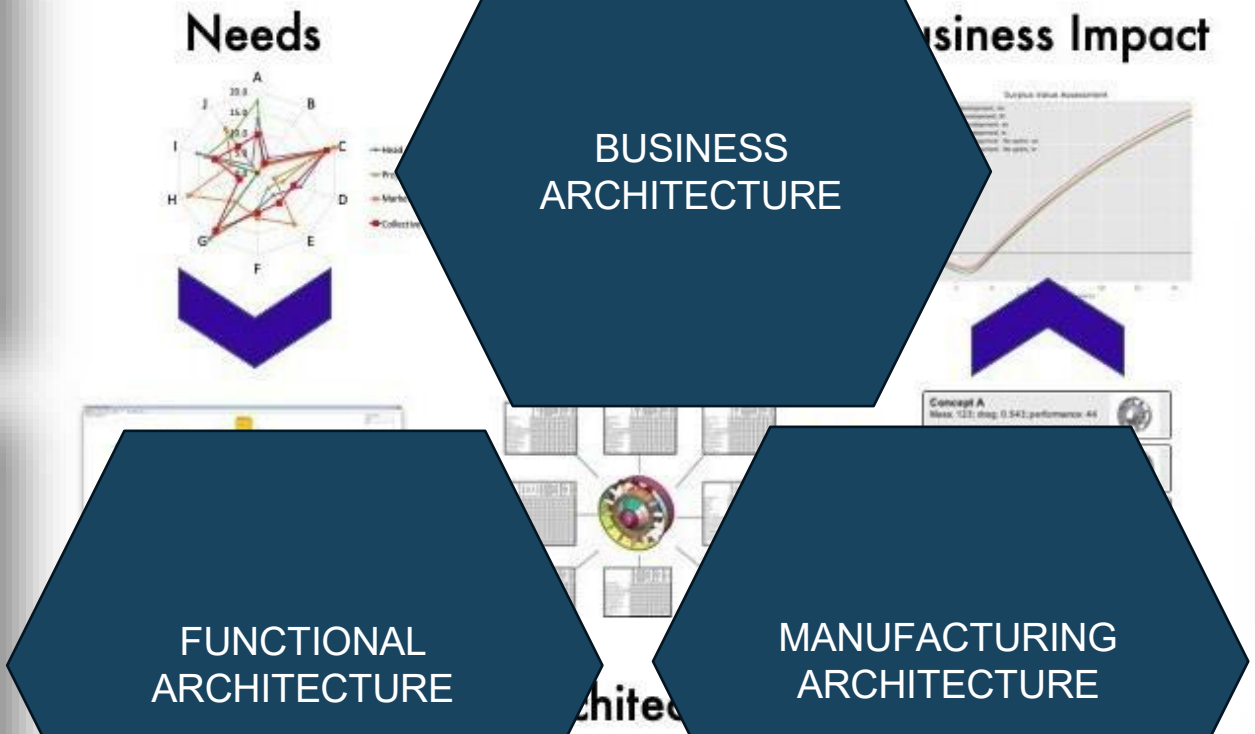
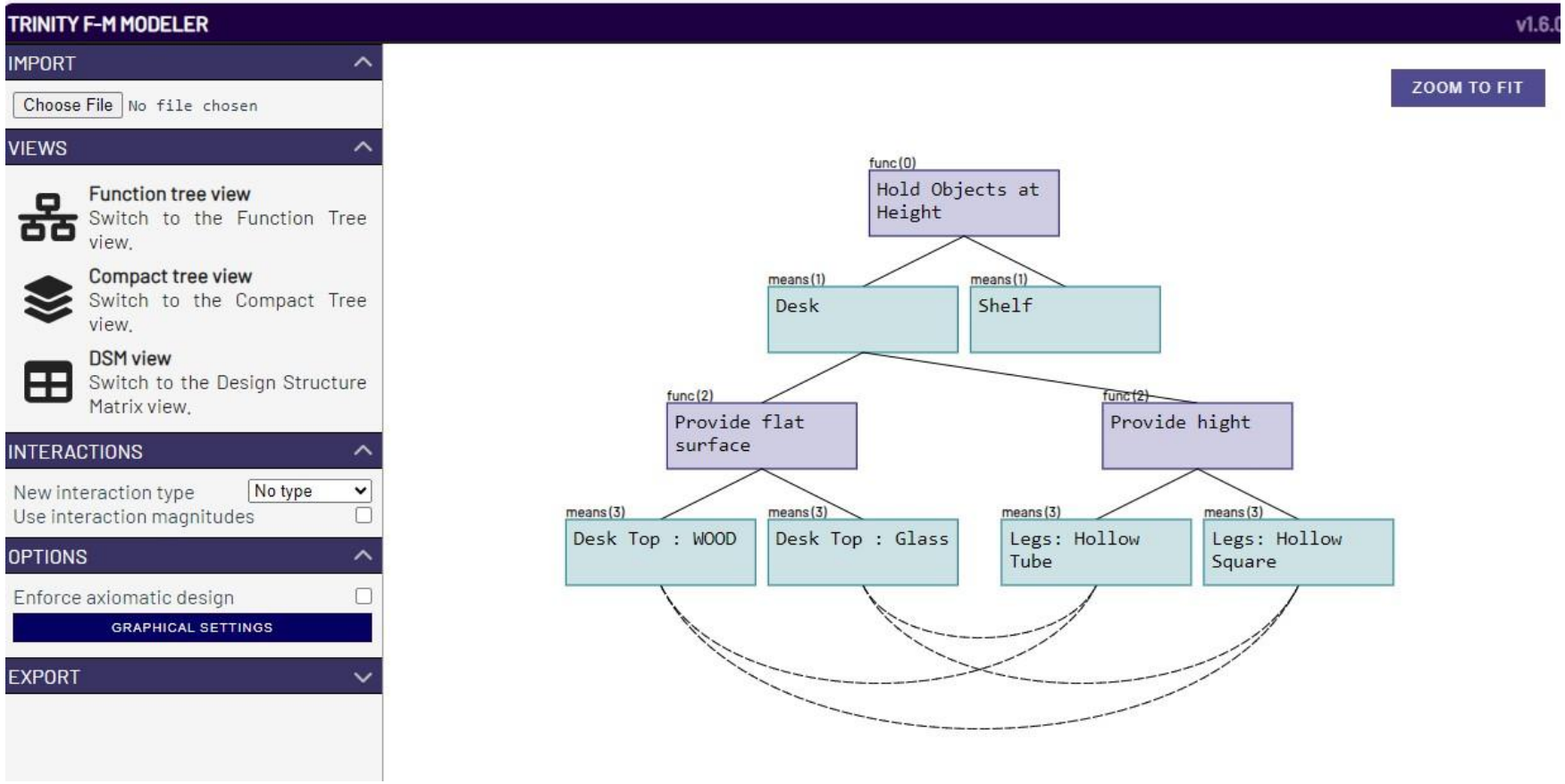
Architectures
ADD ARCHITECTURE


VALUEAPP
RANDOMIZE
VCS
Flexibility
1.1
Volume
0.9
Perceived Quality
1.3


VALUEAPP
Value Creation Strategies
ADD VCS


Needs
usiness Impact
BUSINESS ARCHITECTURE
FUNCTIONAL ARCHITECTURE
MANUFACTURING ARCHITECTURE

TRINITY – Open Access Modelling tool



https://trinity.martinsson-bonde.com/

Methods to design and analyse modular architectures

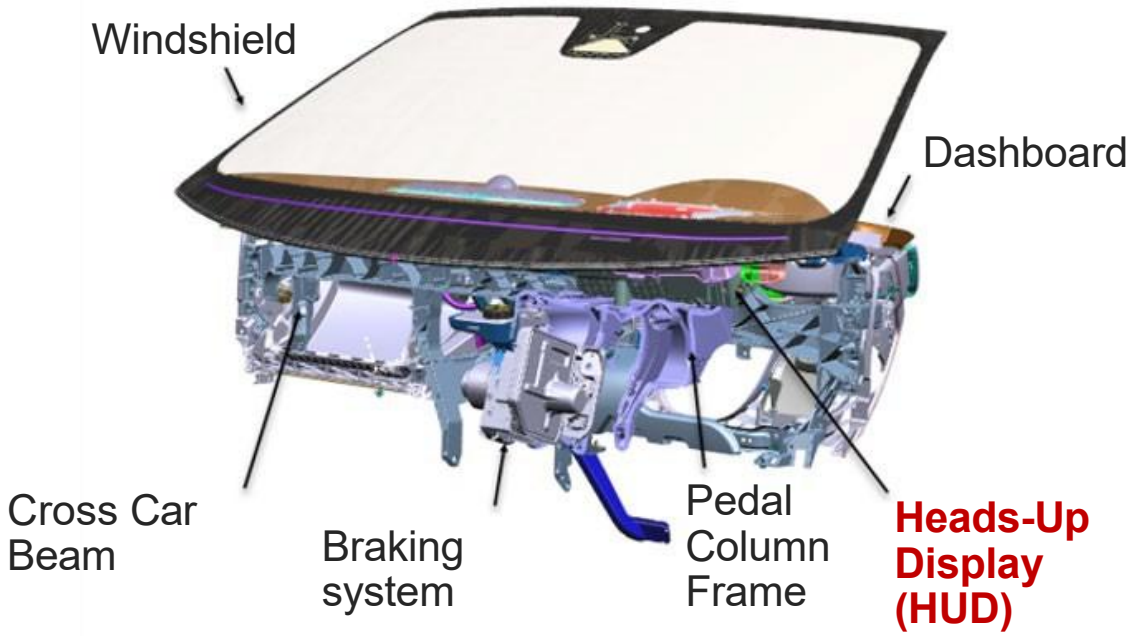
Examples

Message

What is next

1. FLEXIBILITY OF A PLATFORM?

Inigo Alonzo Fernandez

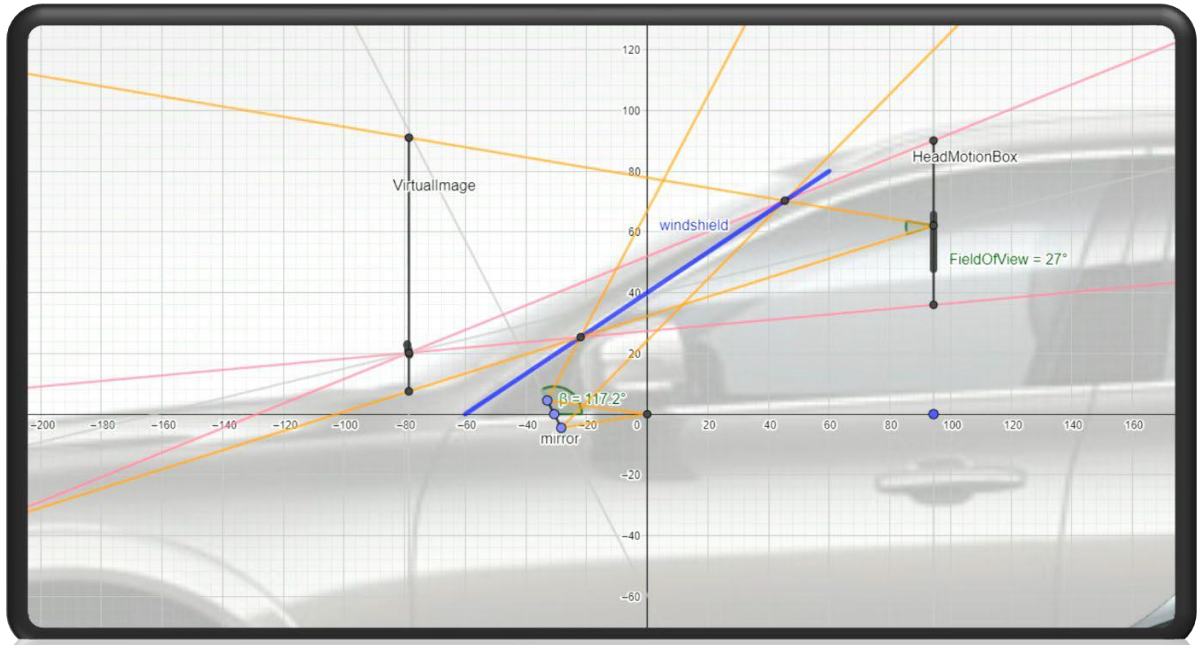


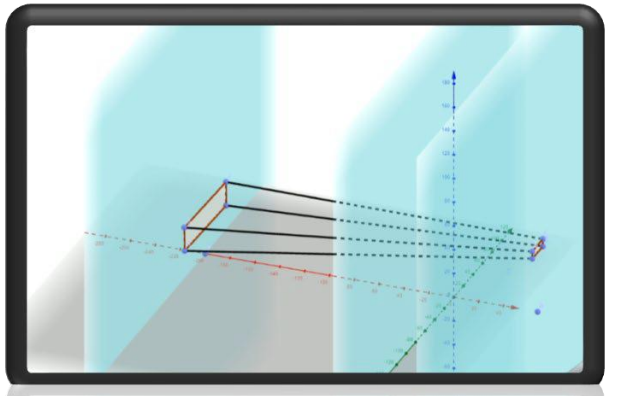
A classic situation where market driven technology changes is proposed, that may challenge the existing limitations of a platform

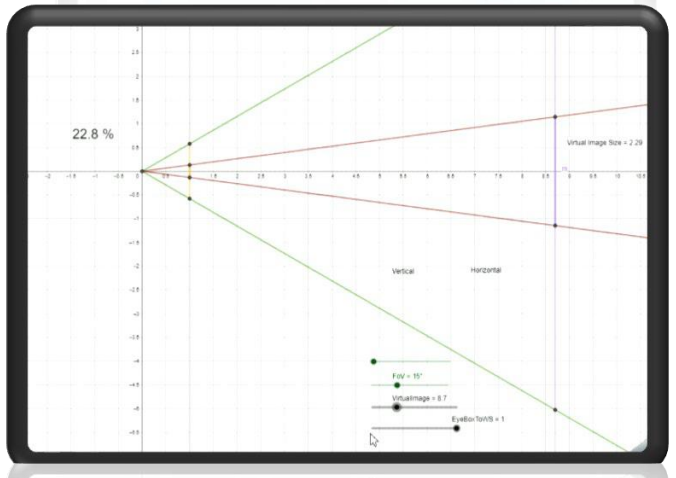
How to evaluate?

VISP - Value and flexibility Impact analysis for Sustainable Production, VINNOVA FFI 2018-02692

