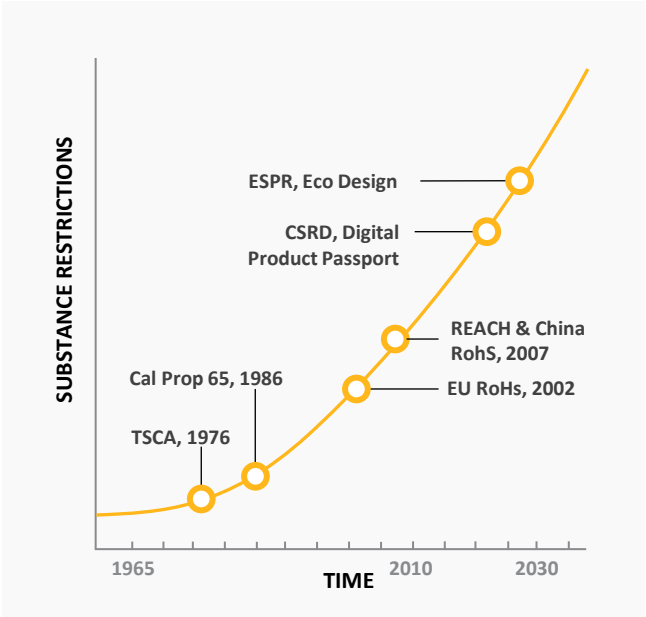
Powering Innovation That Drives Human Advancement

Optimizing Sustainable Product Design with Material Intelligence

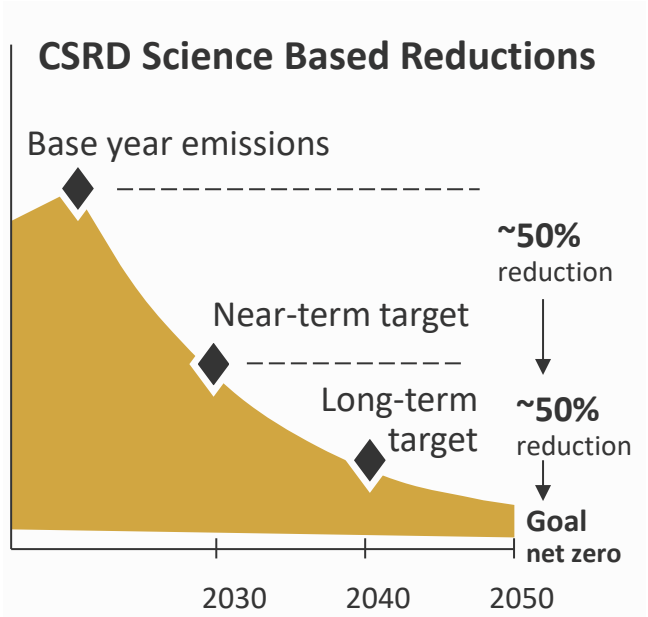
Benedikt Duerbeck, Senior Application Engineer

Materials information ‘triple challenge’ for sustainability



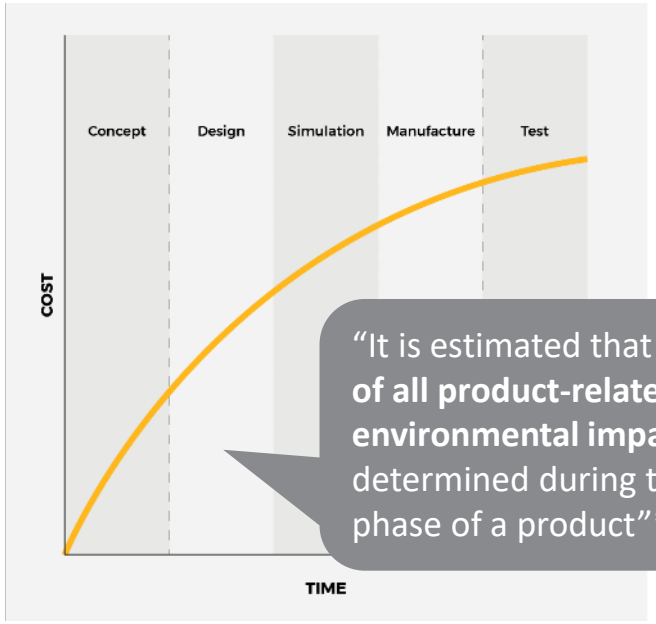
Reporting to address global legislations for sales & operations

Regulatory Driver



Innovations to answer increasing customer demands (Co2 goals)

Industry Challenges



Reduce emissions in early design stages (cost reduction)

Business Driver

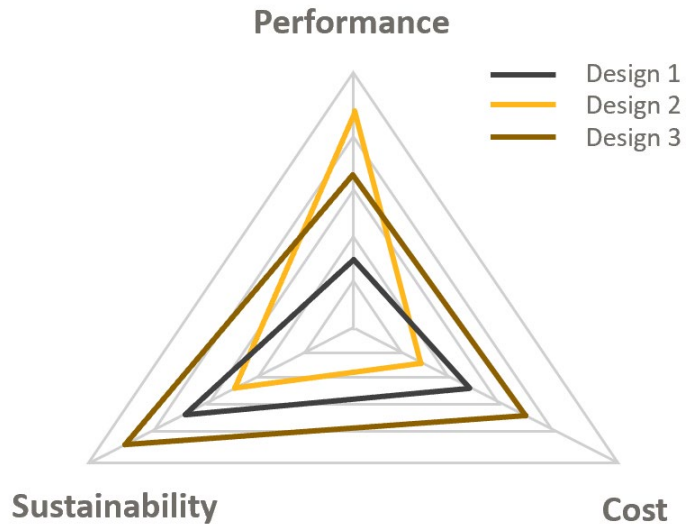
What are the main objectives in the product design process?