GENERATE THE DATA NECESSARY TO EVALUATE

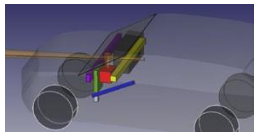




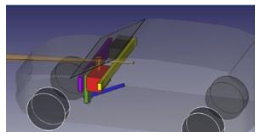


Results: Flexibility assessment

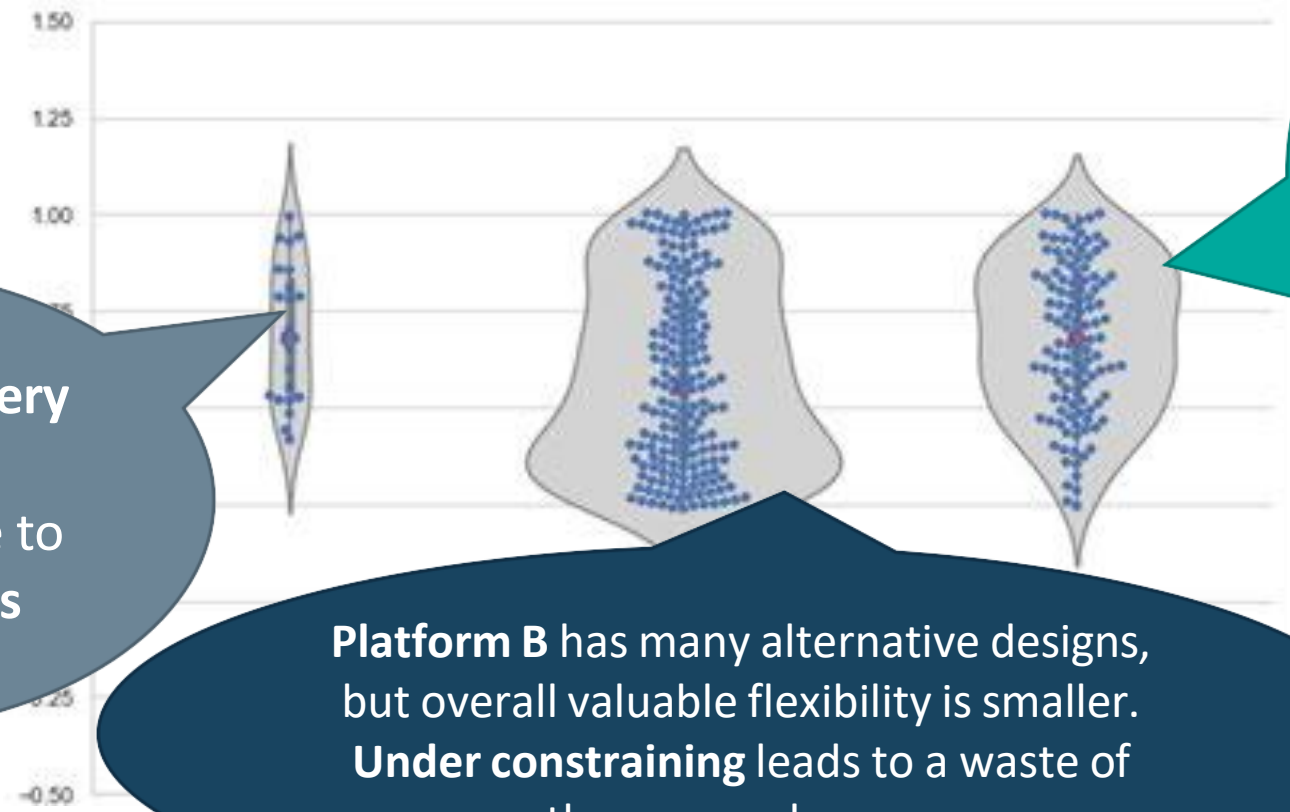
Platform A



Platform B



Platform C

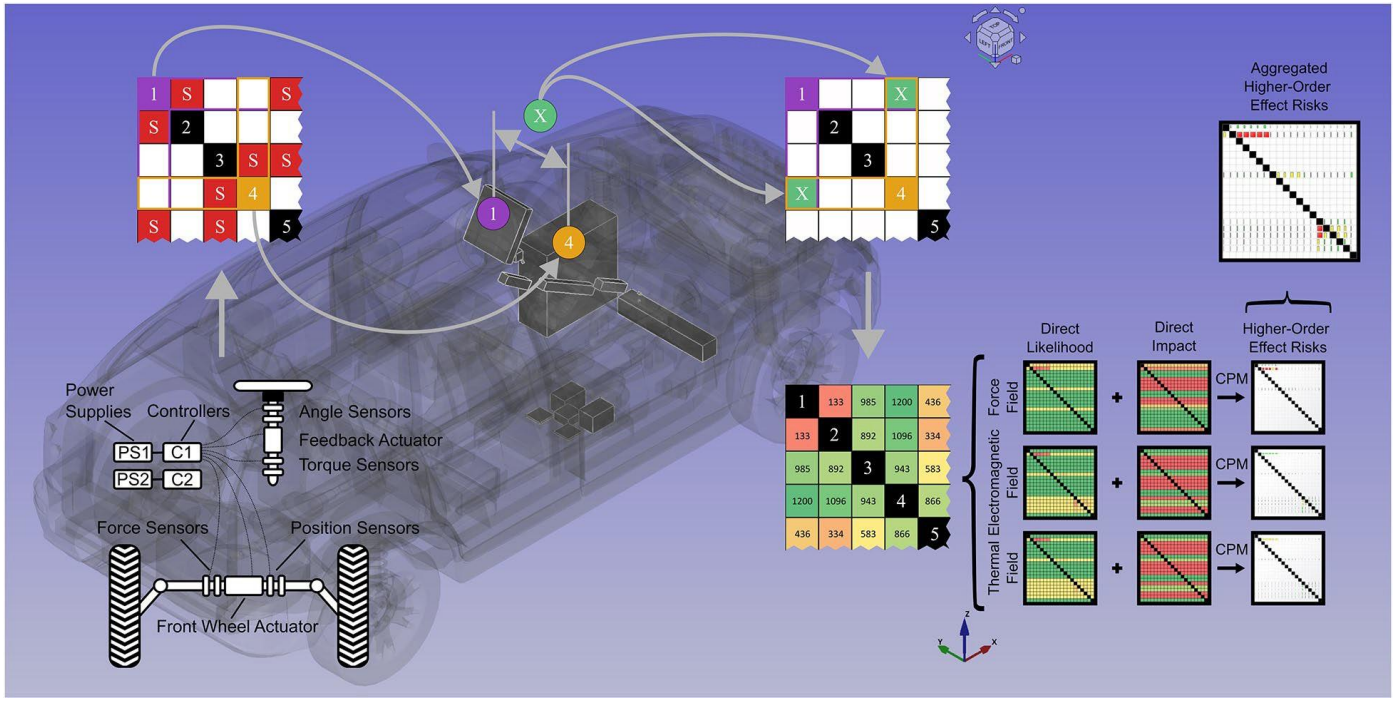


Platform A has **very few** design alternatives, due to **over-constrains**

Platform B has many alternative designs, but overall valuable flexibility is smaller. **Under constraining** leads to a waste of the reserved space.

Platform C has a **balanced** delimitation of the constraints, **high flexibility** with freedom for defining many alternative designs.

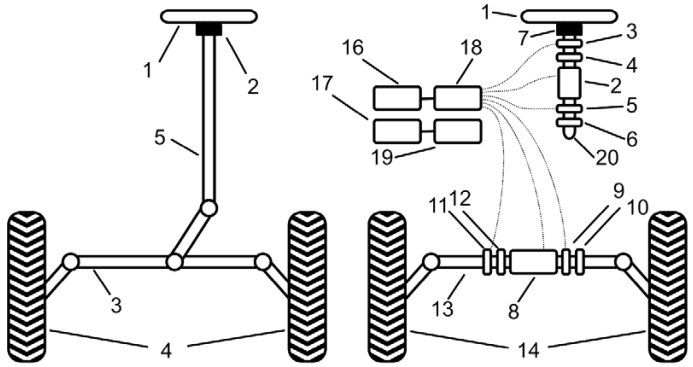
2. Example – risk analysis

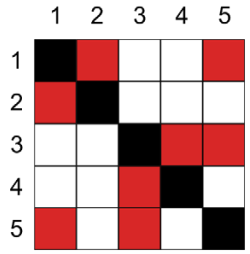


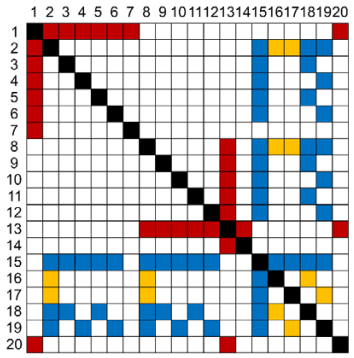
- a novel method for modeling technical risk propagation due to new technology infusion in platforms, specifically aimed at mitigating higher-order field effects from the early stages of the design process

Alonso Fernández, I., Panarotto, M., & Isaksson, O. (2024). Modeling Technical Risk Propagation Using Field-Effects in Automotive Technology Infusion Design Studies. *Journal of Mechanical Design*, *146*(12).

Model the architectural alternatives







(a) Conventional Steering (b) Steer-by-Wire

- Using the methods presented, alternative architectures
  - Conventional steering vs
  - Steer-by-wire steering

were modelled, after identifed critical interfaces and dependencies

Alonso Fernández, I., Panarotto, M., & Isaksson, O. (2024). Modeling technical risk propagation using field-effects in automotive technology infusion design studies. *Journal of Mechanical Design*, *146*(12), 121702.

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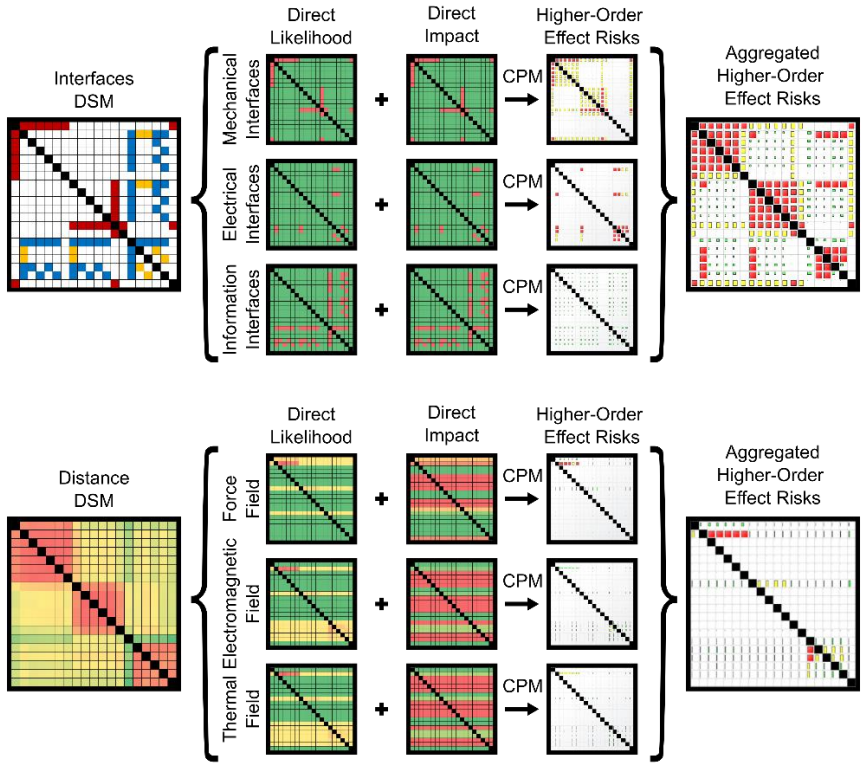
Results



By identifying regions vulnerable to these enable localized mitigation strategies, av overdesign.

Alonso Fernández, I., Panarotto, M., & Isaksson, O. (2024). Modeling technical risk propagation using field-effects in automotive technology infusion design studies. *Journal of Mechanical Design*, *146*(12), 121702.

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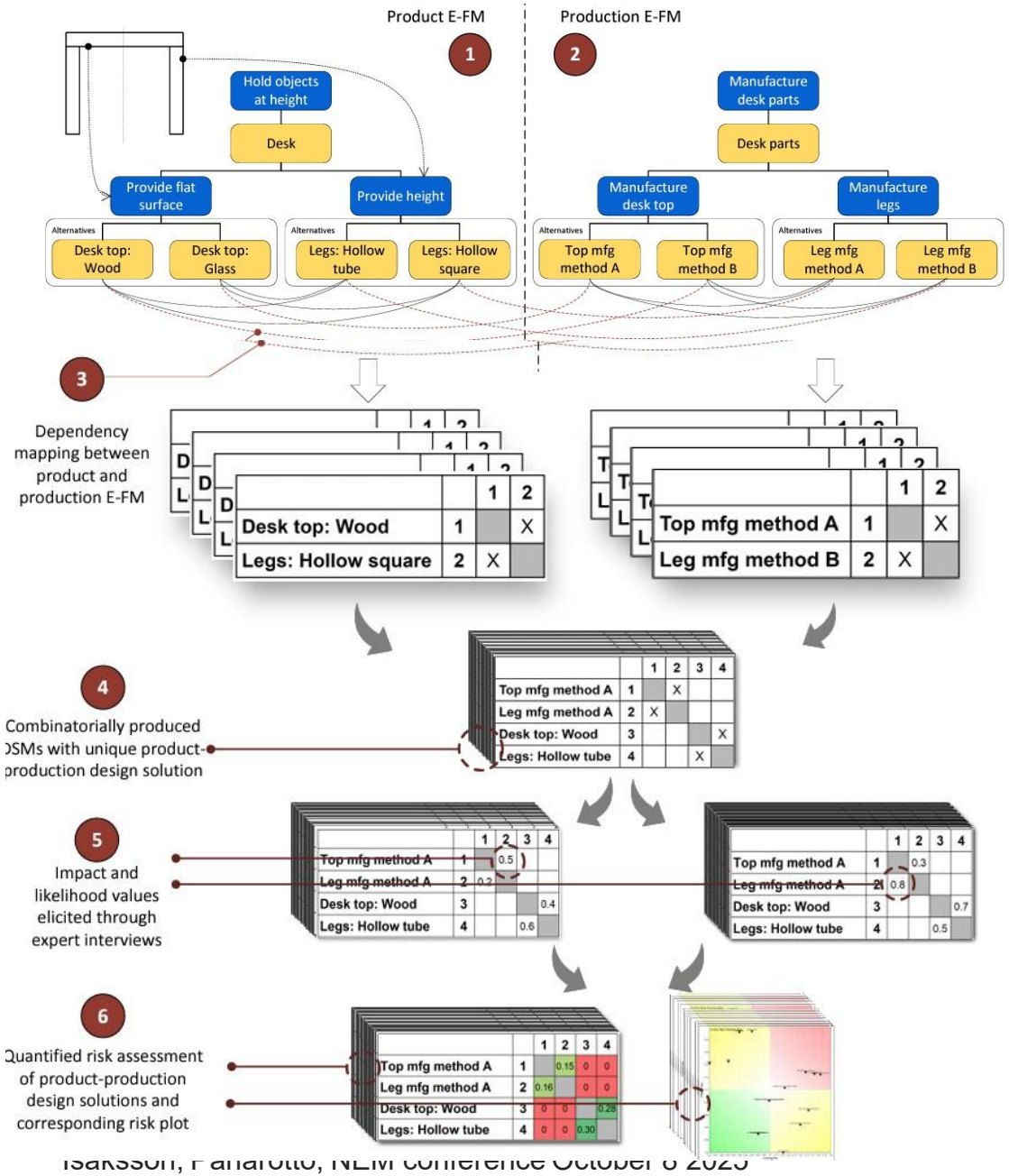
Analysis of alternatives

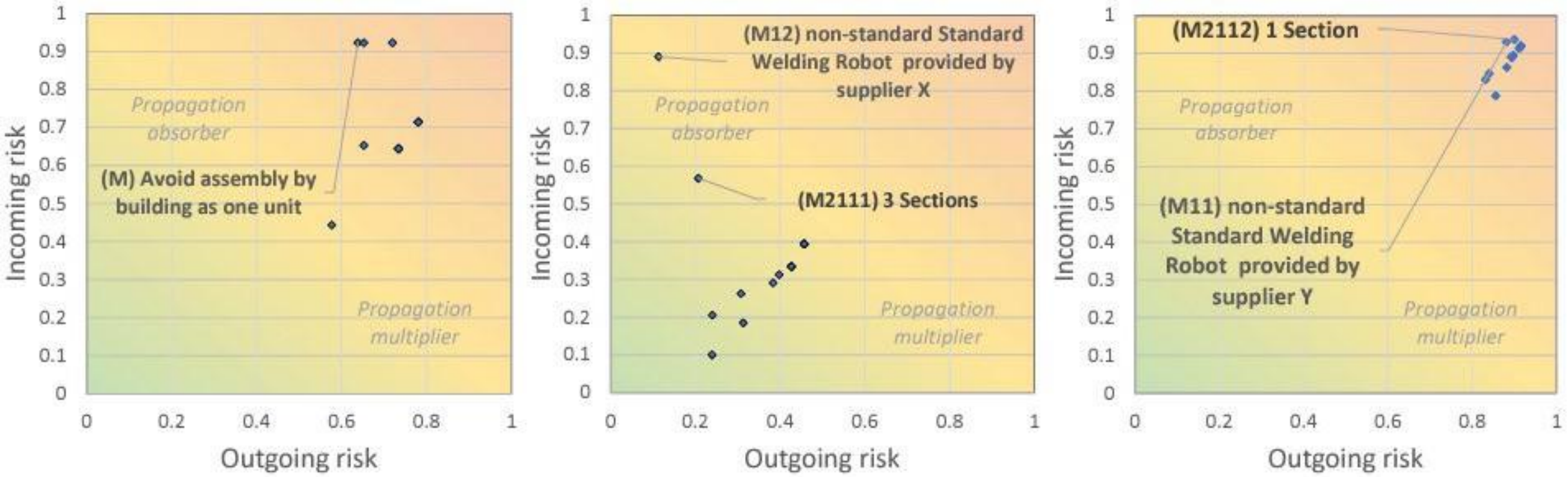


Quantified Risk Analysis of all possible combination enabled

(Using Change Propagation Analysis)

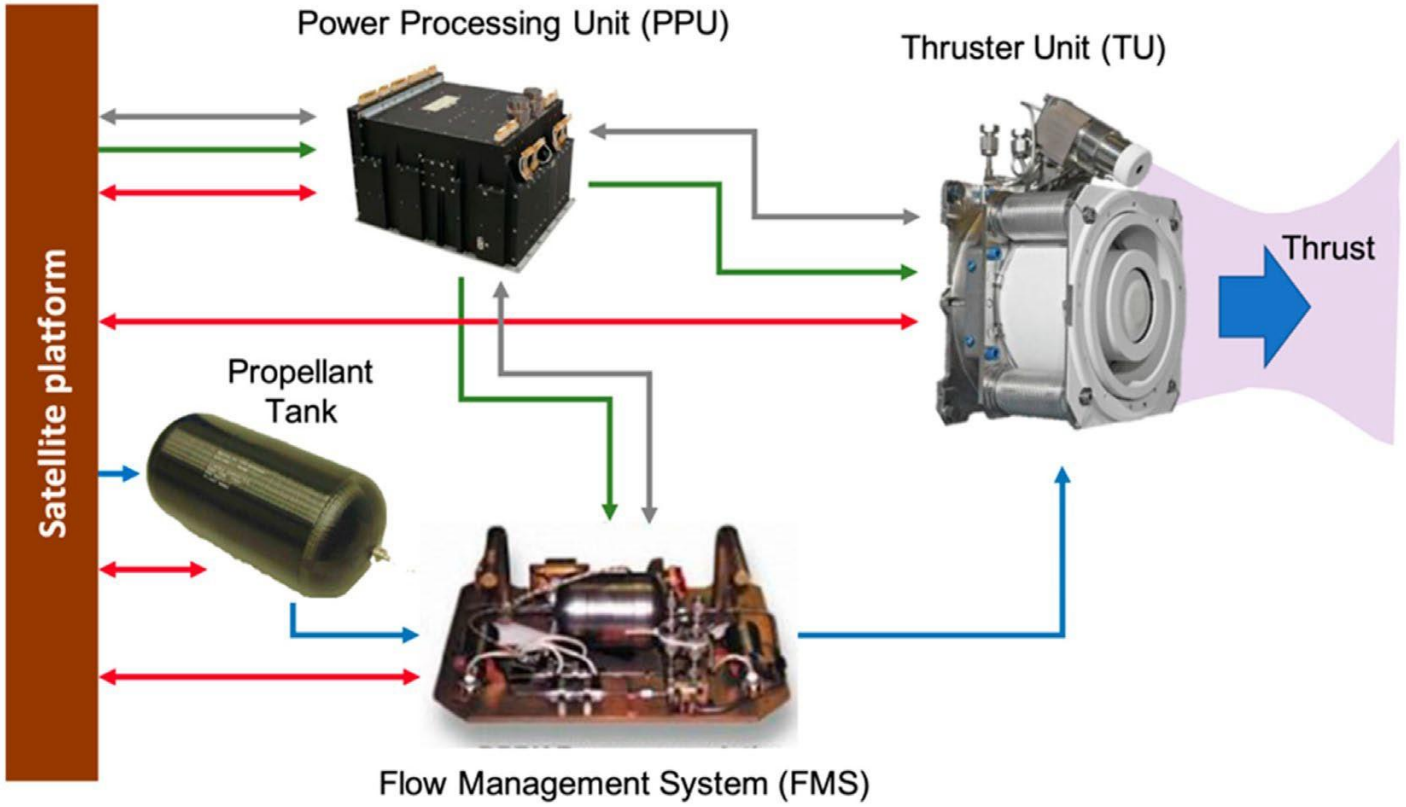
Brahma, A., Panarotto, M., Kipouros, T., Isaksson, O., Andersson, P., & Clarkson, P. J. (2023). Function driven assessment of manufacturing risks in concept generation stages. *Proceedings of the Design Society*, *3*, 1995-2004.

Risk evaluation of alternative architectures



Brahma, A., Panarotto, M., Kipouros, T., Isaksson, O., Andersson, P., & Clarkson, P. J. (2023). Function driven assessment of manufacturing risks in concept generation stages. *Proceedings of the Design Society*, *3*, 1995-2004.

3. Value of alternative multi- technological architectures



- How integrated shoud a multitechnological architecture be?
- Value assessment require alternatives to be compared to market scenarios.

Model altternative modular integration architectures

- Model alternative architectures
- Explored performance of alternative degrees of integrated architectures

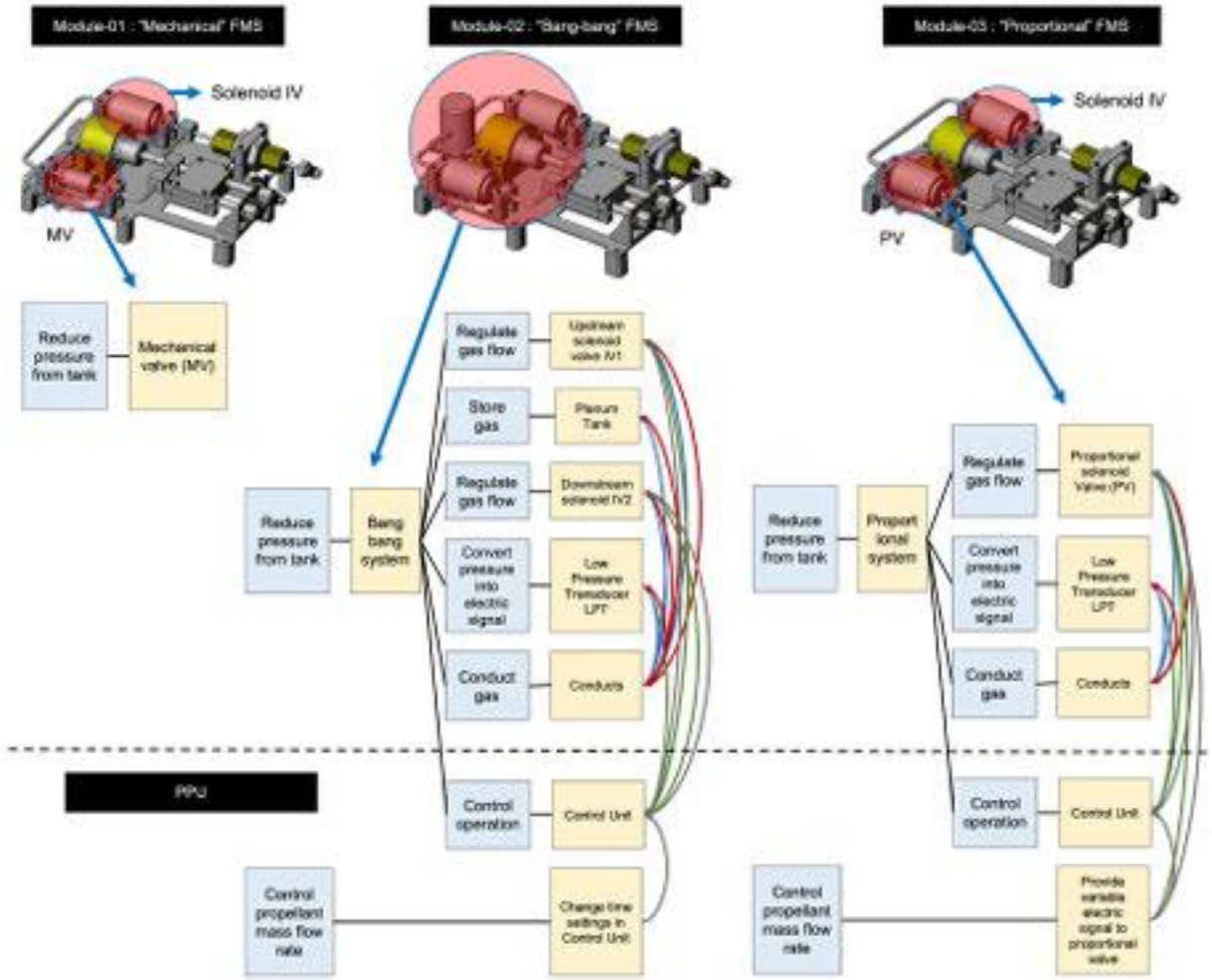
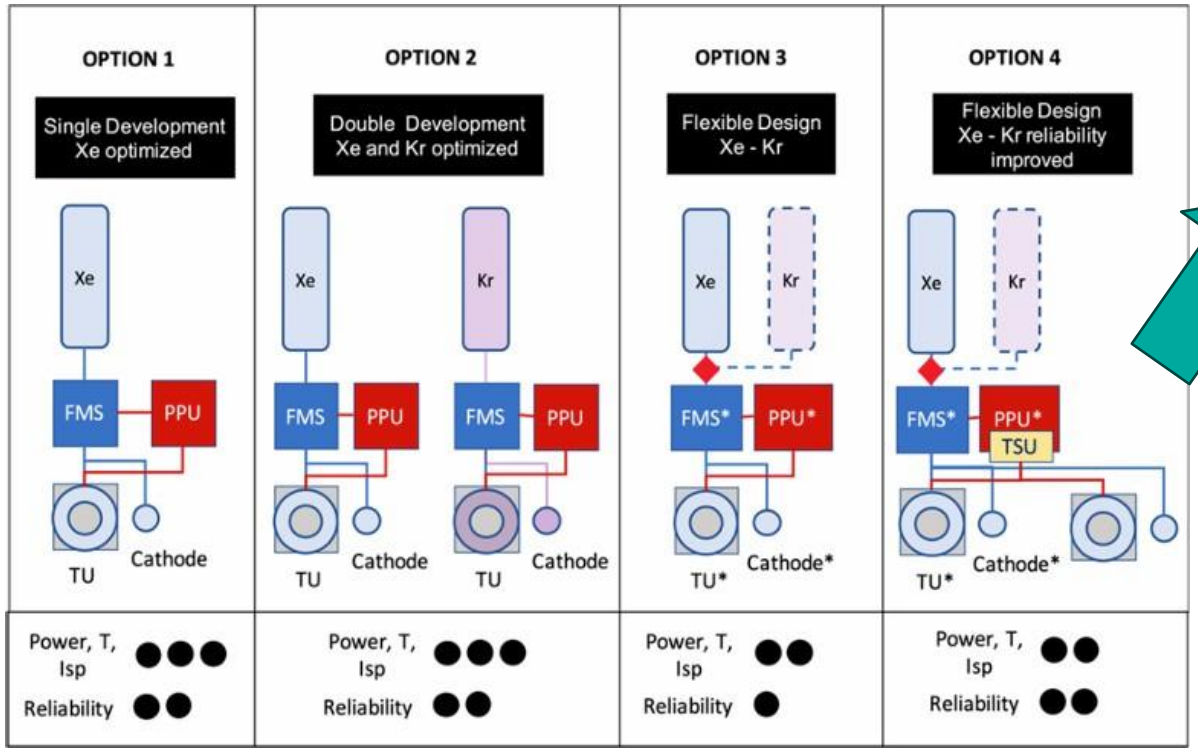
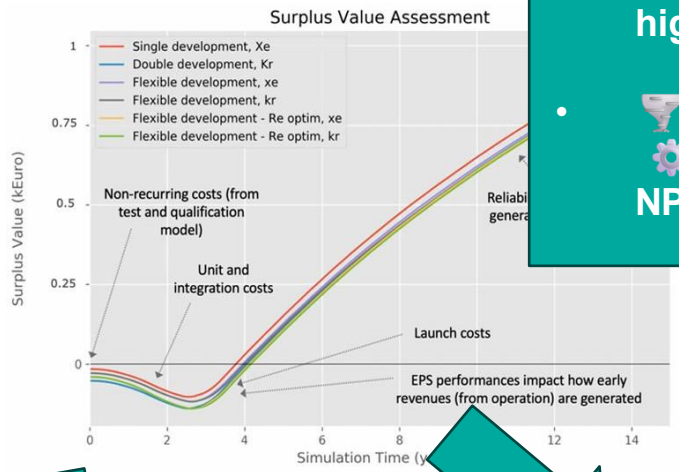
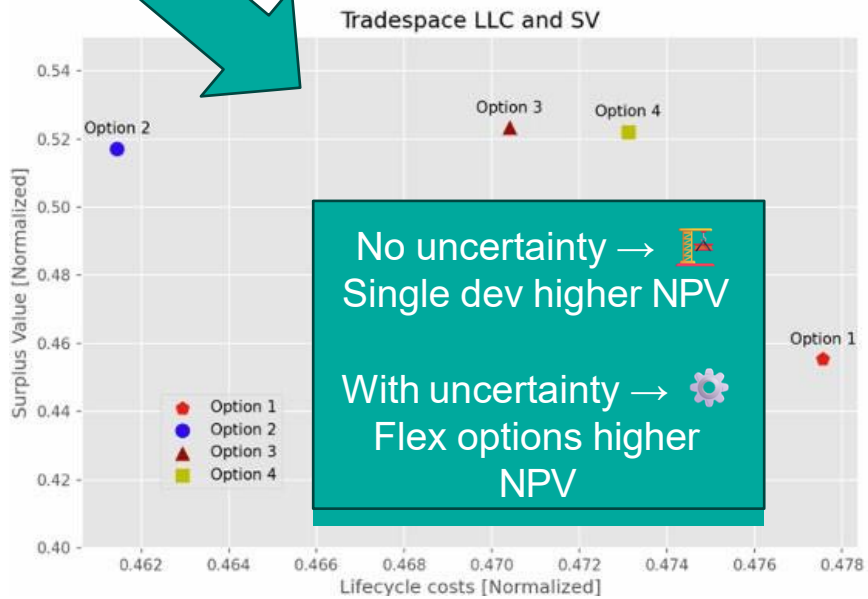


Fig. 5. Alternative Modular Platforms for the Flow Management System.

Value of alternative platforms







💰 **NPV Analysis**

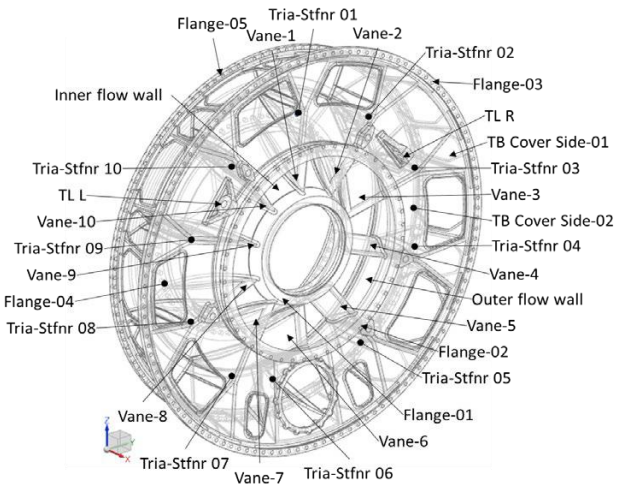
- 🧮 **No Uncertainty:** 🏗️ **Single development → higher NPV**
- 🌪️ **With Uncertainty:** ⚙️ **Flexible options → higher NPV**

Panarotto, M., Borgue, O., & Isaksson, O. (2020). Modelling Flexibility and Qualification Ability to Assess Electric Propulsion Architectures for Satellite Megaconstellations. *Aerospace*, *7*(12), 176. https://doi.org/10.3390/aerospace7120176

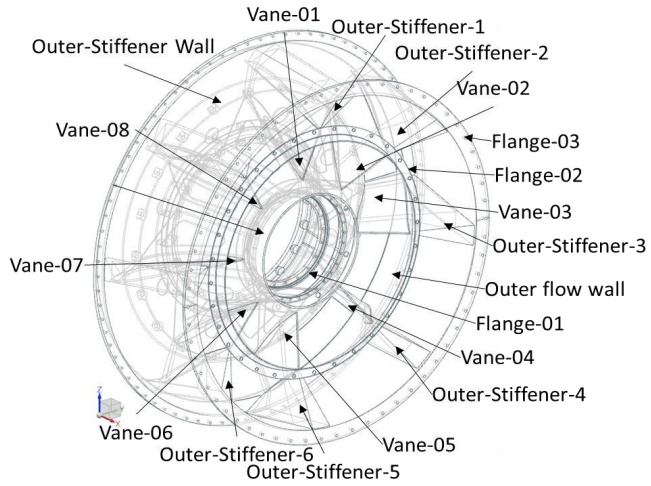
4. Measure complexity and similarity???

Can complexity be systematically determined?