Today

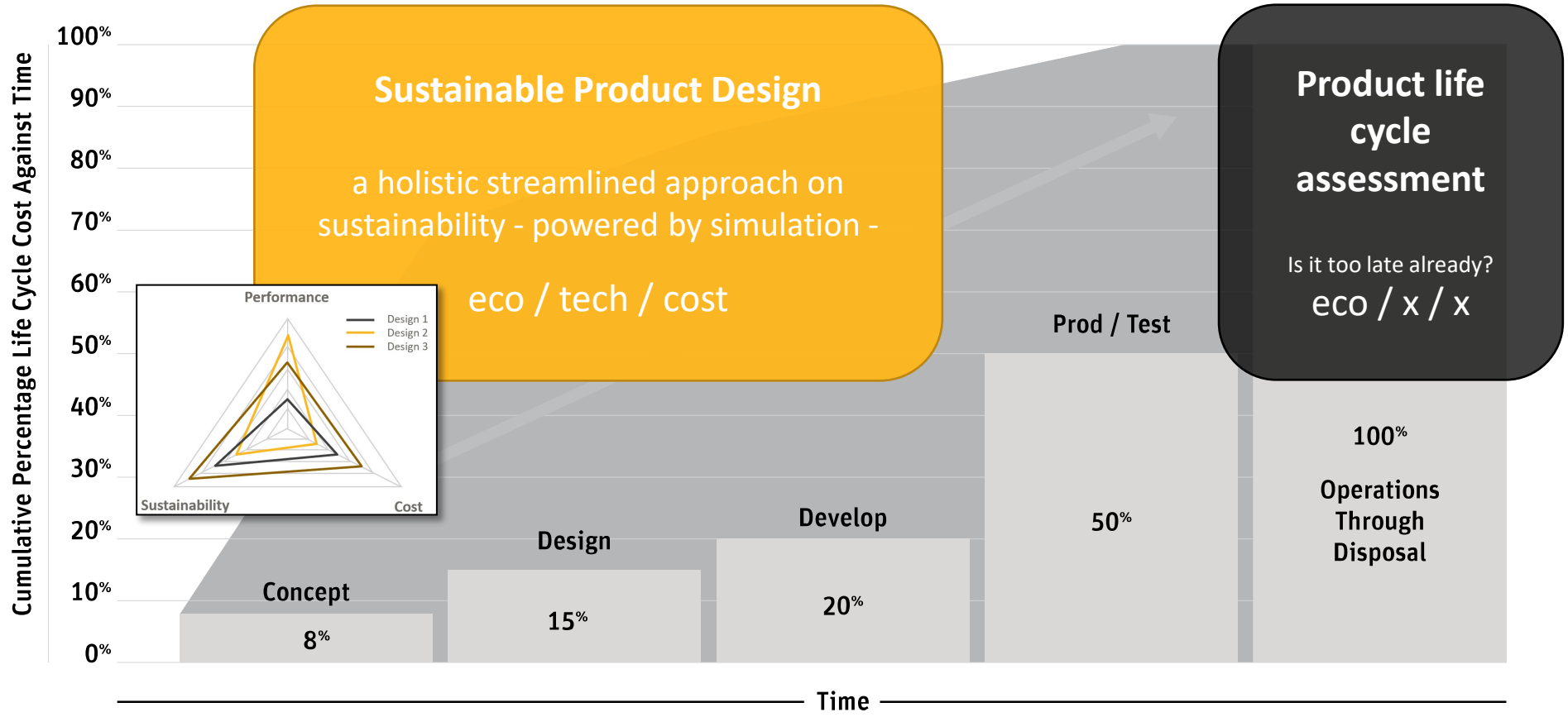
- Today the focus in product design is based on a compromise between performance and cost
- What if you could extend this in the **triangle** of technical **performance / cost / sustainability** for your products on an **enterprise level** ?

Future vision

- Enable understanding of customer designs at all levels:
  - What impact do **different materials** choices have?
  - What impact does changing my geometry have?
  - How is multiphysics **performance impacted**?
  - What happens if I use a different supplier?
  - How do these **factors interact** with each other?



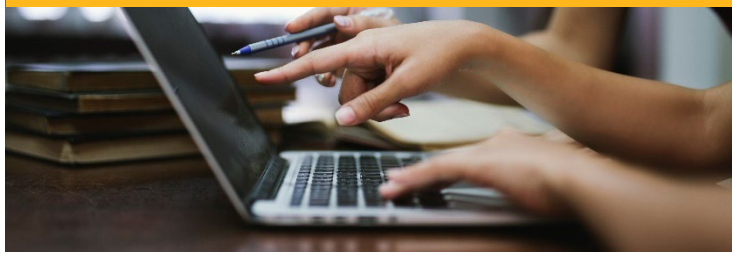
Smart, distinct decisions early in the development cycle



Typical Sustainability Business Challenges

LATE CHANGES

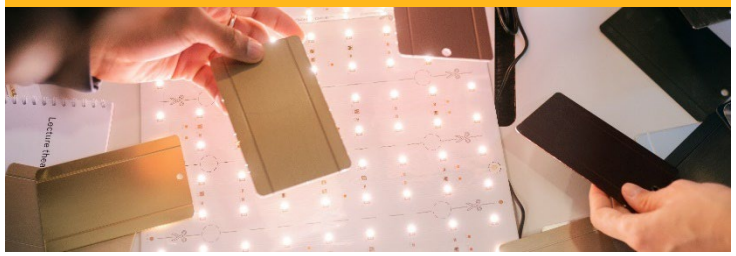
"I need CO_2 data to-hand when I select a material, not at the end of the product life cycle"



Late changes in design can cost $ millions

LIMITED DATA

"I need a better understanding of how to trade-off between cost, weight and carbon footprint"



Limited data on sustainability attributes for materials

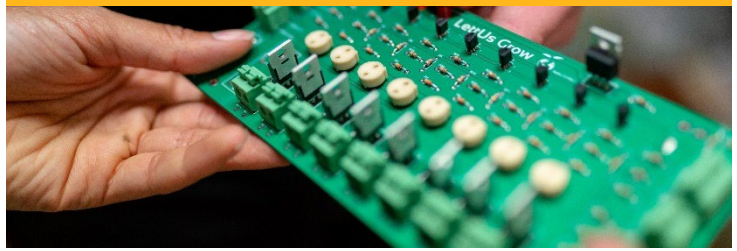
TRACEABILITY

"We're adding more recycled content into our packaging, but losing traceability of testing data"

Losing valuable IP when designing more sustainable materials

RISK

"We want to manage evolving regulations that threaten to make our product non-compliant"



Risk of product recalls costing $ millions

Engineer what's ahead by digitizing materials information

Drive efficiency

HIGHER ENGINEER PRODUCTIVITY ↑ **70%** less time searching for data

LOWER MATERIALS COST ↓ **$millions** saved on raw material costs

Stay agile

Unique Open Ecosystem

Integrated with: CAD, CAE, PLM

Digital transformation

DIGITAL THREAD = TRACEABILITY = ENGINEERING INTELLIGENCE

Innovate faster

Greater materials accuracy =

40% FEWER REPEAT SIMULATIONS

Deliver on sustainability

Products that…

Reduce energy use

Reduce risk on compliance

Reduce CO_2 footprint

Help achieve your corporate sustainability goals

80%

Of all product-related environmental impacts are determined during design phase*

Make faster material trade-offs at early design stages:

- CO_2 Footprint
- Recyclability
- Energy & Water Usage
- Restricted Substances

*https://ec.europa.eu/jrc/en/research-topic/sustainable-product-policy

Deliver on sustainability

Solution

- Ansys Granta **for Managing & Selecting Material**
- **Advanced Materials Reference Data**
- Manage **Material Compliance** in Bill of Materials
- Access to the **EMIT consortium**

Benefit

- Digital architecture to track and enable **net-zero carbon + recyclability goals**
- A **20% reduction in CO_2 footprint** of like-for-like products
- Designing **45% lighter** with suitable alternative materials
- Visibility of **CO_2 footprint, recyclability and substance compliance** data to every engineer in CAD, CAE, PLM.
- Trade-off between **performance, cost and sustainability** for optimal product design right from the start.