Product 1

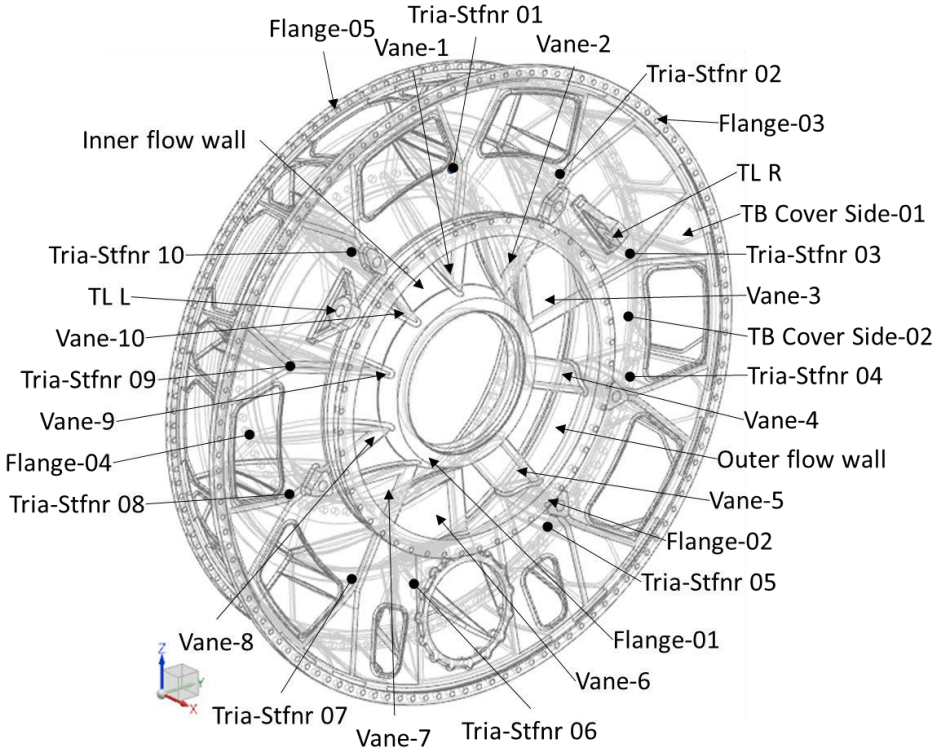


Product 2

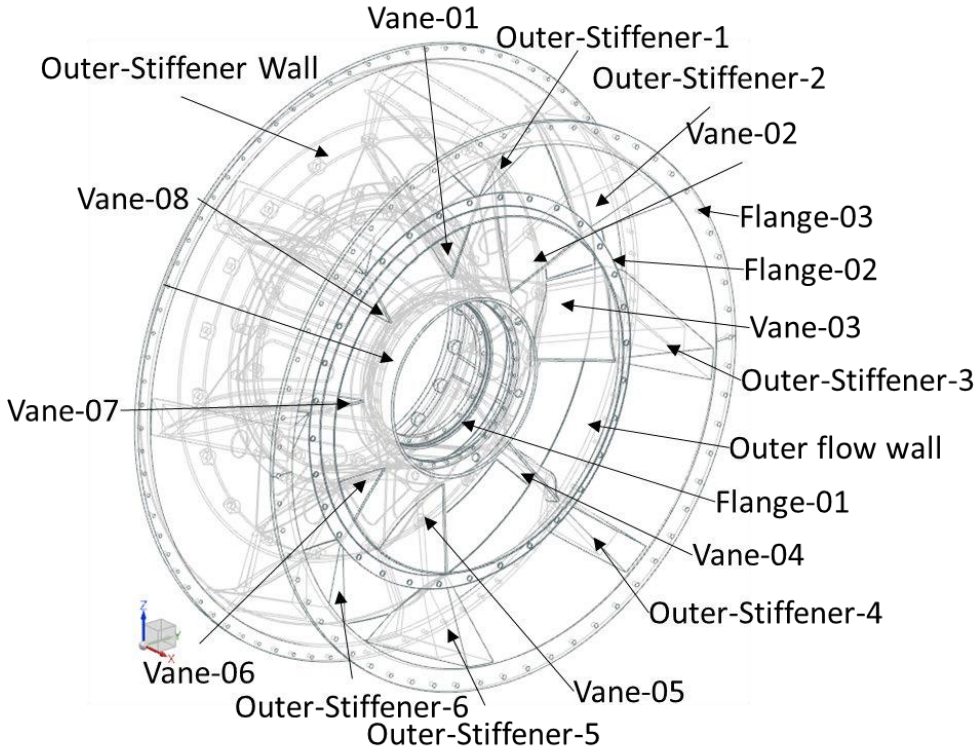


Comparing risk and effort to develop functionally integrated products?

Product 1



Product 2



How can we measure Complexity of Integrated Products?

Components (C1)

Interactions (C2)

Layout (C3)

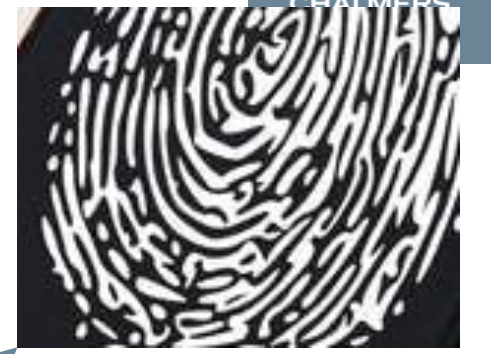
$$C = C1 + C2C3$$

SINHA, K. & DE WECK, O. L. 2016. Empirical Validation of Structural Complexity Metric and Complexity Management for Engineering Systems. *Systems Engineering, 19*, ***193-206.***

Architecture Metrics and

Product 2, Only 25 % more complex

But 50% more expensive!

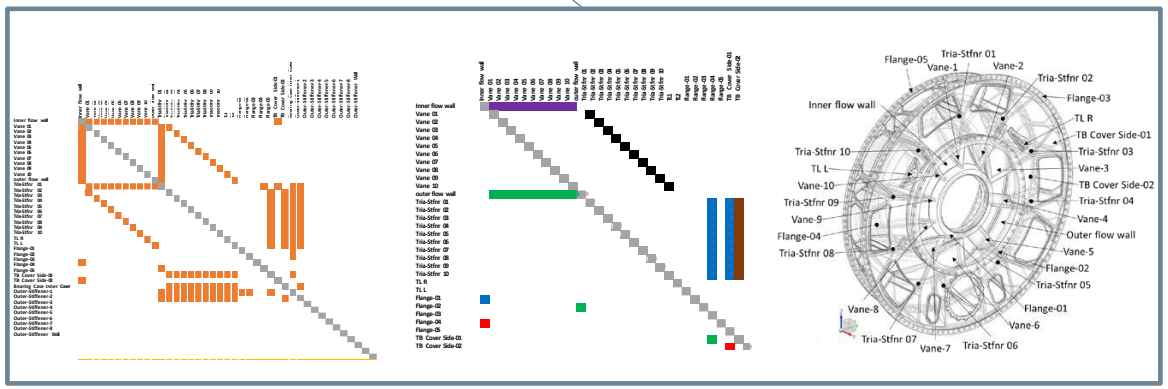


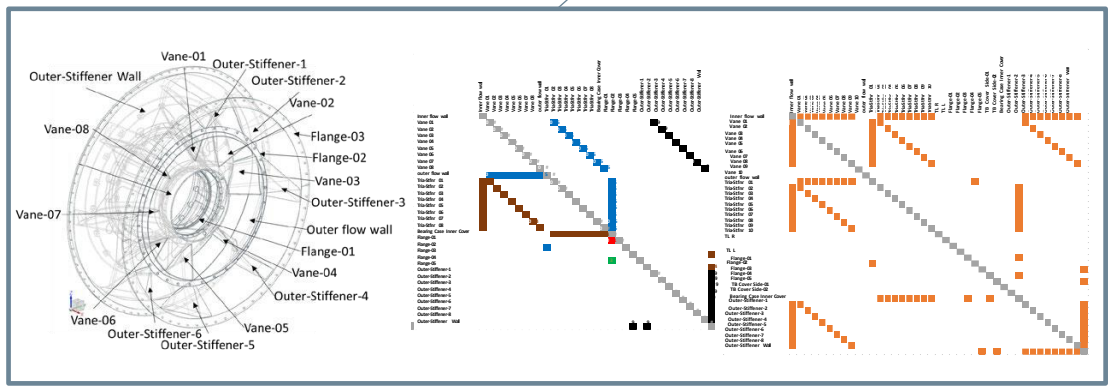
Archirecture Figerprint!

C = 236

C = 296

Archirecture Figerprint!





RAJA, V., JOHANNESSON, H. & ISAKSSON, O. 2018. Describing and evaluating functionally integrated and manufacturing restricted product architectures. Research in Engineering Design, 29, 367-391.

Raja, Visakha., Kokkolaras, Michael., Isaksson, Ola. 2018. “A Simulation-assisted Complexity Metric for Integrated Architecture Aero-engine Structures Design”.

Methods to design and analyse modular architectures

Examples

Message

What is next

Message

> Formal METHOD to describe modules enable modular engineering
  - Enables mixed technology/disciplinary products (software, electric, physical, etc)

> Methods developed to ensure repeatable, robust evaluation of modular architectures

Examples shown

- RISK — Possible to evaluate risk of alternative architectures
- FLEXIBILITY — A metric is available for use
- VALUE TRADE OFF — Foster communication between programs and engineering
- COMPLEXITY — Can be quantified and included in modelling
- … — More underway…

➢ Implementation in modelling tools enable scaleability and impact

Example: TRINITY for Function-Means Modelling

Methods to design and analyse modular architectures

Examples

Message

What is next

Research

- **New Project started** together with VOLVO on how to enable combined software and hardware architecture and definition in ”Design for Data as a Product (DDaaP)” VINNOVA FFI
- **Preparing National Wide research** to enable DATA DRIVEN DESIGN using advancements in digital infrastructure
- Exploring **novel approaches** to manage margins, field effects etc for modularity
- **European** research and education initiatives via ERASMUS **open**.
- **Open for collaboration** – do contact Ola.Isaksson@chalmers.se and Massimo.Panarotto@polimi.it.

Setting up a project

Each Alliance shall implement a coherent, comprehensive and variable set of interconnected activities to enhance innovation in higher education, vocational education and training and enterprises (including large, small and medium-sized enterprises and social enterprises) and the broader socio economic environment.

Lot 1: Alliances for Education and Enterprises

At least one of the following activities (non-exhaustive list) should be included in each Alliance for Education and Enterprises:

Boosting innovation

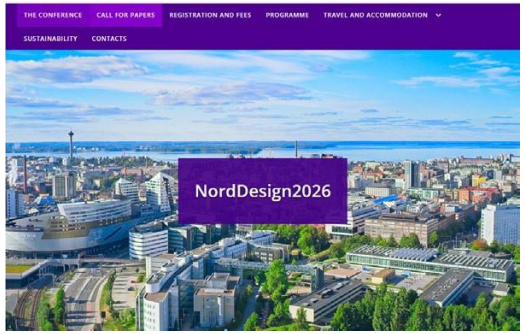
- jointly developing and implementing new learning and teaching methods (like new multidisciplinary curricula, learner-centred and real problem-based teaching and learning using innovative technologies and making greater use of micro-credentials)
- developing and testing continuous education programmes and activities with and within enterprises
- developing and implementing educational and training programmes to support the development of skills needed in the deep-tech domains
- setting up incubators within education and training institutions across Europe, in close cooperation

Education

- Preparing next summershool in Product Architecture Design

- 2022 in VOLVO (CHALMERS/VOLVO)
- 2024 in HAMBURG (TUHH)
- **2026 in COPENHAGEN (DTU) (Late June 2026)**

- **https://www.tuhh.de/pkt/aus-weiterbildung/wissenschaftliche-veranstaltungen/pad-summer-school**



ICED is the Design Society's biennial flagship event, uniti
educators to share advances in design. Covering methoc
and emerging technologies, it fosters academia-industr
workshops, and networking, strengthening the internatic

n

The 26th Internation: on Engineering Desig (ICED27)

Hamburg, Germany
16 - 20 August 2027

Call for Papers: **May 2026**
Full Paper Submission Deadline: **December 2026**

Conferences

- Venues to meet, present, educate, discuss
- Upcoming 2026 (with a clear content on MODULAR strategies, tools and methods)
- The NORDDESIGN conference, 12.-14.8.2026, Tampere, Finland
- The International DSM Conference, Milan Italy October 2026
- ICED 2027 in HAMBURG – Aug 2027


POLITECNICO
MILANO 1863
The 28th International DSM Conference
Milan, Italy,
September 29-October 1, 2026

PLEASE JOIN US IN MILAN!

- Conference Theme: *"Threads of collaboration: Interlacing Minds and Machines"*
  - *The conference will take place one week after the Milano Fashion Week*
- Venue: Bovisa Campus, Politecnico di Milano
- Co-organized with the involvement of ABB
- Endorsement by the Design Society under approval

Some references used

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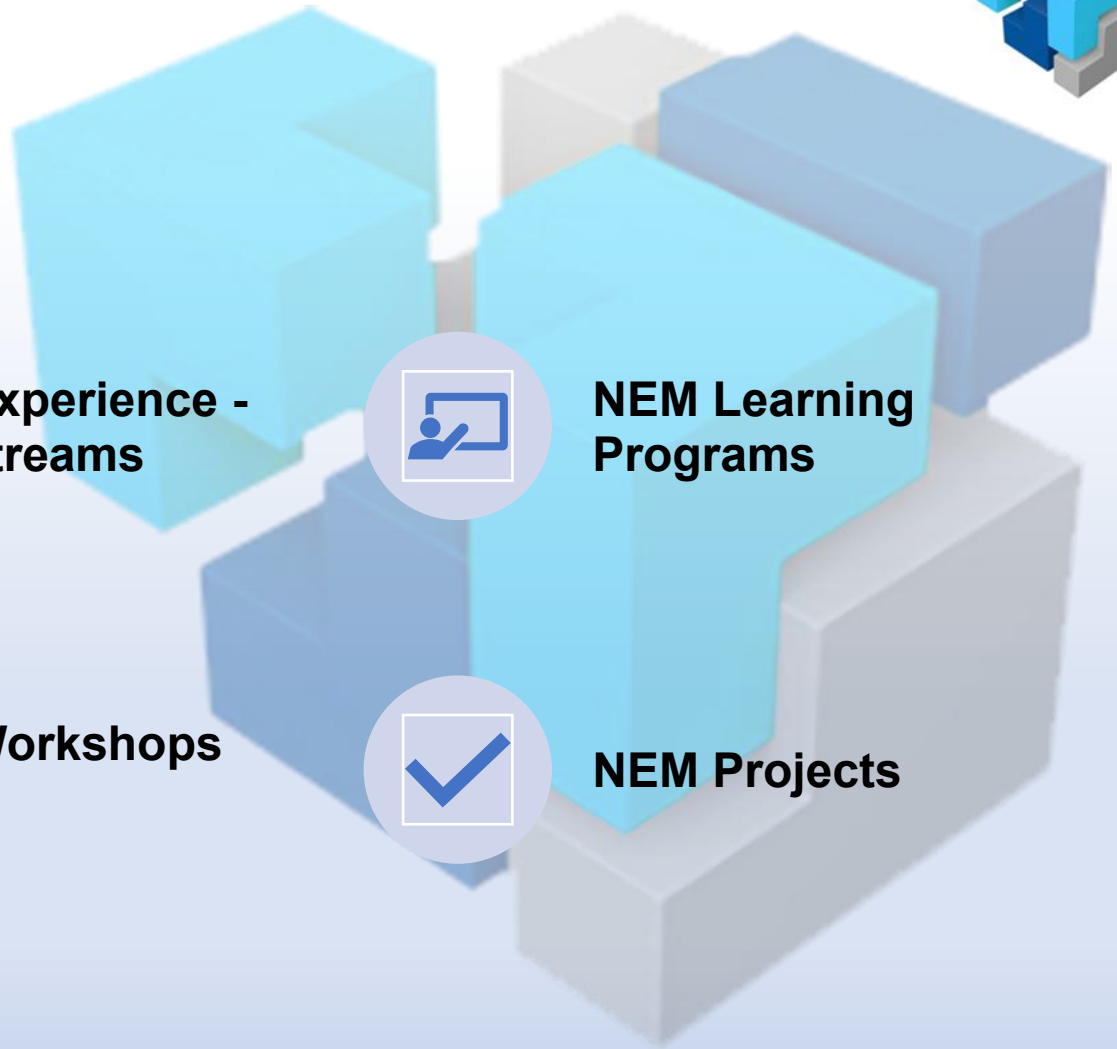
- Bonde, J. M., Breimann, R., Malmqvist, J., Kirchner, E., & Isaksson, O. (2024). The impact of specialized software on concept generation. *Proceedings of the Design Society*, *4*, 663-672.
- Alonso Fernández, I., Panarotto, M., and Isaksson, O. (June 7, 2024). "Modeling Technical Risk Propagation Using Field-Effects in Automotive Technology Infusion Design Studies." ASME. J. Mech. Des. December 2024; 146(12): 121702. https://doi.org/10.1115/1.4065611

CHALMERS

UNIVERSITY OF TECHNOLOGY

N.E.M.



NEM Network – Meetings/Webinars

NEM Experience - Workstreams

NEM Learning Programs

NEM Services

NEM Workshops ++

NEM Projects

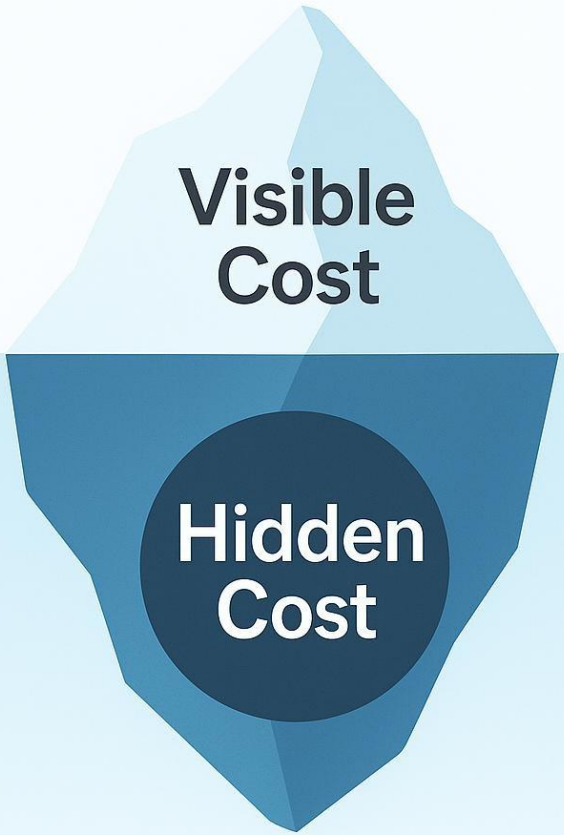
AIMO

TERMA

EXHAUSTO

KM
Reliable.
Flexible.
Available.