Solving sustainability challenges with Material Intelligence

Sustainable Packaging

Use alternative materials - **reduce CO_2 footprint by ~10%**

Lightweighting

Search materials for ~45% weight reduction without sacrificing performance

Durable Design

Combined engineering and environmental data – **design in a longer lifetime** for your products

Material Circularity

Capture and use data on recycled materials – **adapt your designs for improved sustainability**

Remove Harmful substances

Meet reporting obligations with a **faster and more thorough assessment** of Material Compliance risk

Environmentally Friendly Materials

Assess product environmental impact and take a data-driven approach to supply chain decisions to **reduce CO2 footprint by 20%+**

Managing materials information brings significant business value

Reduce repeat simulation projects by

40%

With more accurate materials data

Reduce prototype materials and tests by

1/2

Compared with conventional trial-and-error methods

Efficiency Savings of

+$10m (pa)

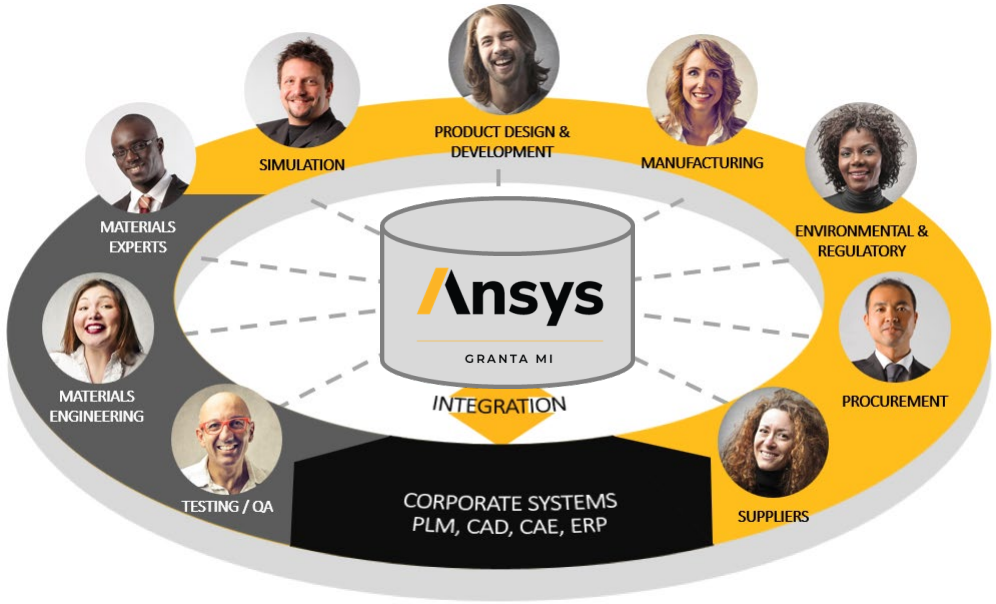
In time saved, optimization and reduced waste

Materials Information Management

‘What data do we have on material X ?’

One Authoritative Source of the Truth

Capture your Materials IP



Avoid product recalls, duplication of testing, knowledge loss

Accelerate time to market

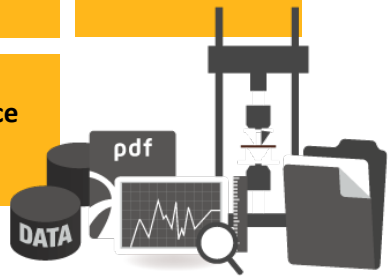
Save $ millions per year

All your material data in one place

Aesthetics | Material properties | Supplier specifications

Detailed engineering properties | Simulation models | Testing and analysis

In-service data | Compliance data



Proprietary materials information

Ansys GRANTA MI

MaterialUniverse™

JAHM curve data

Additive Manufacturing | Aero | Composites | Eco | Electro-magnetics

ESDU | High Temperature Alloys | Medical | Metals | Polymers

Comprehensive Material Library
of reference information:
Metals, plastics, composites…

Additive Manufacturing Template

Composites Template

Metals Template

AI/ML

Material Compliance

Enterprise Integration

Supplement in-house materials data with Ansys reference data

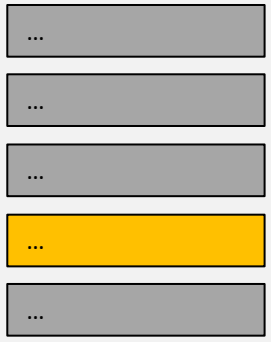
Ansys reference data

MaterialUniverse™
- 4,000+ engineering materials
- Technical, Economic & Environmental data
- Unique, complete & comparable dataset
- Data quality indicators

Advanced Materials – Eco ecoinvent
- 18,000+ records
- Selected indicators from ecoinvent
- Includes location-specific data

Restricted Substances
- Global Legislation & Directives
- 23,000+ restricted Substances inc. PFAS
- 150+ Coatings & 650+ Specifications

Gap Filling



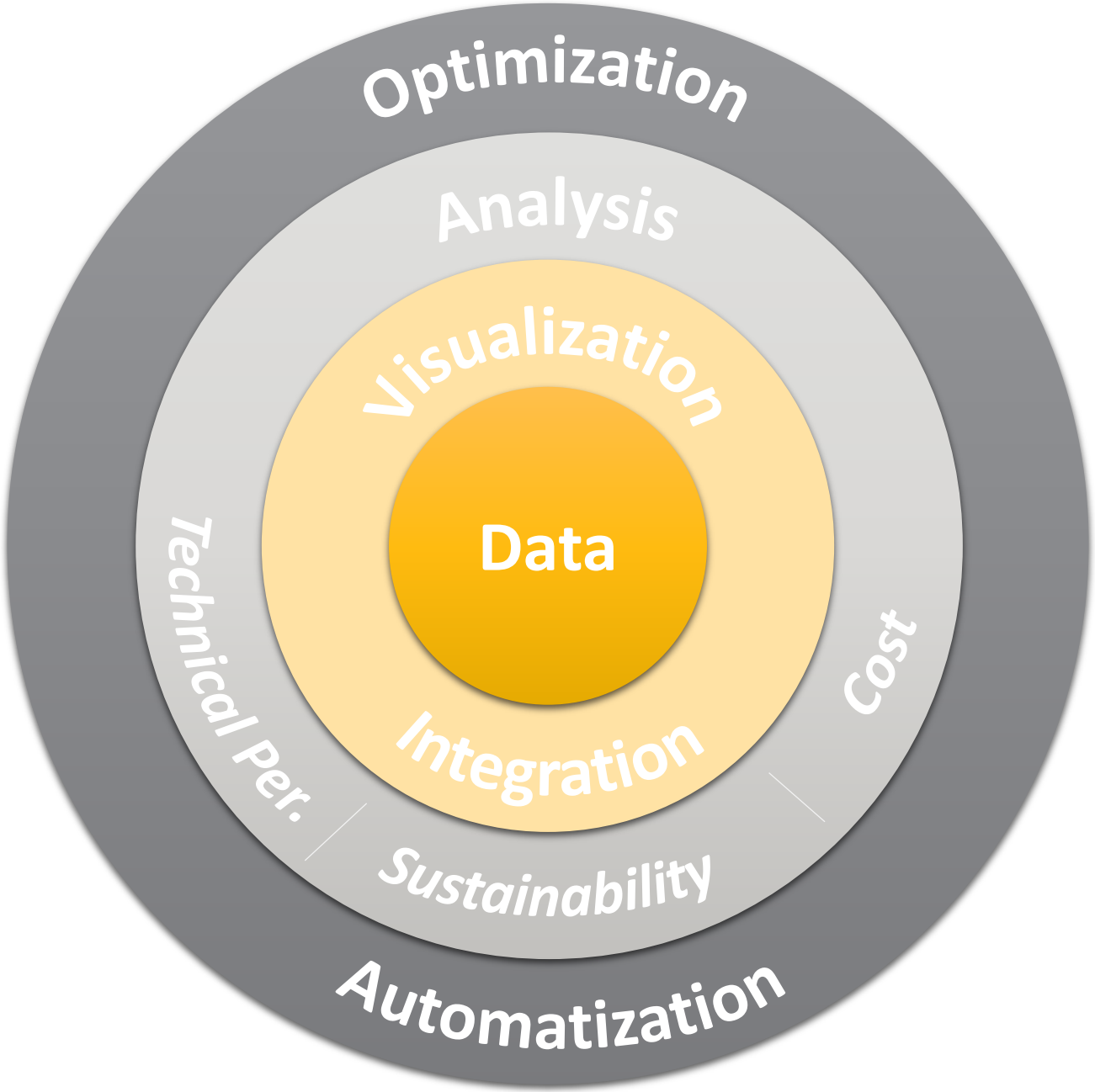
In-house data

Proprietary materials information

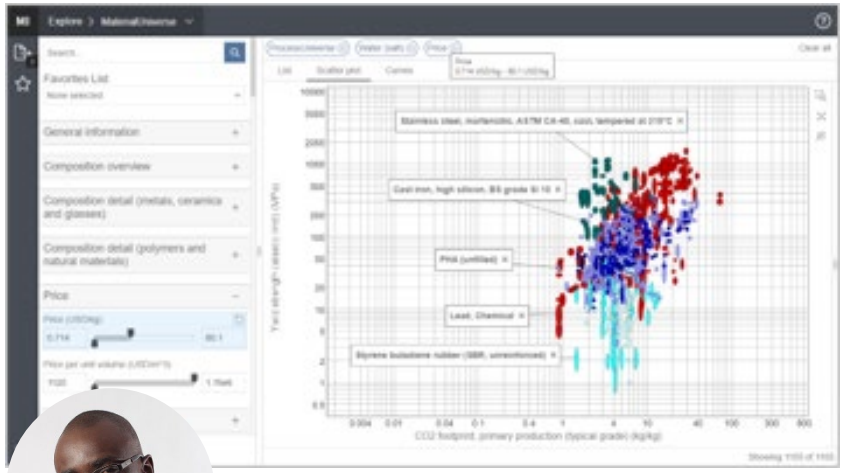
Aesthetics	Material properties	Supplier specifications
Detailed engineering properties	Simulation models	Testing and analysis
In-service data	Compliance data	Sustainability data

Step by step…

The **right data**, with the **right detail**, to the **right person** at the **right time** in the *design process*



Sustainability during Design

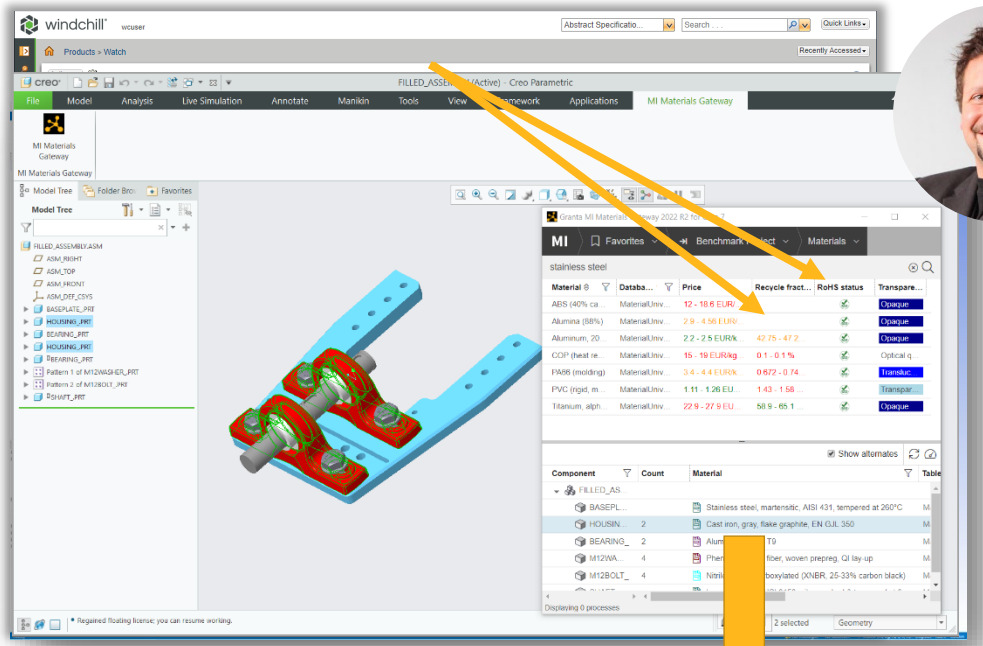


Materials Experts

Trade-off technical, economic & **sustainability** requirements

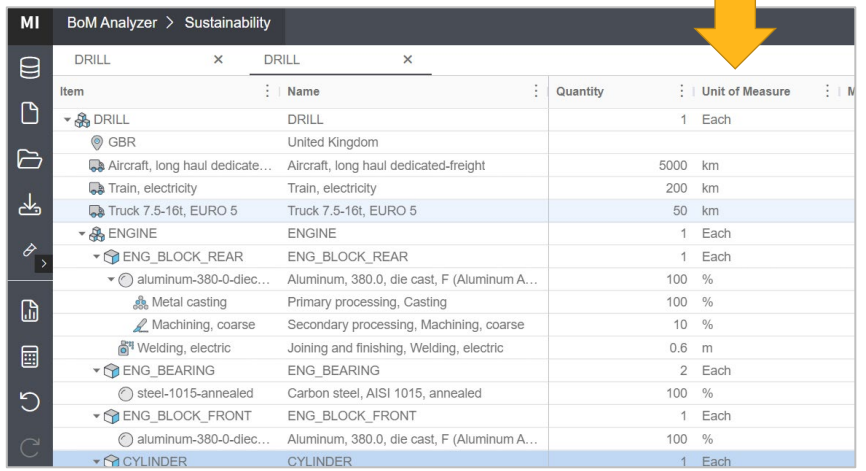
Publish updated preferred materials lists