RUNI
TURN WASTE TO VALUE



DTU

N.E.M

AARHUS UNIVERSITY

INDUSTRIENS FOND

Thomas B. Thriges Fond

Agenda

- Why Financial systems cannot do modularization!
- Results
- How can AIMO assist modularization

Why do we still strugle to quantify the potential of modularization

Because our financial systems cannot share cost objects !!!

Definition

“Indirect costs are costs that are not directly accountable to a cost object”

Fact

Terma
+35.000 parts
+10.000.000 relations

What can we ask then ?

How much have the product earned ?

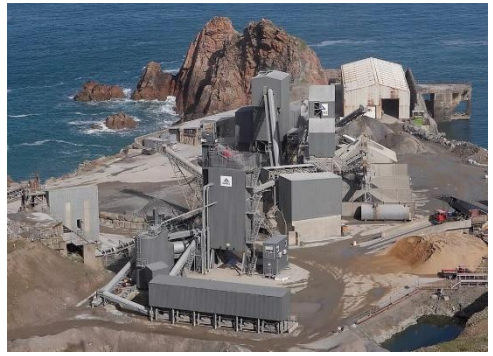
What can we ask then ?

But not how much have the company earned on the product ?

3 Years
Hundreds of interviews
And many different
methods tested

RUNI
TURN WASTE TO VALUE

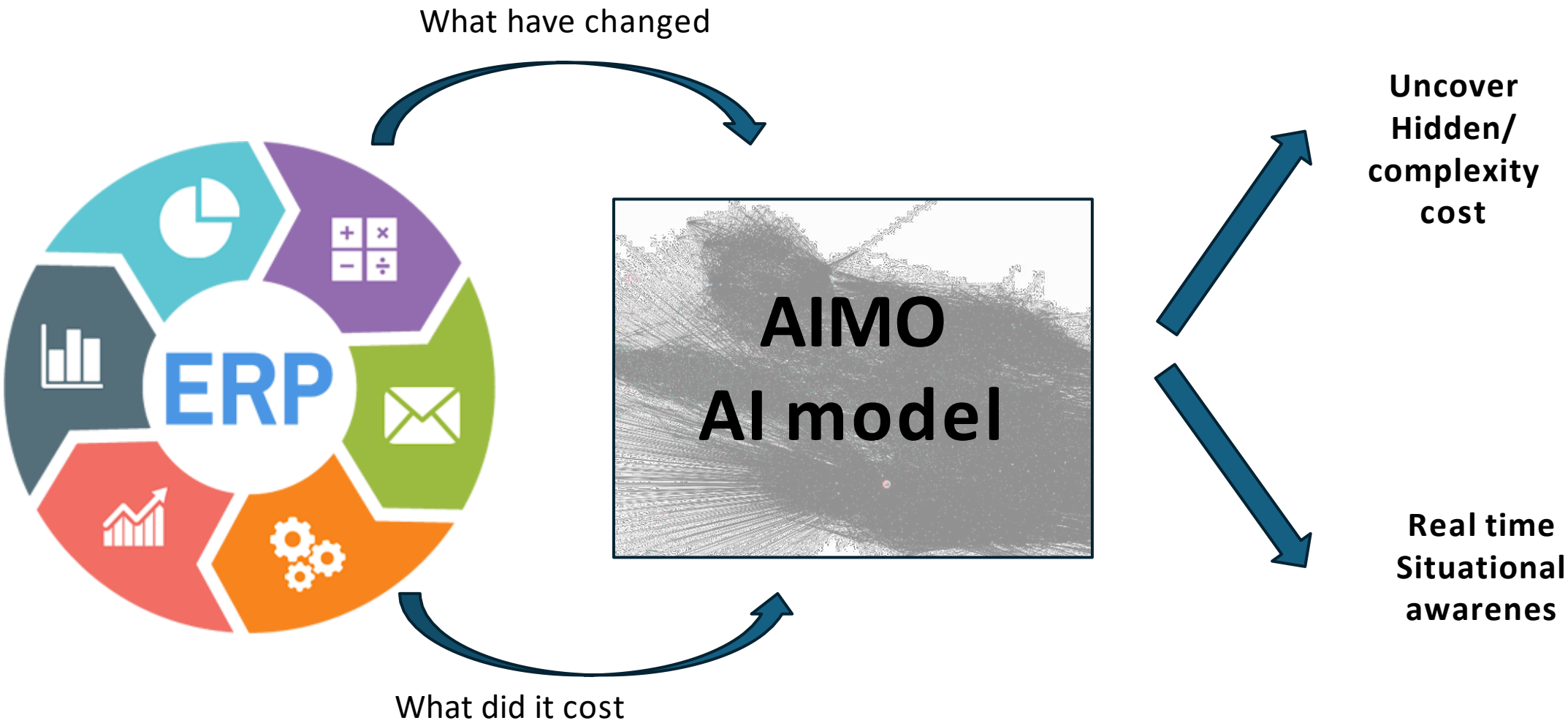
K-M
Reliable.
Flexible.
Available.



TERMA

EXHAUSTO

The solution



Results – Is it important ?

6 Years ago Terma made a new variant of a Antenna

Existing product
HG antenna

New product
Compact antenna

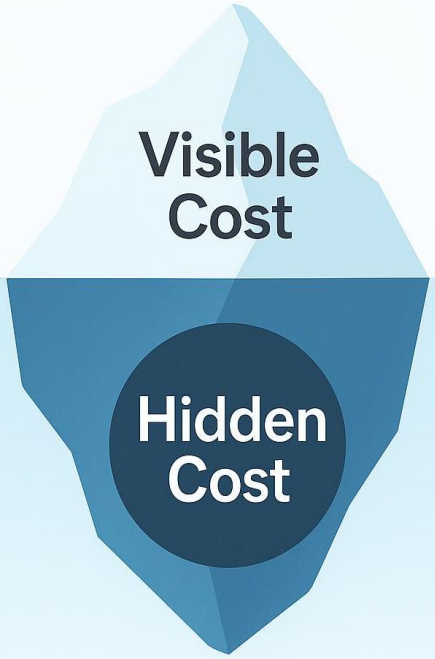
How much did we save

	Compact	HG
Total direct cost	31.863.180,48 kr.	45.080.000,00 kr.
Product Developement	4.119.062,03 kr.	
Savings	**9.097.757,49 kr.**	

Return on Investment 52%

With AIMO uncovering the hidden cost

	Compact	HG
Unit cost	31.863.180,48 kr.	45.080.000,00 kr.
Product Developement	4.119.062,03 kr.	- kr.
Procurement	1.662.043,00 kr.	516.685,00 kr.
Shipping	602.246,00 kr.	187.223,00 kr.
Wharehouse	1.173.206,00 kr.	364.718,00 kr.
Planning	1.766.319,00 kr.	540.077,00 kr.
Sustainment	1.029.600,00 kr.	- kr.
Quality	18.287,00 kr.	- kr.
Production engineering	94.424,00 kr.	- kr.
Sourcing	61.640,00 kr.	- kr.
Direct cost savings increased sales HG		- 7.937.644,82 kr.
Total	42.390.007,51 kr.	38.751.058,18 kr.
Savings	**-**	**3.638.949,33 kr.**



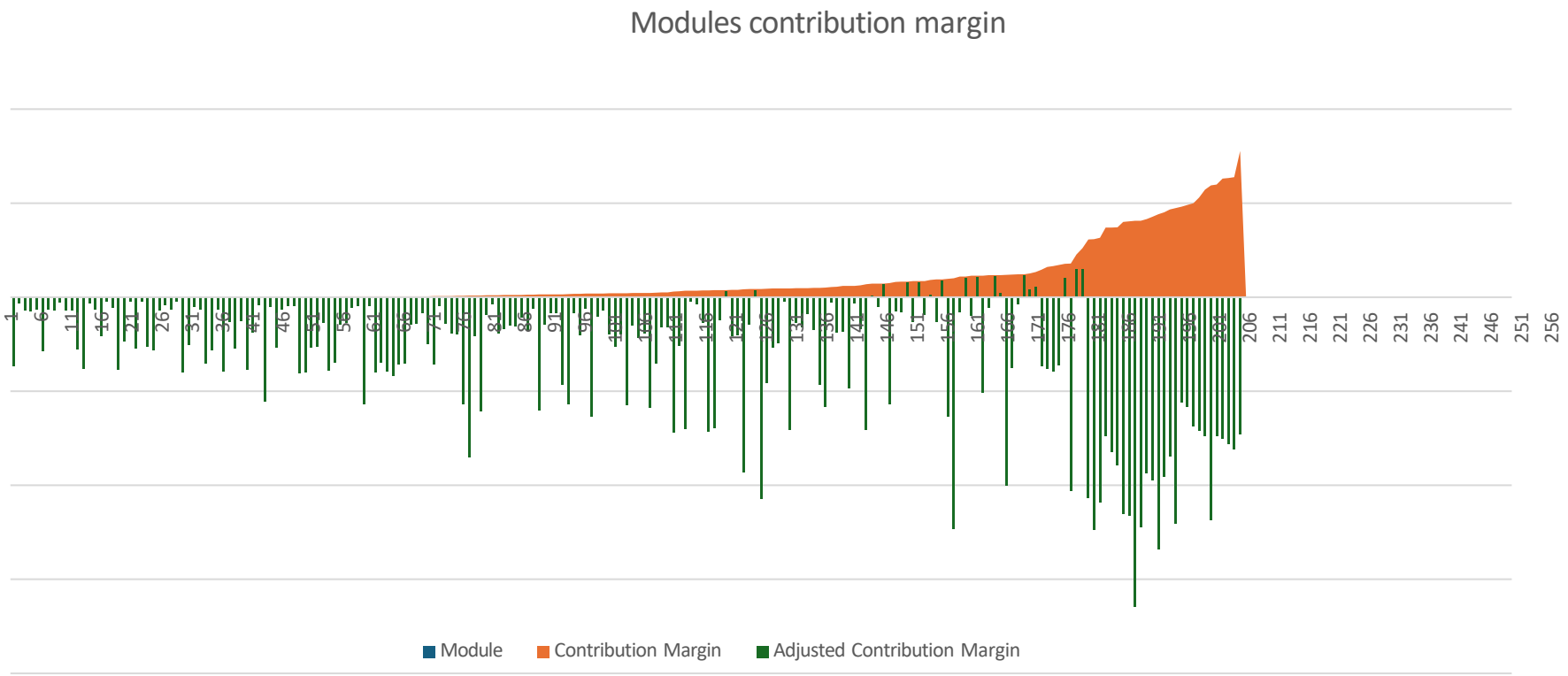
Return on Investment -92%

What can we learn from an existing modular platform making the new

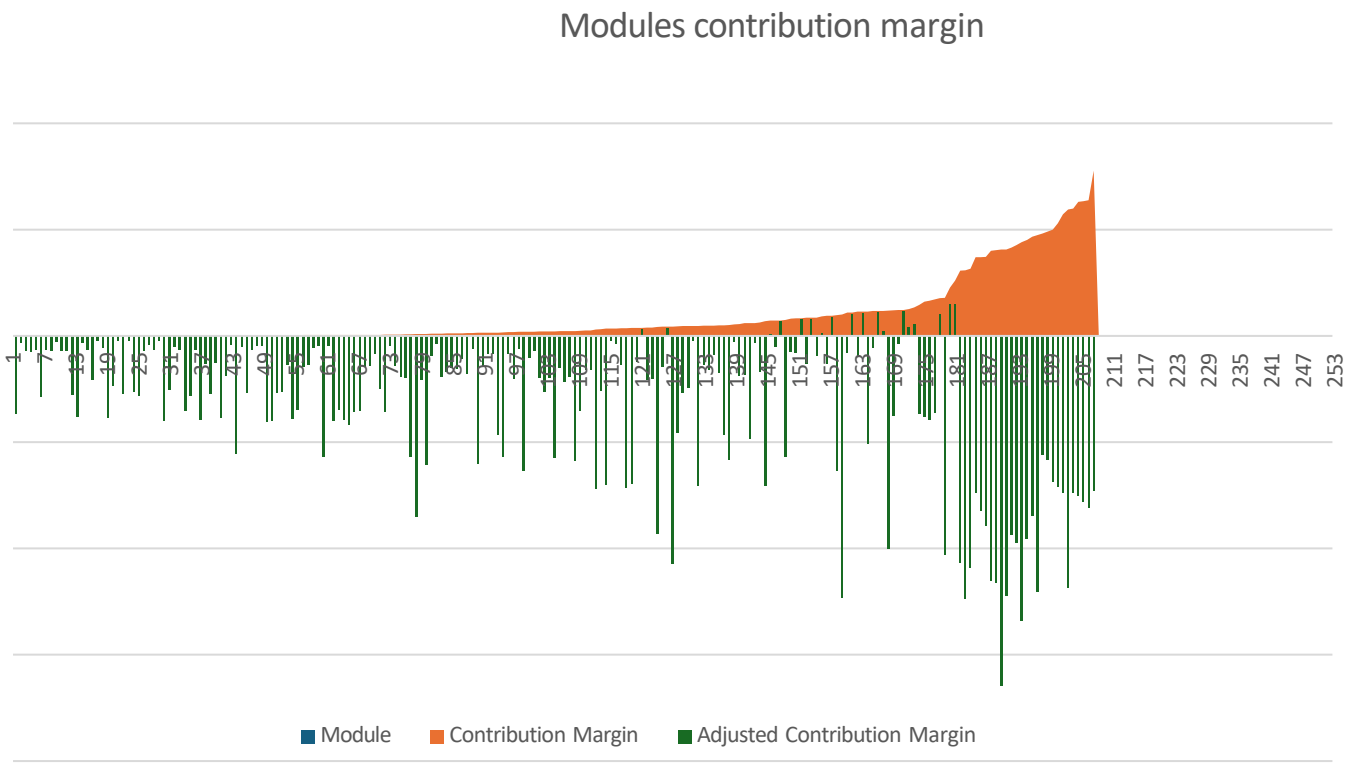
EXHAUSTO

- Build partly by consultants
- Modules are ungoverned
- Modules can only be shared within a size (10 sizes)
- Philosophy all sizes must have all modules

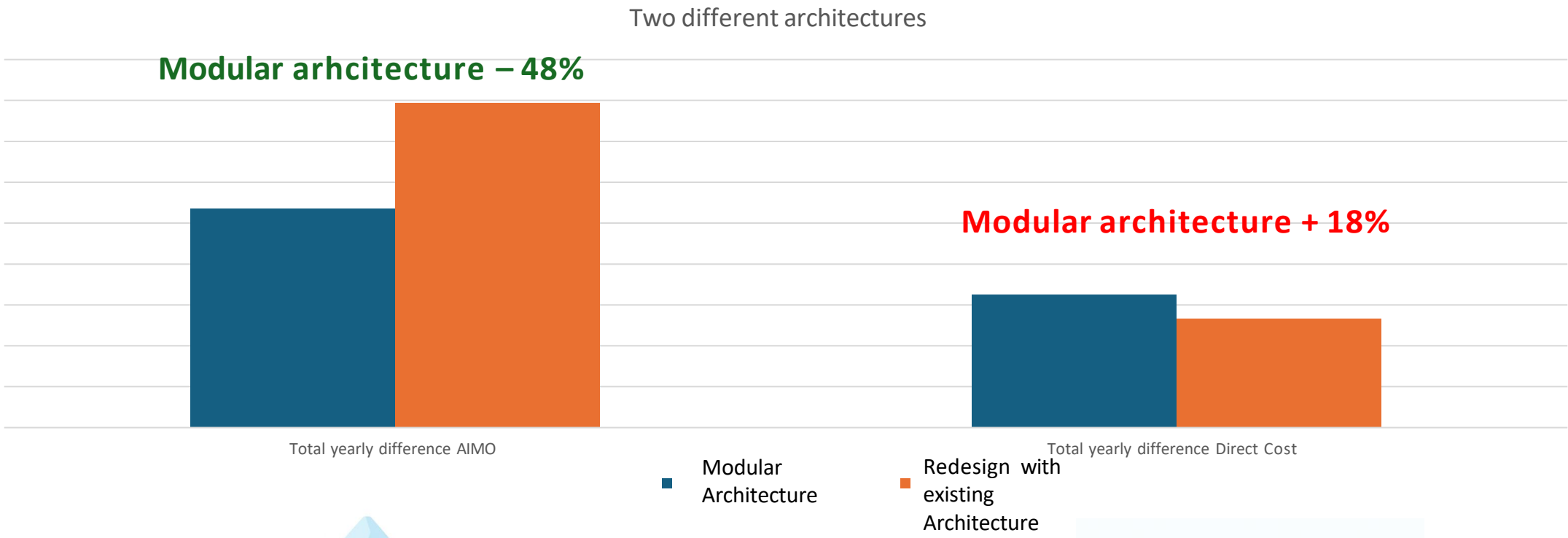
Only 9% of modules have been profitable



We carry to much complexity



Simulation of two architectures for new radar product architecture in Terma



What can the AIMO do

AIMO can quantify Hidden / complexity / indirect cost

This can show the ”hidden” potential of modular products

- *Modularization has much more potential than current systems can quantify*

Assist governance of modular platforms

- *Current systems is biased towards creating new variants because the hidden cost are ”free”*

Prototype Tool
Decision Support for variation decisions

Make full cost and life cycle estimates on

- Replacing variants and or
- Introducing variant and or
- Removing variants

This can be done in seconds

And can be implemented to all affecting variation

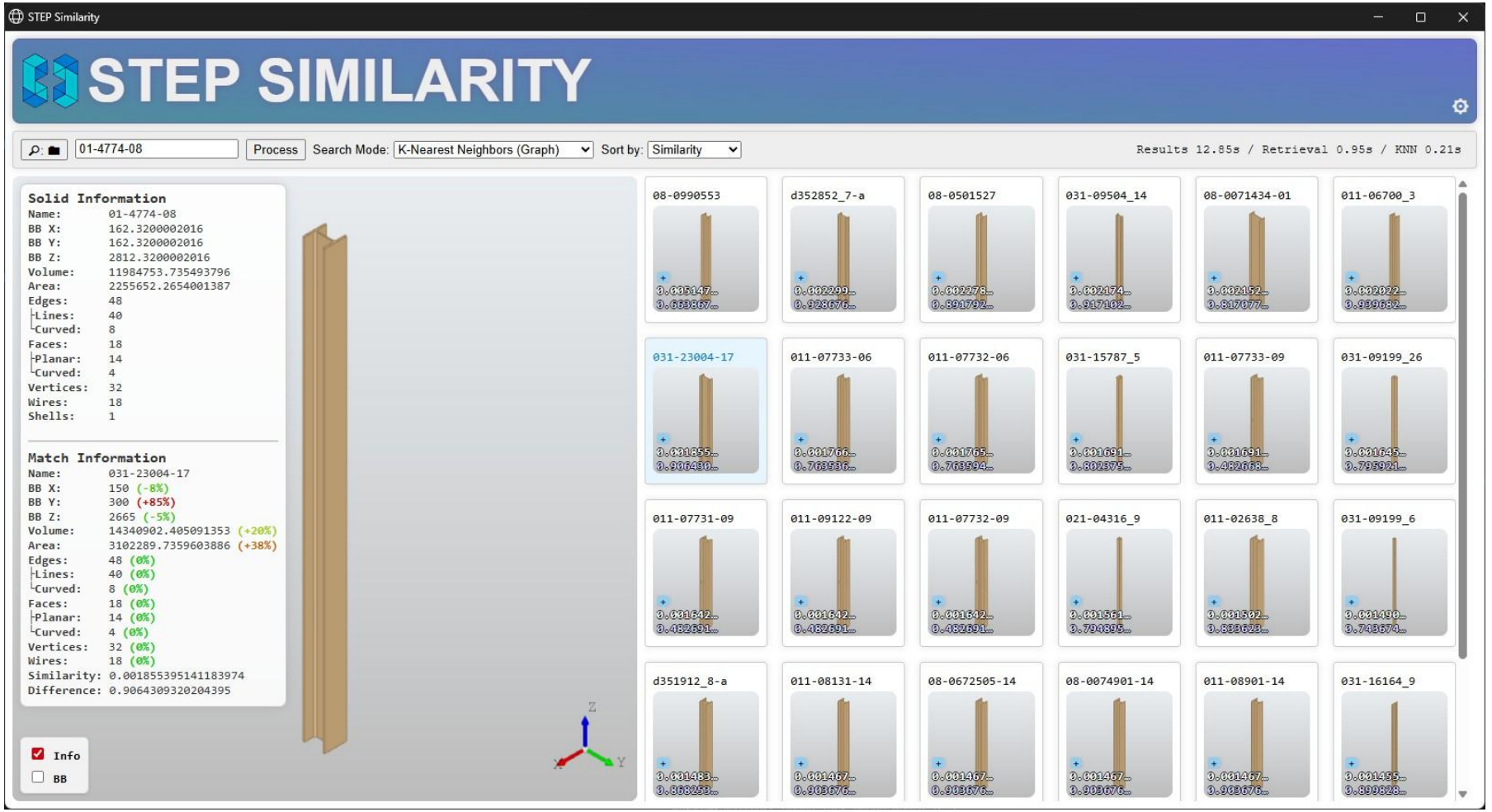
Prototype Tool
Situational awareness

In sales direct cost can vary up to 10-15 % from the average depending on pipeline, stock levels etc.

Affecting salesman behaviour to most profitable solution

We can also make sure procurement and planning gets noticed to capture the gains

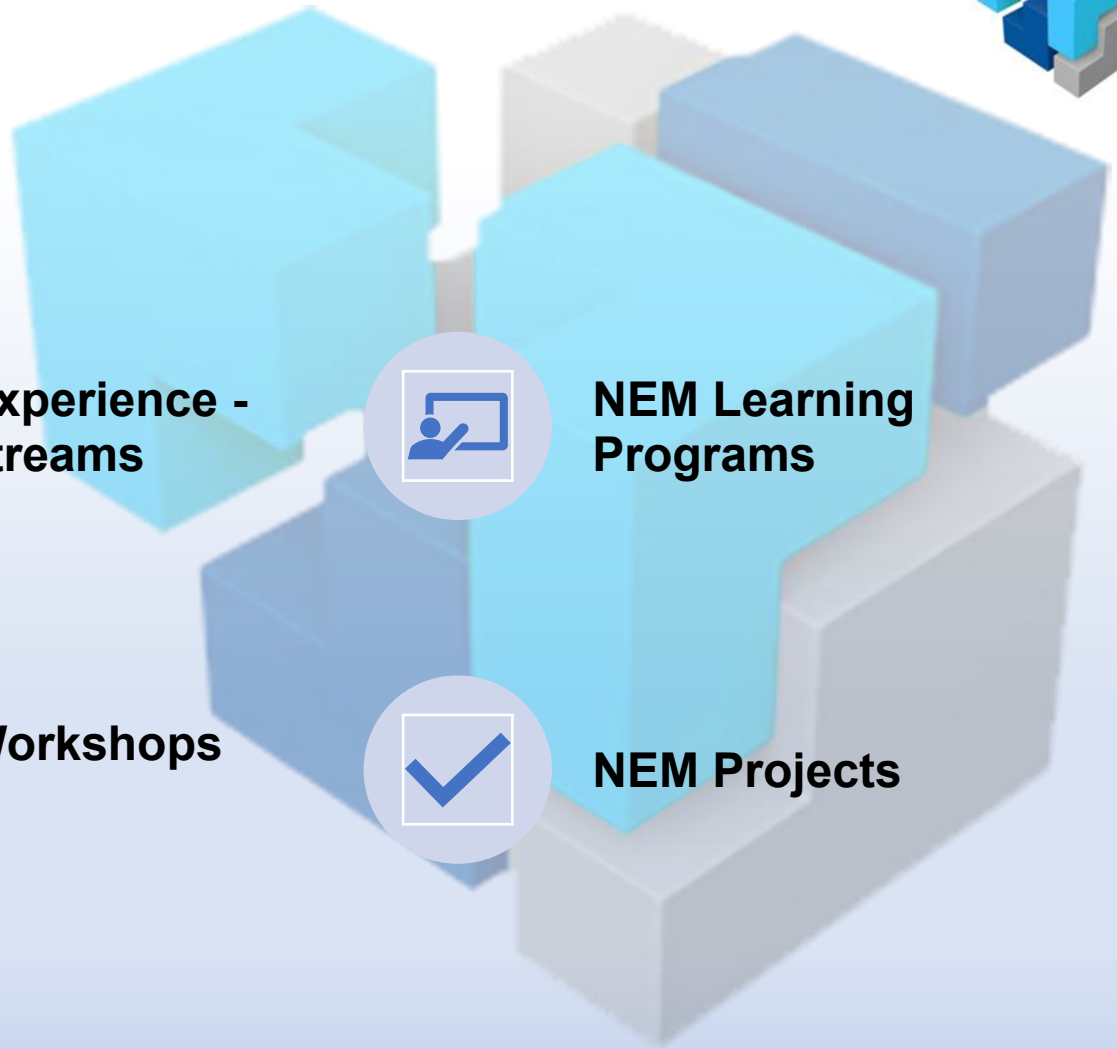
Combining cost with CAD recognition to bring in the physical constraints and suggest alternativs



Next steps for AIMO

- Establish coorperations with companies
- Get funding and launch first commercial offerings
- Build and scale AIMO offerings to other companies

N.E.M.



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NEM Projects

08.10.2025

Odego

Data-based modular development

We empower teams to plan, develop, and execute complex products with data-driven precision.

Hands-on consulting

Software Cquenz

Technical Support

Jungheinrich | Scheuch | Baader | Amazone | FFG Umwelttechnik | Syntegon | Reintjes | KHS | Eppendorf | WAS Ambulanzfahrzeuge | SMB | Achenbach | Viega | Reinhardt-Technik | Siemens | Jenoptik | thyssenkrupp Marine Systems ...

Since 2014

in Hamburg

+2 Mio	-70%	-15%	-60%	-15
Sales	Article codes	Material cost	Construction h	Weeks delivery time

About me

Dr. Sandra Szech

+ **CEO and founder**
  Odego GmbH since 2014 in Hamburg

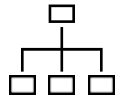
+ **PhD**
  PKT Institute for product development and mechanical engineering design at TUHH

+ **Mechanical engineer**
  TU Berlin and KTH

Our services

Product management
Analyzing & customizing highly variant portfolios

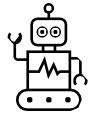
Product development
Developing product concepts, architectures and modular systems



Product maintenance
Establishing processes and structures for long-term successful products

Cquenz
Planning, designing and evaluating products with our software solution Cquenz

Data empowerment
Establishing structures for continuous data analysis in complexity, portfolio & product management as well as development

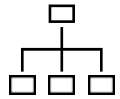


GenAI
Generating competitive advantages with genAI

Our services

Product management
Analyzing & customizing highly variant portfolios

Product development
Developing product concepts, architectures and modular systems



Product maintenance
Establishing processes and structures for long-term successful products

Cquenz
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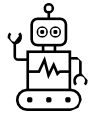
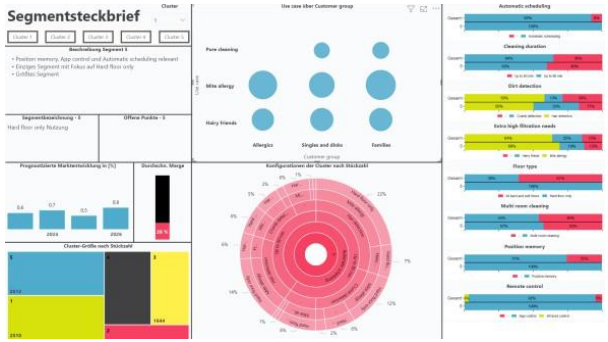
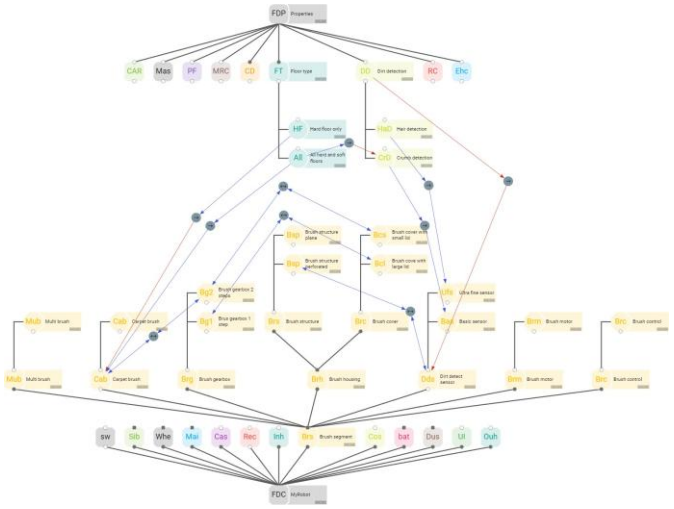


GenAI
Generating competitive advantages with genAI

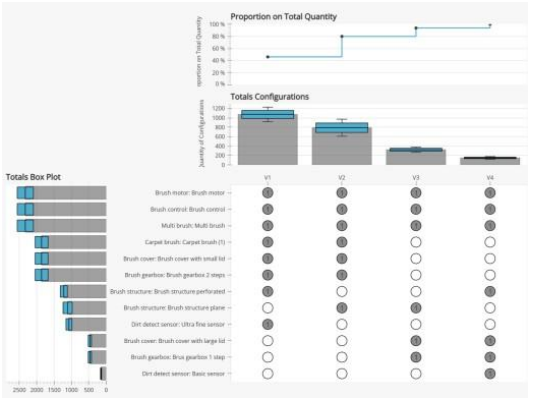
Data-based development in product management and engineering



Analyzing portfolios

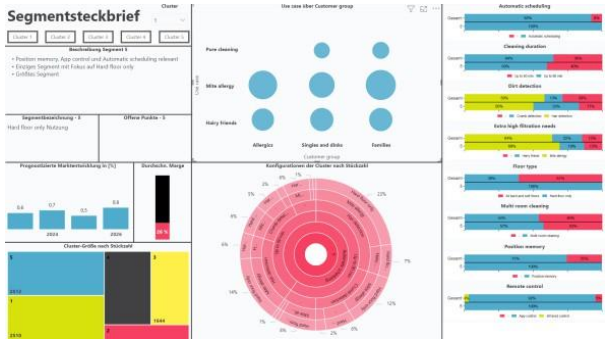


Developing modular systems

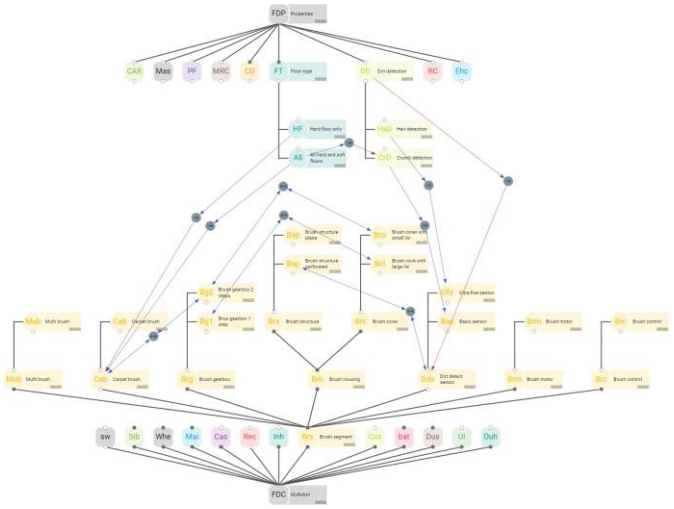


Simulating costs, lot size, rollout, CO2

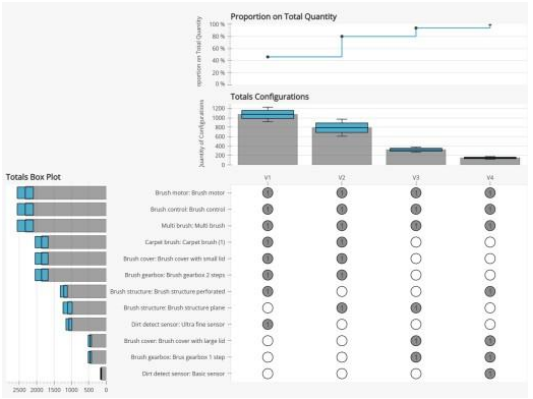
Data-based development in product management and engineering