Sustainability metrics flagged in UI



CAD & Simulation Engineers

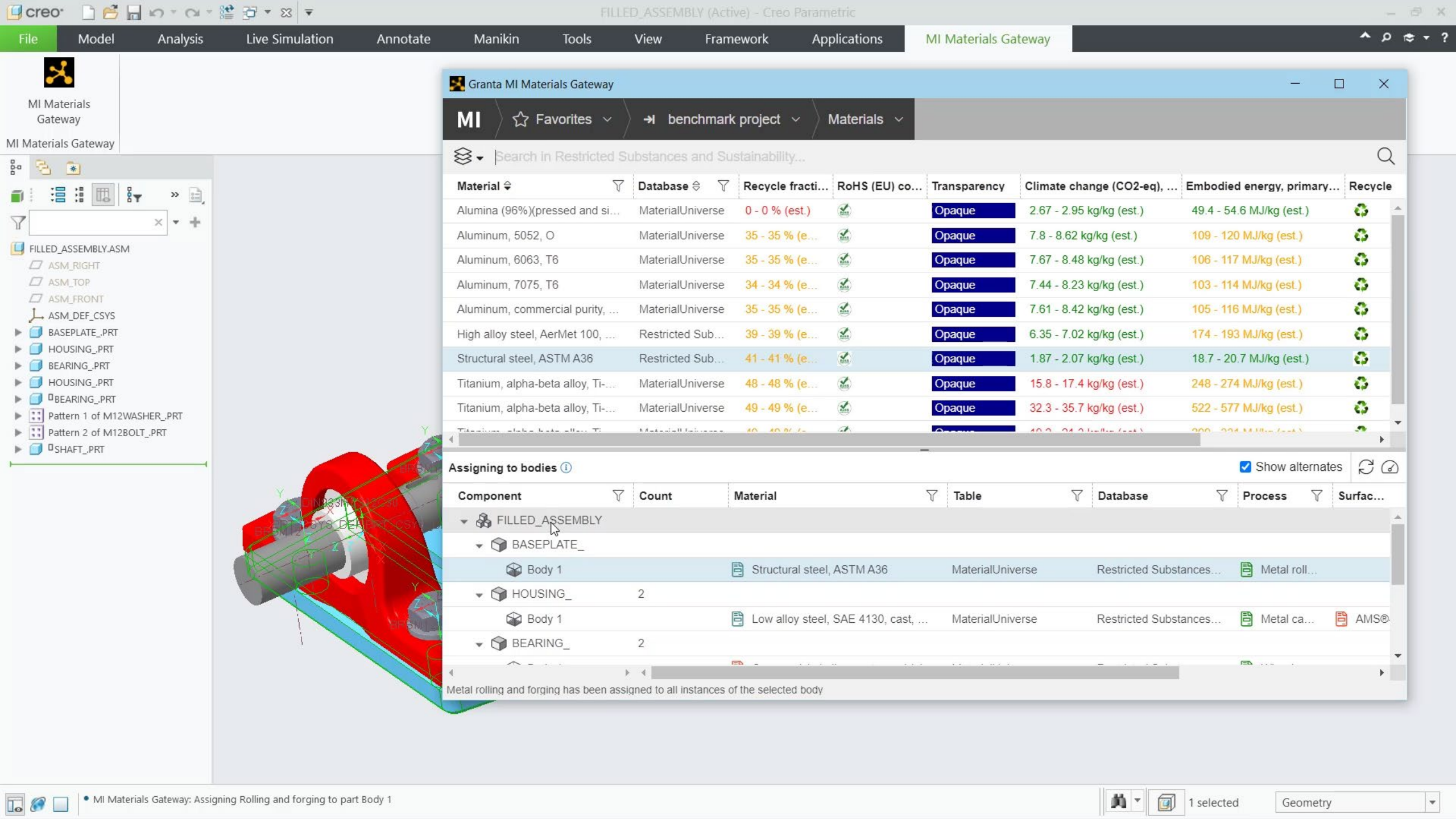
Run sustainability analysis



Item	Name	Quantity	Unit of Measure
DRILL	DRILL	1	Each
GBR	United Kingdom		
Aircraft, long haul dedicate…	Aircraft, long haul dedicated-freight	5000	km
Train, electricity	Train, electricity	200	km
Truck 7.5-16t, EURO 5	Truck 7.5-16t, EURO 5	50	km
ENGINE	ENGINE	1	Each
ENG_BLOCK_REAR	ENG_BLOCK_REAR	1	Each
aluminum-380-0-diec…	Aluminum, 380.0, die cast, F (Aluminum A…	100	%
Metal casting	Primary processing, Casting	100	%
Machining, coarse	Secondary processing, Machining, coarse	10	%
Welding, electric	Joining and finishing, Welding, electric	0.6	m
ENG_BEARING	ENG_BEARING	2	Each
steel-1015-annealed	Carbon steel, AISI 1015, annealed	100	%
ENG_BLOCK_FRONT	ENG_BLOCK_FRONT	1	Each
aluminum-380-0-diec…	Aluminum, 380.0, die cast, F (Aluminum A…	100	%
CYLINDER	CYLINDER	1	Each

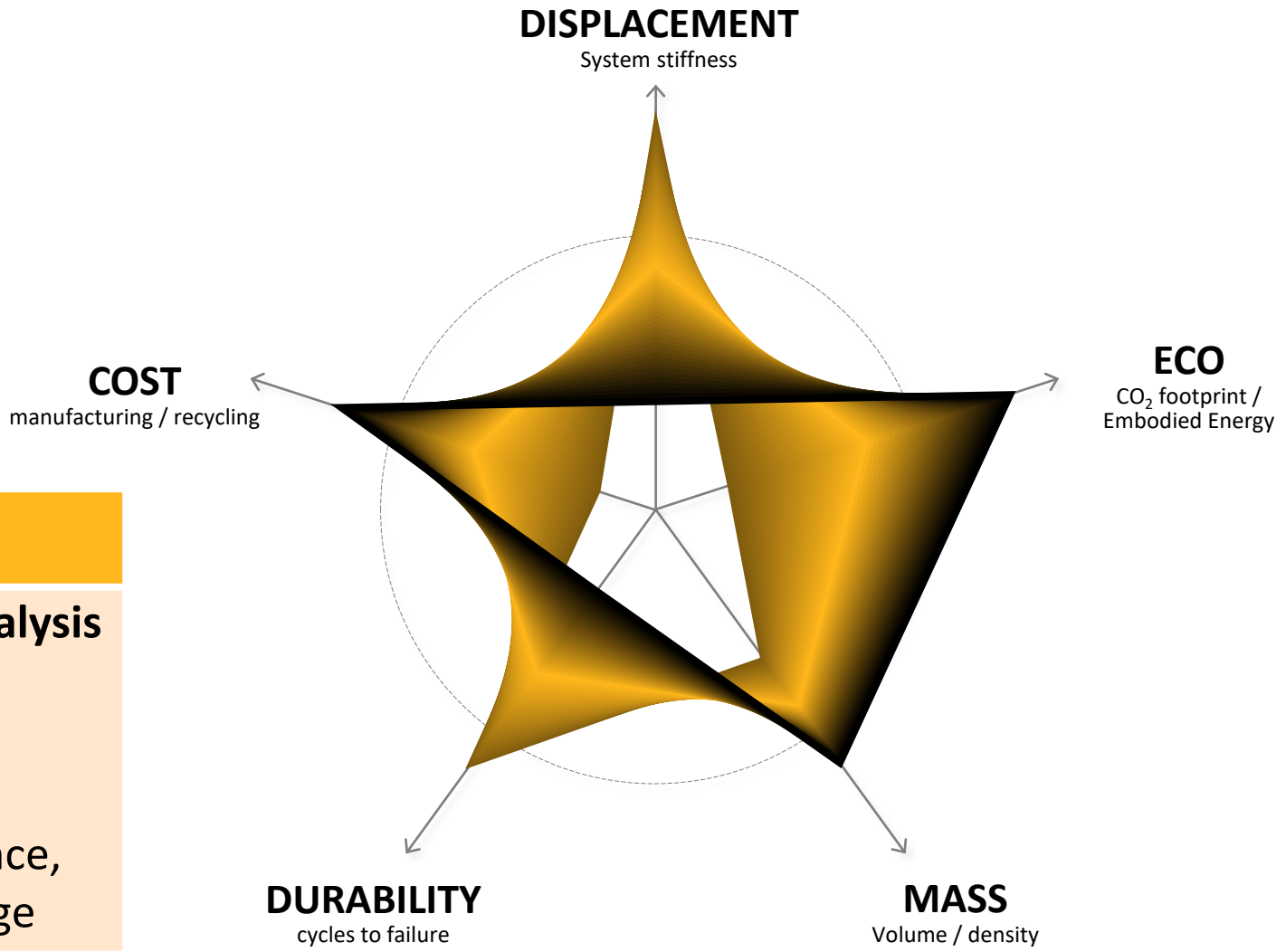
Analyse & compare multiple designs

- **Access all materials directly in native CAD/PLM tools**
- Publish preferred materials and processes
- Flag sustainability metrics directly in design tools


FILLED_ASSEMBLY (Active) - Creo Parametric
File
Model
Analysis
Live Simulation
Annotate
Manikin
Tools
View
Framework
Applications
MI Materials Gateway
MI Materials Gateway
MI Materials Gateway
Granta MI Materials Gateway
MI
Favorites
benchmark project
Materials
Search in Restricted Substances and Sustainability...
Material
Database
Recycle fracti...
RoHS (EU) co...
Transparency
Climate change (CO2-eq), ...
Embodied energy, primary...
Recycle
Alumina (96%)(pressed and si...
MaterialUniverse
0 - 0 % (est.)
Opaque
2.67 - 2.95 kg/kg (est.)
49.4 - 54.6 MJ/kg (est.)
Aluminum, 5052, O
35 - 35 % (e...
7.8 - 8.62 kg/kg (est.)
109 - 120 MJ/kg (est.)
Aluminum, 6063, T6
7.67 - 8.48 kg/kg (est.)
106 - 117 MJ/kg (est.)
Aluminum, 7075, T6
34 - 34 % (e...
7.44 - 8.23 kg/kg (est.)
103 - 114 MJ/kg (est.)
Aluminum, commercial purity, ...
7.61 - 8.42 kg/kg (est.)
105 - 116 MJ/kg (est.)
High alloy steel, AerMet 100, ...
Restricted Sub...
39 - 39 % (e...
6.35 - 7.02 kg/kg (est.)
174 - 193 MJ/kg (est.)
Structural steel, ASTM A36
41 - 41 % (e...
1.87 - 2.07 kg/kg (est.)
18.7 - 20.7 MJ/kg (est.)
Titanium, alpha-beta alloy, Ti-...
48 - 48 % (e...
15.8 - 17.4 kg/kg (est.)
248 - 274 MJ/kg (est.)
49 - 49 % (e...
32.3 - 35.7 kg/kg (est.)
522 - 577 MJ/kg (est.)
Assigning to bodies
Show alternates
Component
Count
Material
Table
Database
Process
Surfac...
FILLED_ASSEMBLY
BASEPLATE_
Body 1
Structural steel, ASTM A36
MaterialUniverse
Restricted Substances...
Metal roll...
HOUSING_
2
Low alloy steel, SAE 4130, cast, ...
Metal ca...
AMS®
BEARING_
Metal rolling and forging has been assigned to all instances of the selected body
FILLED_ASSEMBLY.ASM
ASM_RIGHT
ASM_TOP
ASM_FRONT
ASM_DEF_CSYS
BASEPLATE_.PRT
HOUSING_.PRT
BEARING_.PRT
HOUSING_.PRT
BEARING_.PRT
Pattern 1 of M12WASHER_.PRT
Pattern 2 of M12BOLT_.PRT
SHAFT_.PRT
MI Materials Gateway: Assigning Rolling and forging to part Body 1
1 selected
Geometry

Sustainable Product Design Framework

- Link materials data (**technical, sustainability, cost**) with simulation and automation tools to give a wholistic understanding of a design