Analyzing portfolios



Developing modular systems



Simulating costs, lot size, rollout, CO2

General	General	General	General	General	General	General	General	General	General	External	External	External	External	External	External	External	External	External	External	External	External	External
ID	Kunde	Year	Branche	Age group	status	Region	price	costs	margin	Intelligent navigation	Dirt detection	Additional	Additional	Additional	Color	Position m	Automatic	Multi room	Recomme	Floor type	Remote co	Extra high
220	Kunde LRC	2024	Nerds	20<40	won	Amerika	300,53 €	55,50 €	245,04 €	Intelligent navigation	-	-	-	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
221	Kunde YKO	2024	Nerds	20<40	won	Asien	303,94 €	18,48 €	285,45 €	Intelligent navigation	Hair detection	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Mite allergy
222	Kunde WGG	2024	Nerds	20<40	won	Westeuropa	318,88 €	75,36 €	243,52 €	Intelligent navigation	Hair detection	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Mite allergy
223	Kunde JDN	2024	Nerds	20<40	won	Osteuropa	307,10 €	25,57 €	281,53 €	Intelligent navigation	Hair detection	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Hairy friend
224	Kunde YOF	2024	Nerds	20<40	won	Osteuropa	326,01 €	38,97 €	287,03 €	Intelligent navigation	-	yes	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	-
225	Kunde SWO	2024	Nerds	20<40	won	Westeuropa	305,69 €	54,45 €	251,24 €	Intelligent navigation	-	yes	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
226	Kunde MBV	2024	Nerds	20<40	won	Osteuropa	318,22 €	76,90 €	241,32 €	Intelligent navigation	-	yes	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
227	Kunde FGY	2024	Nerds	20<40	won	Osteuropa	307,60 €	48,13 €	259,47 €	Intelligent navigation	-	yes	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
228	Kunde MWV	2024	Nerds	20<40	won	Asien	320,56 €	74,69 €	245,87 €	Intelligent navigation	-	yes	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
229	Kunde ZFL	2024	Nerds	20<40	won	Asien	302,53 €	8,13 €	294,39 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	-
230	Kunde JOQ	2024	Nerds	20<40	won	Asien	333,92 €	70,29 €	263,63 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Hairy friend
231	Kunde ZHE	2024	Nerds	20<40	won	Asien	309,09 €	62,72 €	246,37 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Mite allergy
232	Kunde EHG	2024	Nerds	20<40	lost	Amerika	298,96 €	40,51 €	258,46 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Hairy friend
233	Kunde JWM	2024	Nerds	20<40	won	Amerika	308,06 €	49,72 €	258,34 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Hairy friend
234	Kunde SEP	2024	Nerds	20<40	won	Osteuropa	309,51 €	63,38 €	246,13 €	Intelligent navigation	-	yes	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 60 m2	All hard and s	App control &	Mite allergy
235	Kunde FUX	2024	Nerds	20<40	won	Osteuropa	298,83 €	67,85 €	230,98 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
236	Kunde YBS	2024	Nerds	20<40	lost	Asien	299,26 €	39,99 €	259,28 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
237	Kunde CPO	2024	Nerds	20<40	won	Westeuropa	316,79 €	75,60 €	241,19 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
238	Kunde LQZ	2024	Nerds	20<40	won	Osteuropa	298,59 €	54,00 €	244,59 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
239	Kunde UZZ	2024	Nerds	20<40	won	Westeuropa	295,67 €	18,65 €	277,02 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
240	Kunde BIM	2024	Nerds	20<40	won	Osteuropa	307,89 €	39,08 €	268,81 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
241	Kunde ILP	2024	Nerds	20<40	won	Amerika	309,66 €	71,86 €	237,80 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
242	Kunde WXI	2024	Nerds	20<40	won	Osteuropa	292,78 €	29,64 €	263,14 €	Intelligent navigation	-	-	Soft Floor Bru	-	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
243	Kunde LRW	2024	Nerds	20<40	won	Amerika	305,76 €	69,06 €	236,70 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
244	Kunde OYY	2024	Nerds	20<40	won	Asien	301,63 €	57,88 €	243,75 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Hairy friend
245	Kunde XEP	2024	Nerds	20<40	won	Asien	309,73 €	40,50 €	269,23 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Hairy friend
246	Kunde XZC	2024	Nerds	20<40	won	Westeuropa	302,55 €	41,87 €	260,68 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Hairy friend
247	Kunde JFA	2024	Nerds	20<40	won	Amerika	306,21 €	45,12 €	261,09 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
248	Kunde WFH	2024	Nerds	20<40	won	Westeuropa	312,67 €	45,75 €	266,91 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
249	Kunde UTW	2024	Nerds	20<40	won	Osteuropa	315,12 €	49,28 €	265,84 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
250	Kunde UGI	2024	Nerds	20<40	won	Westeuropa	321,53 €	40,72 €	280,82 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
251	Kunde NYQ	2024	Nerds	20<40	won	Osteuropa	305,25 €	51,70 €	253,55 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
252	Kunde ACO	2024	Nerds	20<40	won	Osteuropa	310,10 €	46,36 €	263,73 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
253	Kunde DKT	2024	Nerds	20<40	won	Asien	296,61 €	35,93 €	260,68 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Mite allergy
254	Kunde LAO	2024	Nerds	20<40	won	Amerika	306,61 €	25,43 €	281,18 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Hairy friend
255	Kunde LIM	2024	Nerds	20<40	won	Amerika	306,24 €	38,16 €	268,08 €	Intelligent navigation	Hair detection	-	-	-	Black	Position men	Automatic sc	-	Up to 60 m2	All hard and s	App control &	Hairy friend
256	Kunde EUU	2024	Nerds	20<40	won	Asien	320,29 €	42,53 €	277,76 €	Intelligent navigation	Hair detection	-	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Mite allergy
257	Kunde FLY	2024	Nerds	20<40	won	Asien	328,11 €	32,19 €	295,92 €	Intelligent navigation	Hair detection	-	Soft Floor Bru	Additional Fit	Black	Position men	Automatic sc	Multi room cl	Up to 90 m2	All hard and s	App control &	Hairy friend
258	Kunde RTL	2022	Simply clean a	40<60	lost	Osteuropa	199,88 €	62,58 €	137,30 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Mite allergy
259	Kunde FJU	2022	Simply clean a	40<60	won	Amerika	124,29 €	57,77 €	66,51 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Mite allergy
260	Kunde KDK	2022	Simply clean a	60<80	won	Osteuropa	120,30 €	85,71 €	34,59 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
261	Kunde CBA	2022	Simply clean a	20<40	won	Westeuropa	124,16 €	87,18 €	36,99 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
262	Kunde IUK	2022	Simply clean a	60<80	won	Osteuropa	120,03 €	61,17 €	58,87 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Mite allergy
263	Kunde VOP	2022	Simply clean a	40<60	won	Westeuropa	123,50 €	81,93 €	41,57 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
264	Kunde WIN	2022	Simply clean a	20<40	lost	Asien	126,04 €	70,03 €	56,02 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
265	Kunde SHN	2022	Simply clean a	60<80	won	Amerika	128,80 €	80,55 €	48,26 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
266	Kunde ZSX	2022	Simply clean a	40<60	won	Amerika	124,88 €	82,33 €	42,55 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend
267	Kunde CKR	2022	Simply clean a	60<80	lost	Osteuropa	127,58 €	93,74 €	33,85 €	-	-	yes	Soft Floor Bru	Additional Fit	Black	-	-	-	Up to 60 m2	All hard and s	-	Hairy friend

Data acquistion

We collect data on base of each single order:

- Product specification: features, options, sizes …
- Customer data: branch, region…
- Commercial data: prizes, cost, delivery time, working hours….
- Requests: Proposals, request for proposal…

Market segmentation grid

- Understanding the market
- Identify the strengths and weaknesses of your own portfolio
- Derive measures for a future modular system

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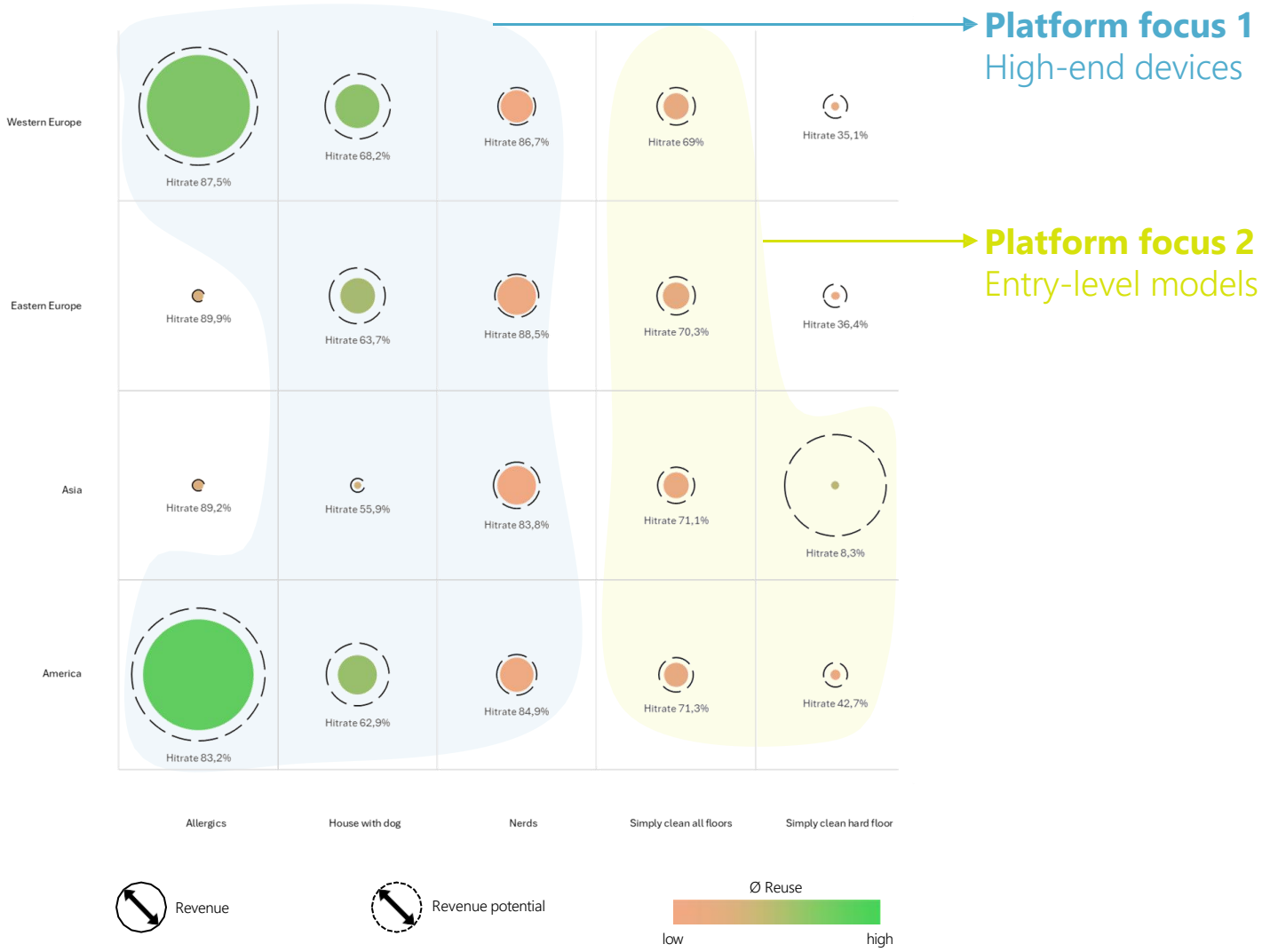
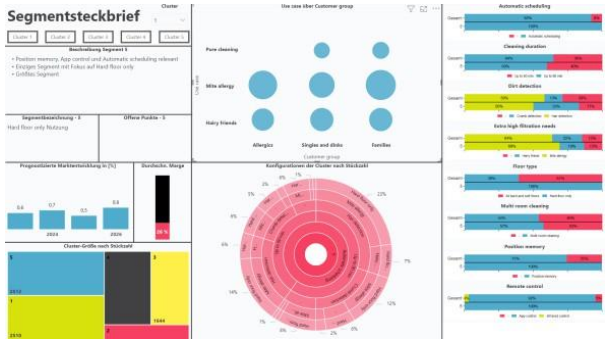
Market segmentation grid

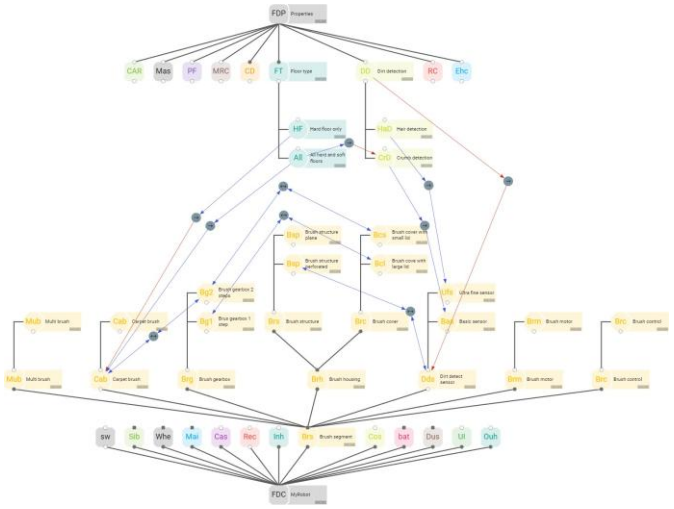
- Understanding the market
- Identify the strengths and weaknesses of your own portfolio
- Derive measures for a future modular system



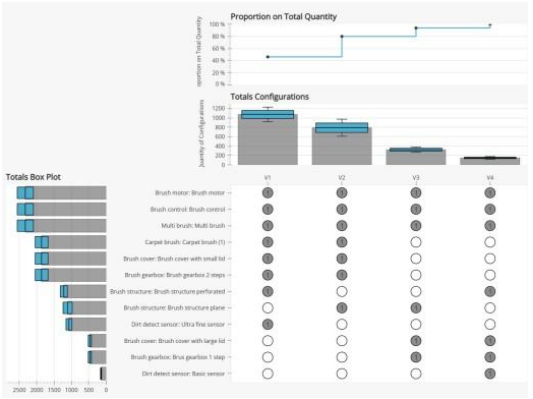
Data-based development in product management and engineering



Analyzing portfolios



Developing modular systems



Simulating costs, lot size, rollout, CO2

Customer

Requirements

External

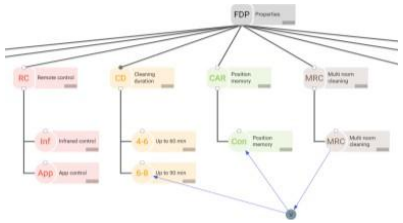
Configuration in modular system

Internal

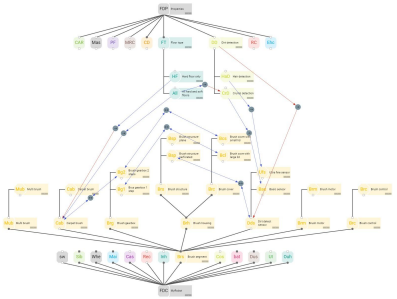
Company

Specifications

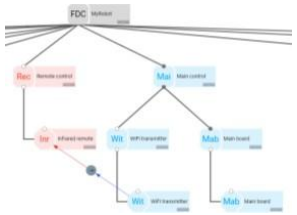
Feature Diagram External



Constraint net

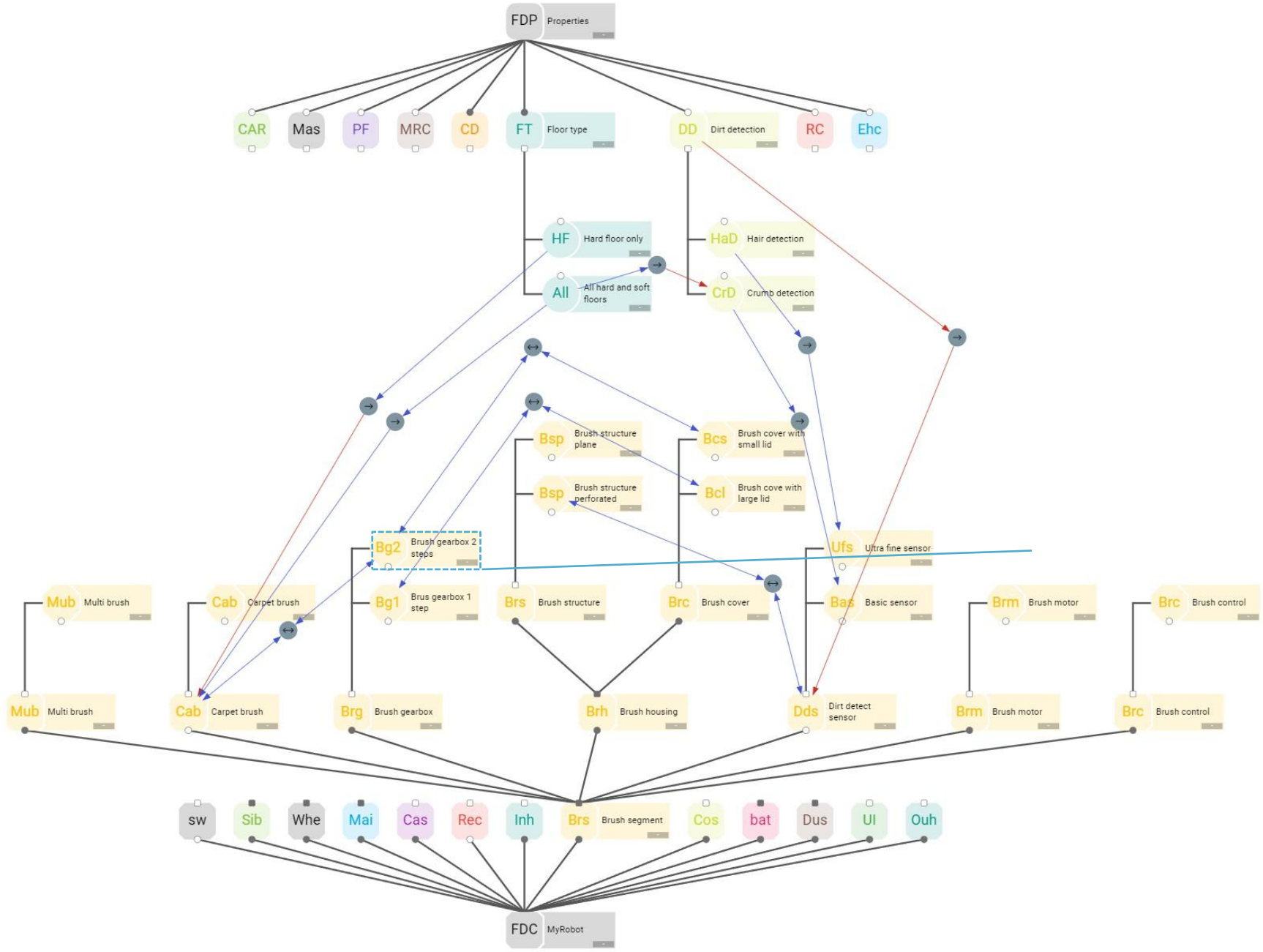


Feature Diagram Internal



Modeling the product concept

- Creating external requirements and internal components
- Linking through constraints
- Variety oriented product structuring
- Reduction of component variants
- All planned variants can be evaluated in one model