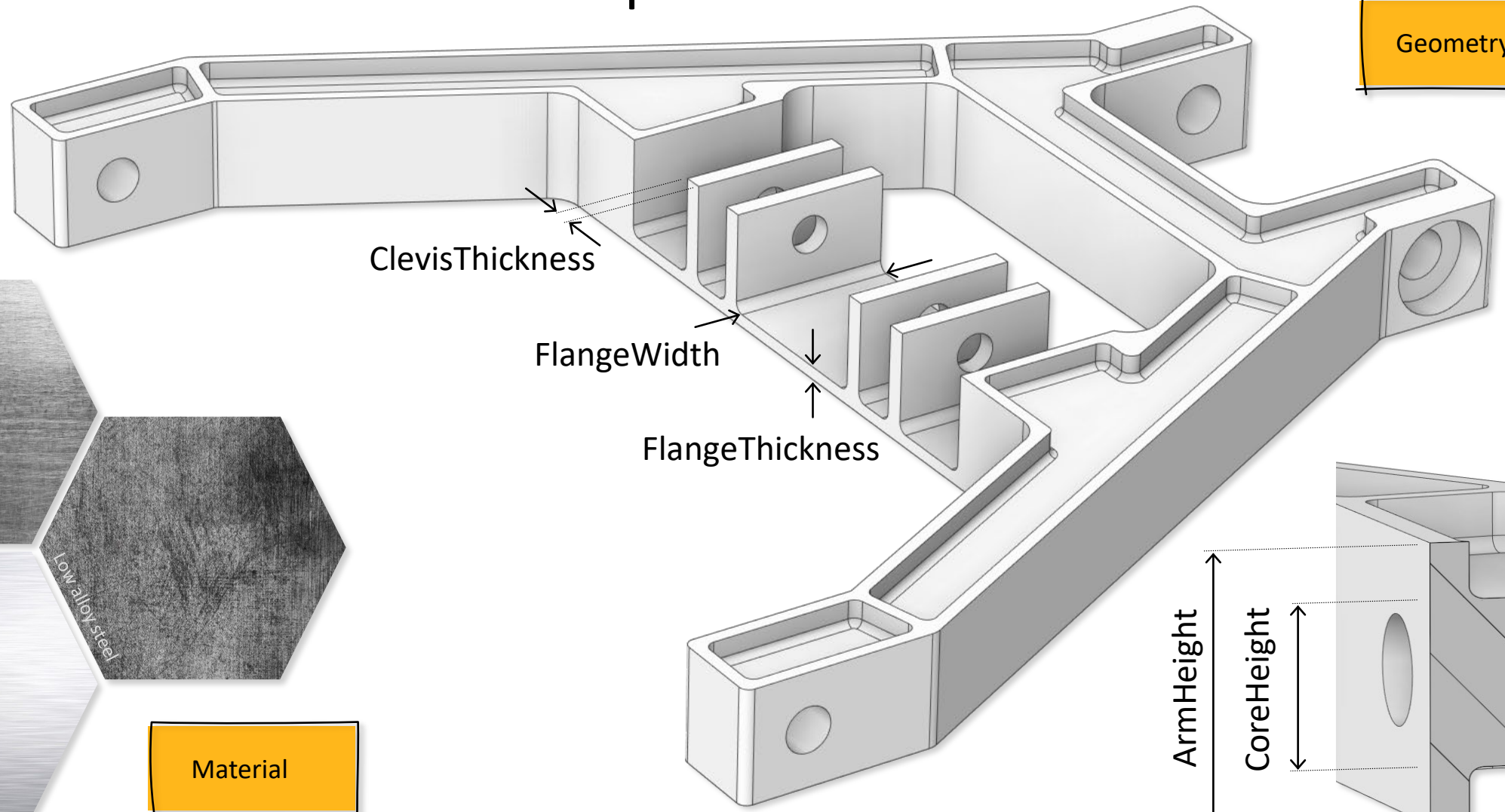


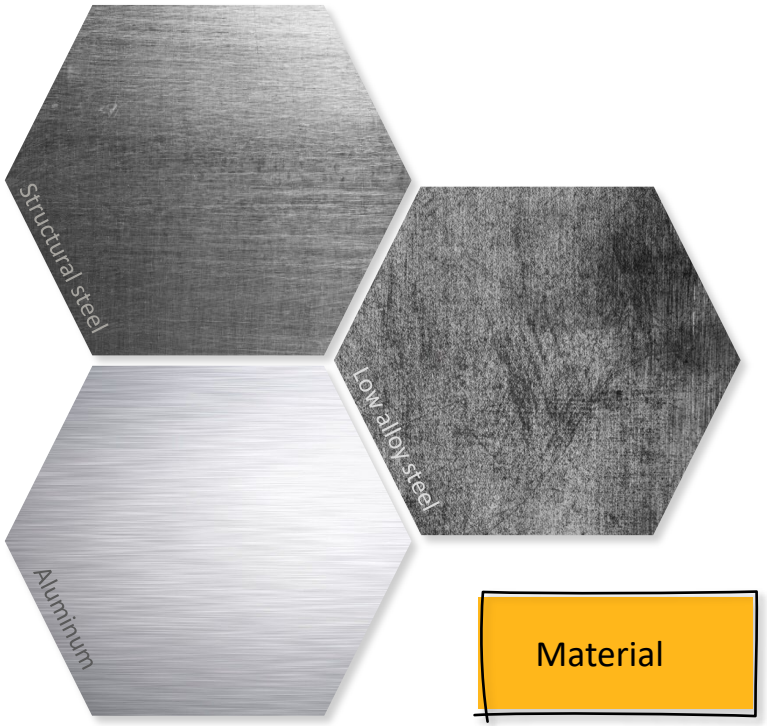
Benefits

- Automate the process of **design space analysis**
  - Ensure no gaps are left
- "Shift left"
  - Enable a deep understanding of how design trade-offs between performance, cost and sustainability at an early stage

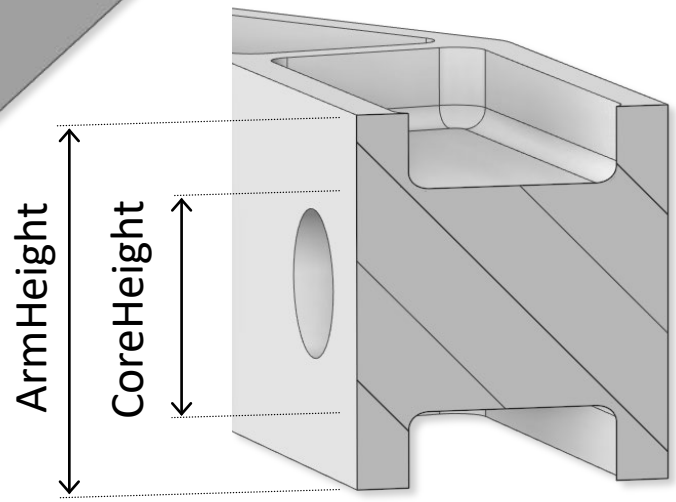
What parameters need to be optimized?