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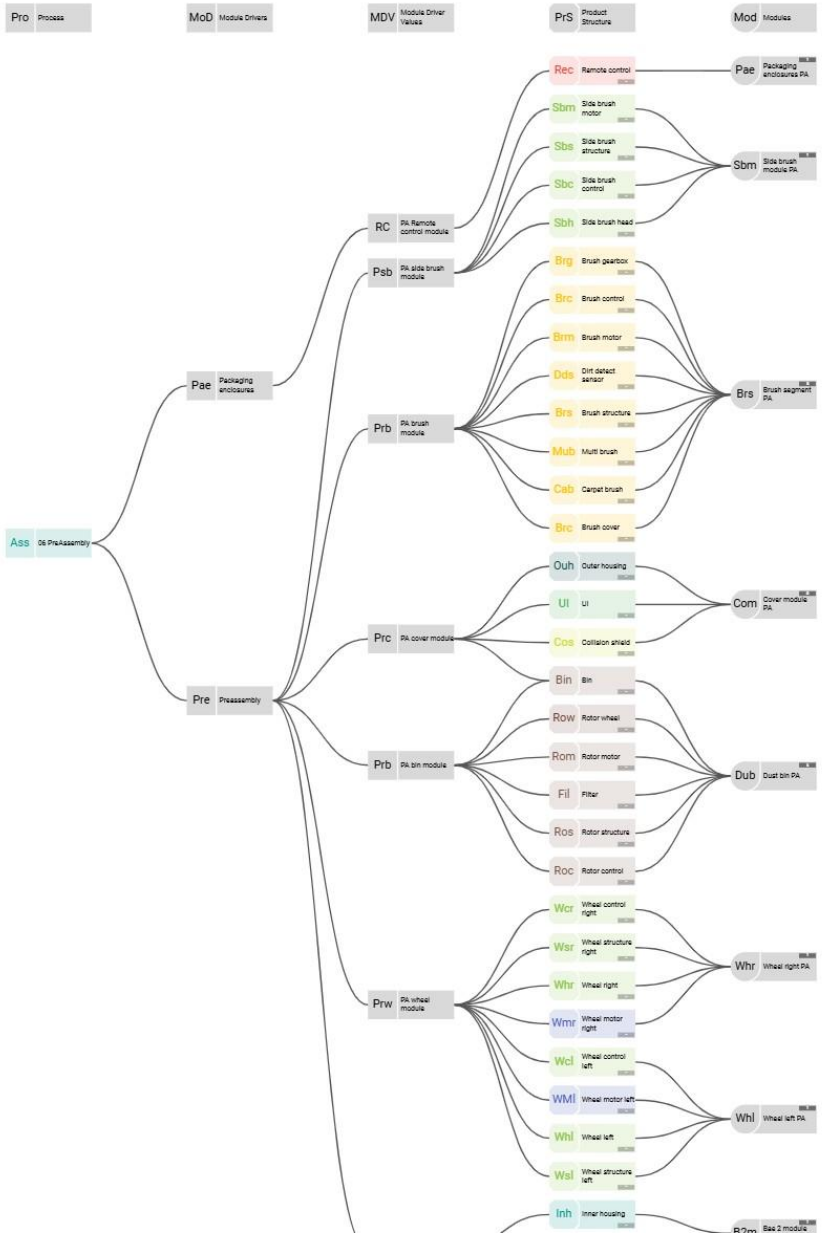
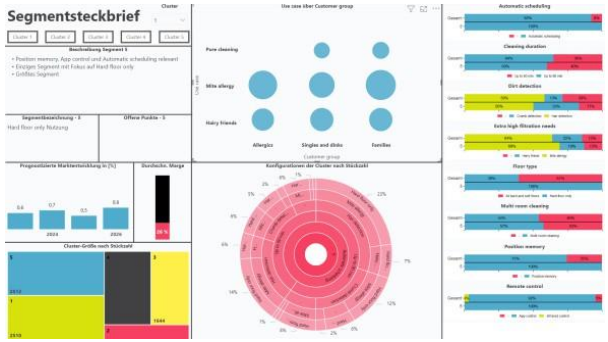
There is much more in Cquenz

- Tree of variety
- Functional architecture
- Interface definition, analysis and clustering (DSM)
- Complexity cost calculation
- Module driver analysis
- Modular structuring for different processes
- Future market scenarios
- ROI and roadmap
- Stocking and purchasing strategy
- AI agent
- ....



Data-based development in product management and engineering



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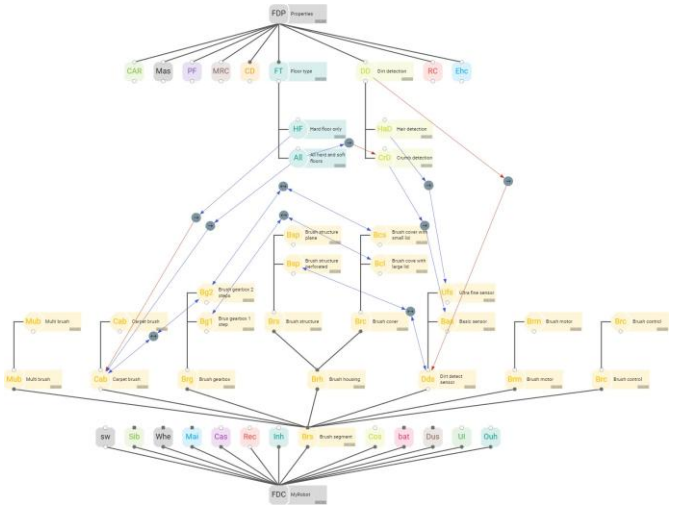
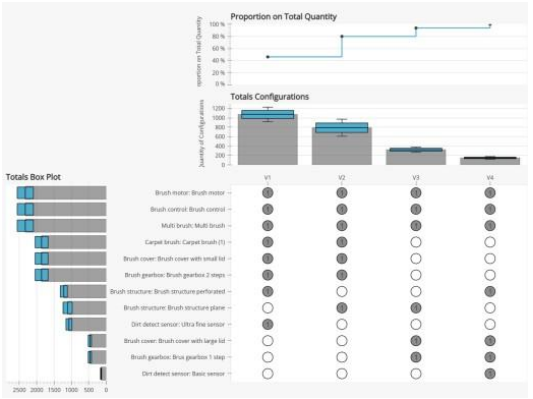


Developing modular systems

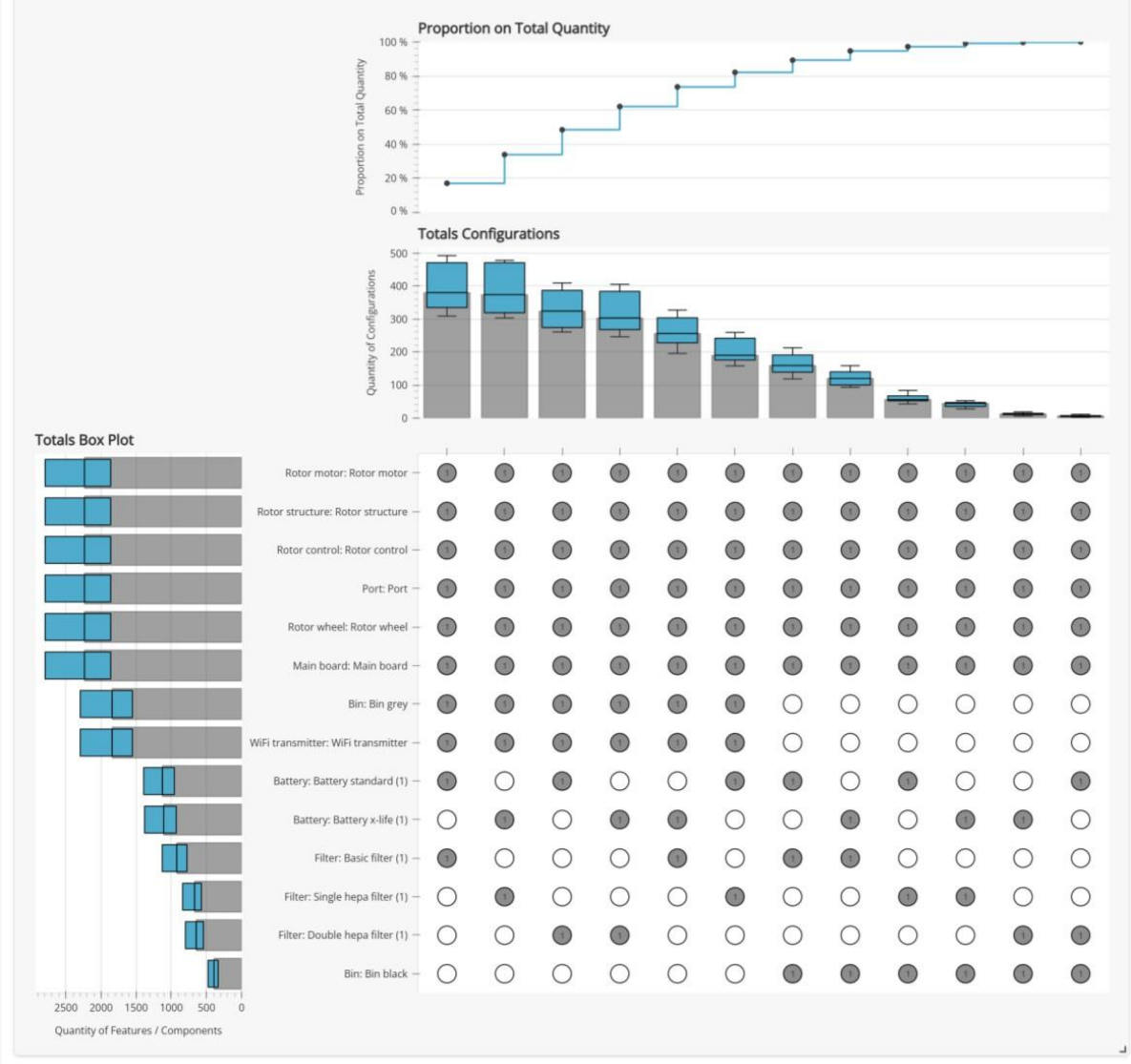


Simulating costs, lot size, rollout, CO2

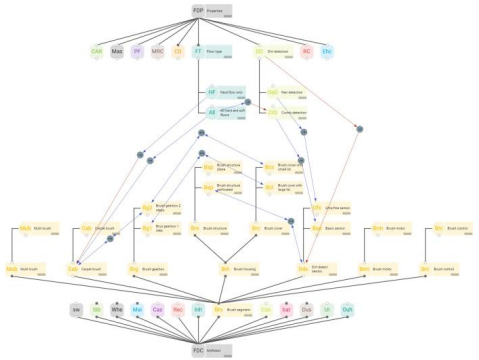
Modularity effects

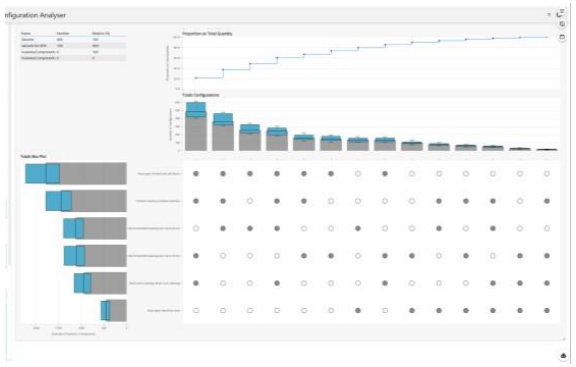
Lot size prognosis for
- Fetaures
- Components
- Modules
- Variants

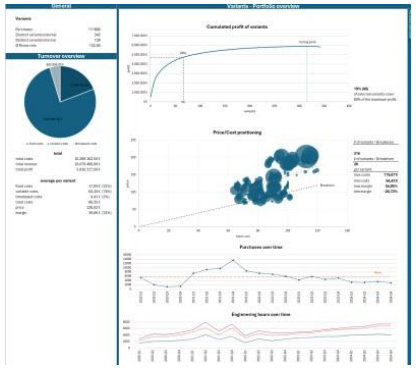
Across
- Market segments
- Future scenarios
- Different processes



Reduce development risk for modularity newcomers and experts







From ETO to CTO

- Establish new modular structures
- Understand, evaluate and communicate how it will work upfront
- Enable your team with a systematic tool-supported approach

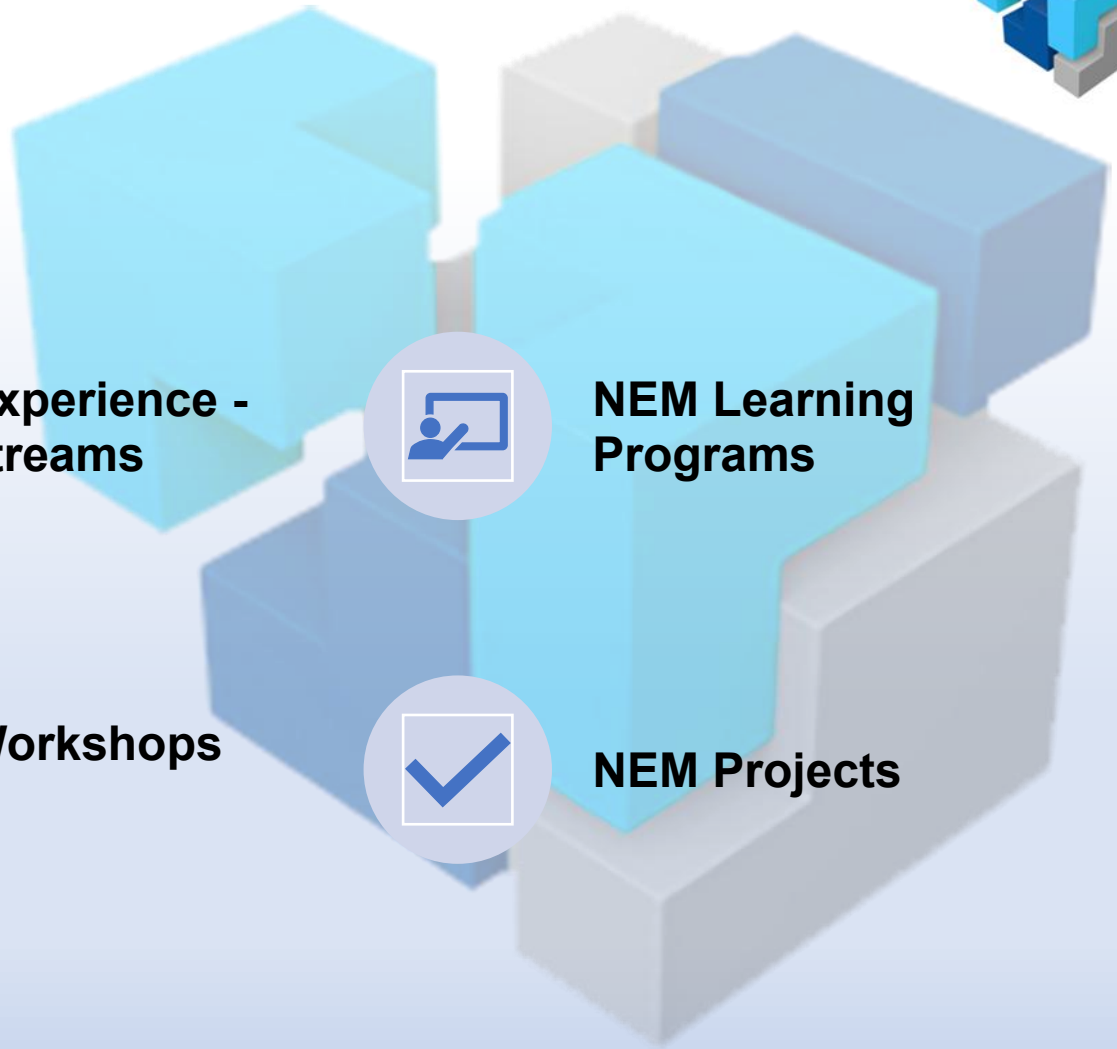
Next gen projects

- Create an automated Cquenz model based on existing data and structures
- Fast quantification of decision impact
- Achieve your project goals with confidence

Continuous management

- Support product management and engineering in continuous portfolio and variety management
- Portfolio monitoring
- Data-based evaluation of measures and action

N.E.M.



NEM Network – Meetings/Webinars

NEM Experience - Workstreams

NEM Learning Programs

NEM Services

NEM Workshops ++

NEM Projects