Geometry

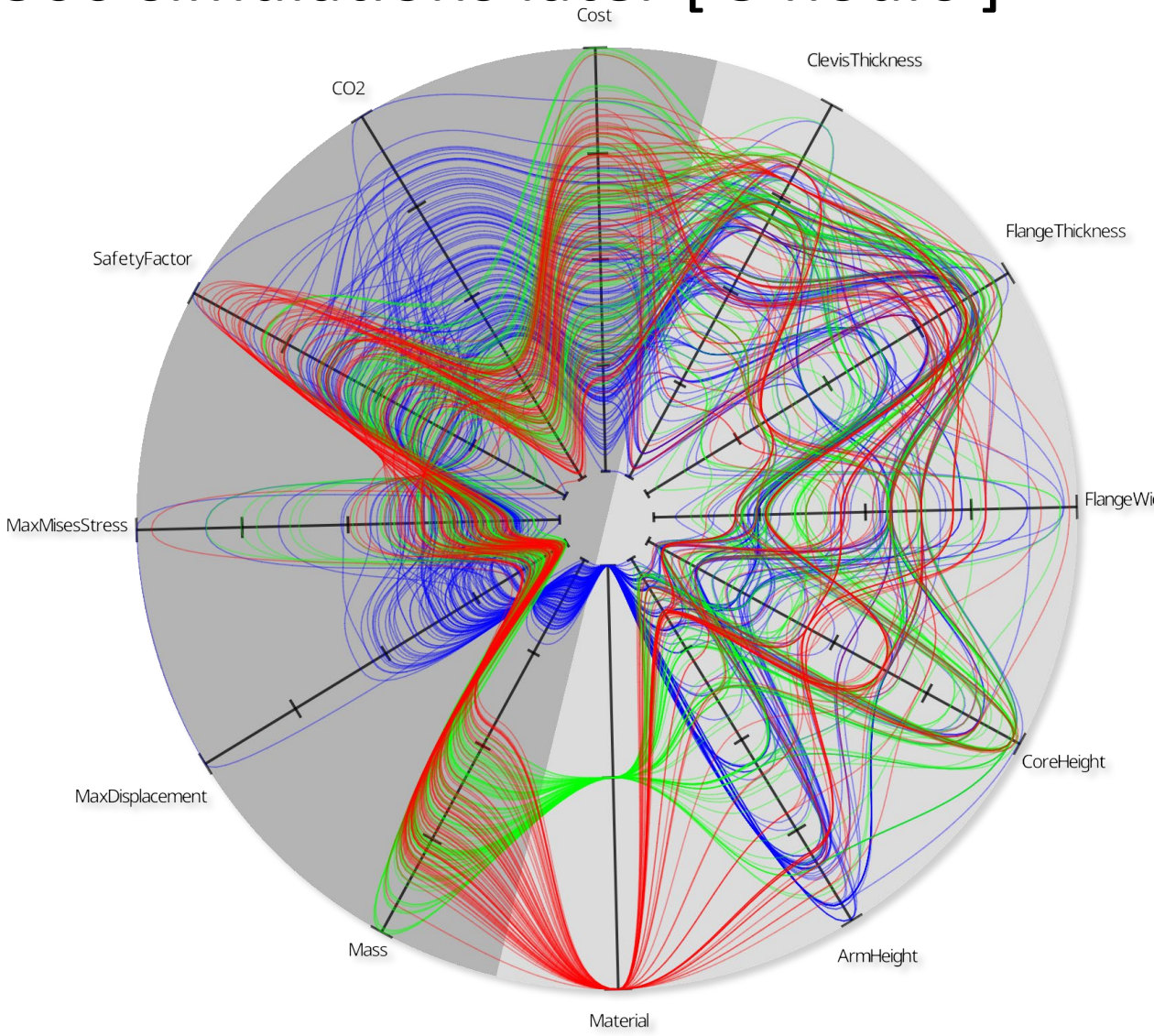


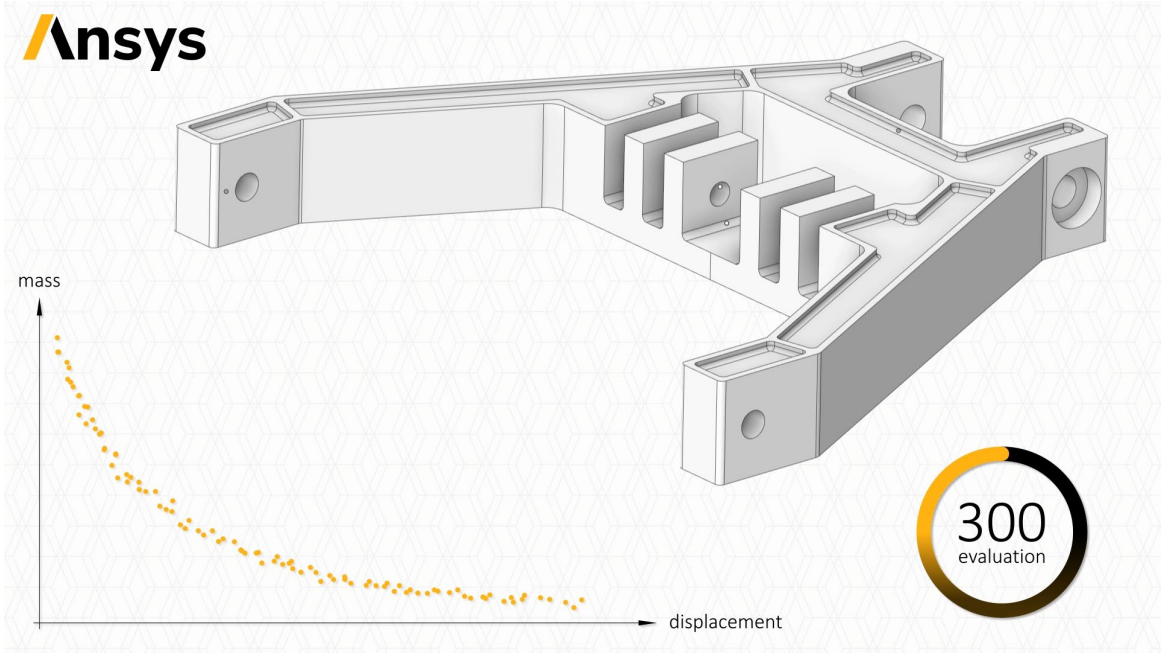


Material



300 simulations later [3 hours]





Response	Objective
MaxDisplacement	minimize
MaxMisesStress	minimize
SafetyFactor	≥ 1.2
Cost	minimize
CO2	minimize

Complete mapping of the design space, finding optimal designs for each competing material.

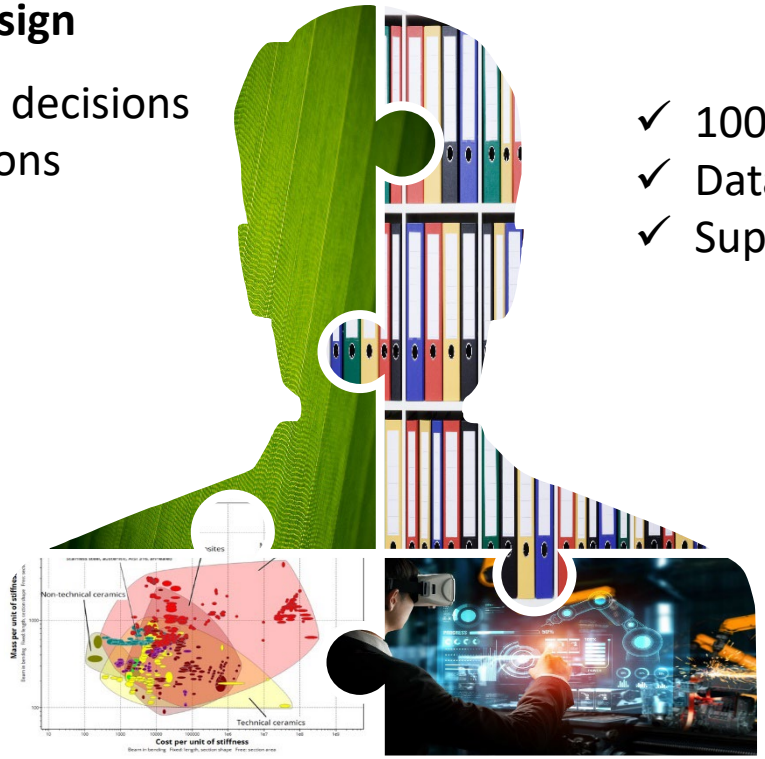
All done in 3 hours

compared to a single 3-hour running simulation with standard solvers.

A Vision for using Materials to get to Net Zero

Build Sustainability into Early Design

- ✓ Awareness of eco impact of material decisions
- ✓ Enable proactive, data-centric decisions
- ✓ Optimize a product early



Reference Data

- ✓ 100s of materials properties
- ✓ Data on technical, economic and sustainability
- ✓ Supplement and gap-fill in-house data

Analysis Tools

- ✓ Advanced material selection
- ✓ Identify alternatives
- ✓ Assess Bills of Materials
- ✓ Rapid what-if studies on material, process, mass, parts

Materials Management Framework

- ✓ One authoritative source of truth
- ✓ Publish preferred material lists
- ✓ Sustainability indicators in CAD, CAE, PLM
- ✓ Data federation to design, simulation & PLM

A <u>Proactive</u> Solution to Reduce Product Carbon Footprint from Concept


Ansys