Sustainable product insight with optiSLang and Granta

20th Weimar Optimization and Stochastic Days 2023

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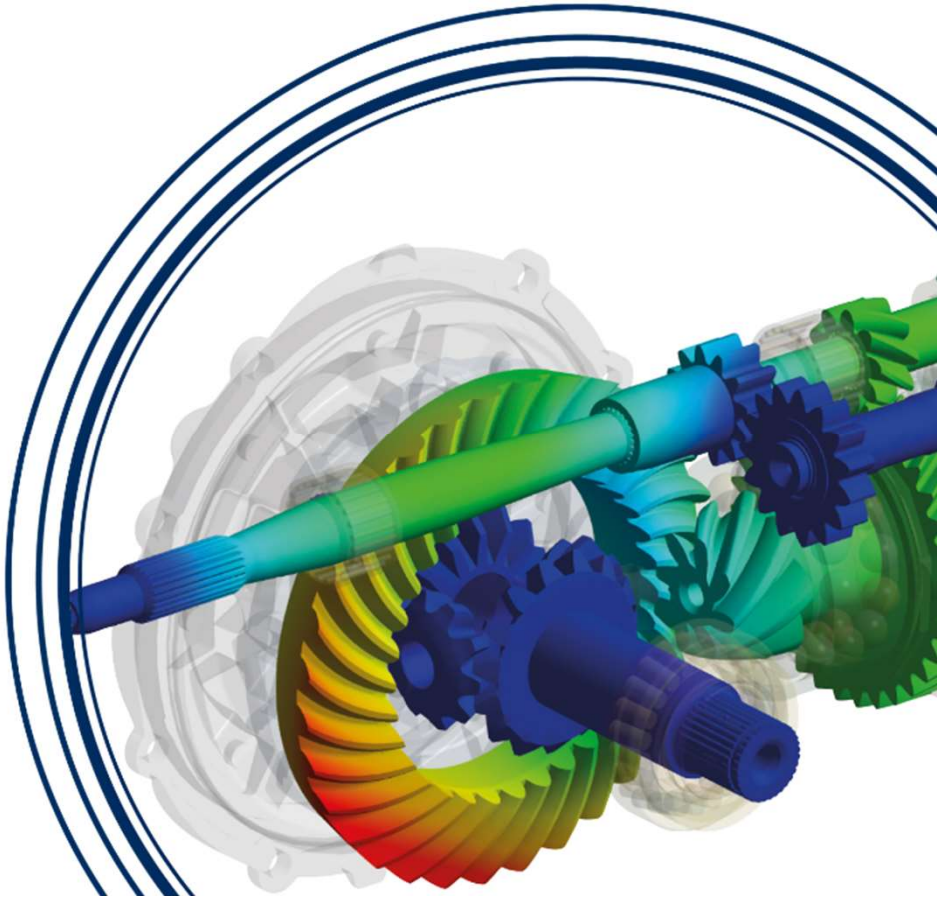


CADFEM Ansys / ELITE CHANNEL PARTNER

Customer interviews:

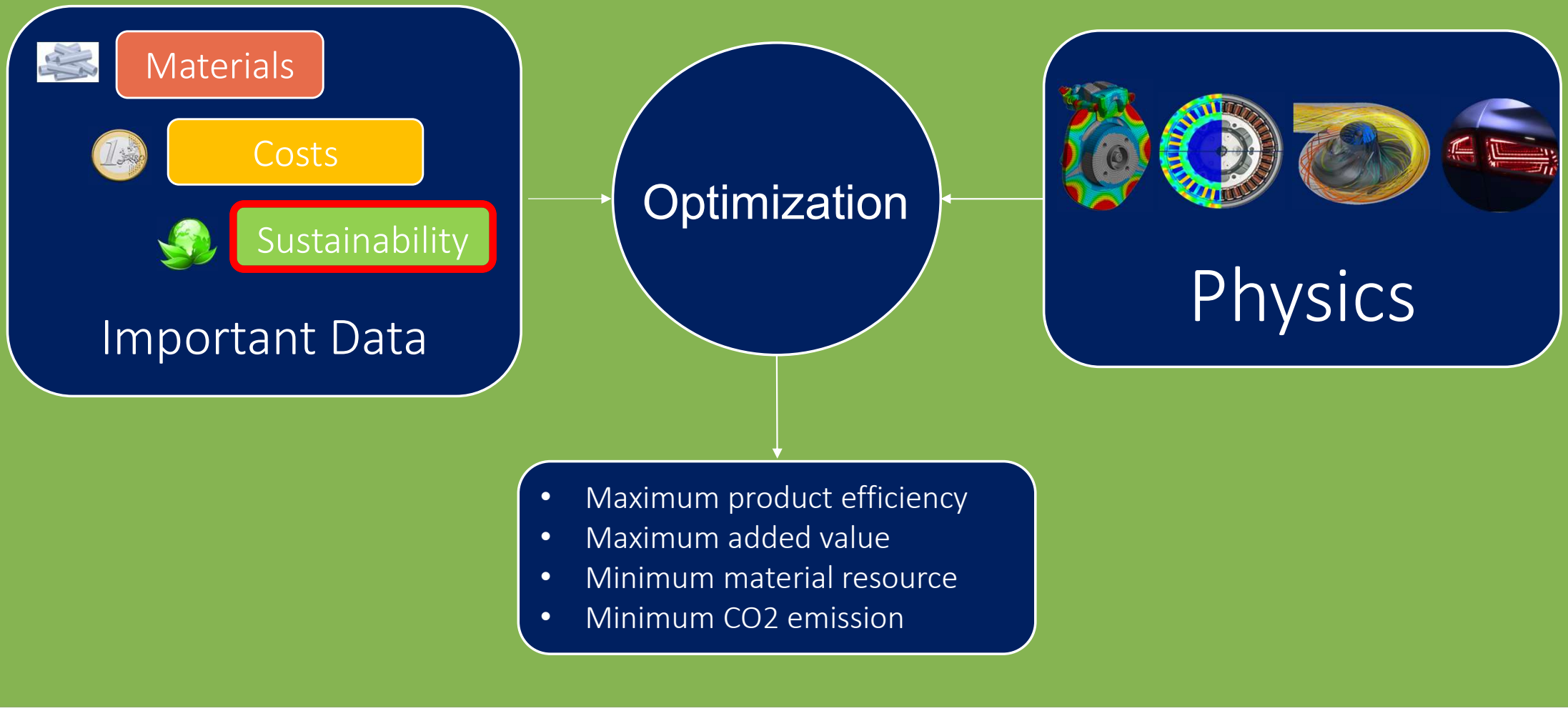
Development priority:

Product optimization & CO_2 Reduction

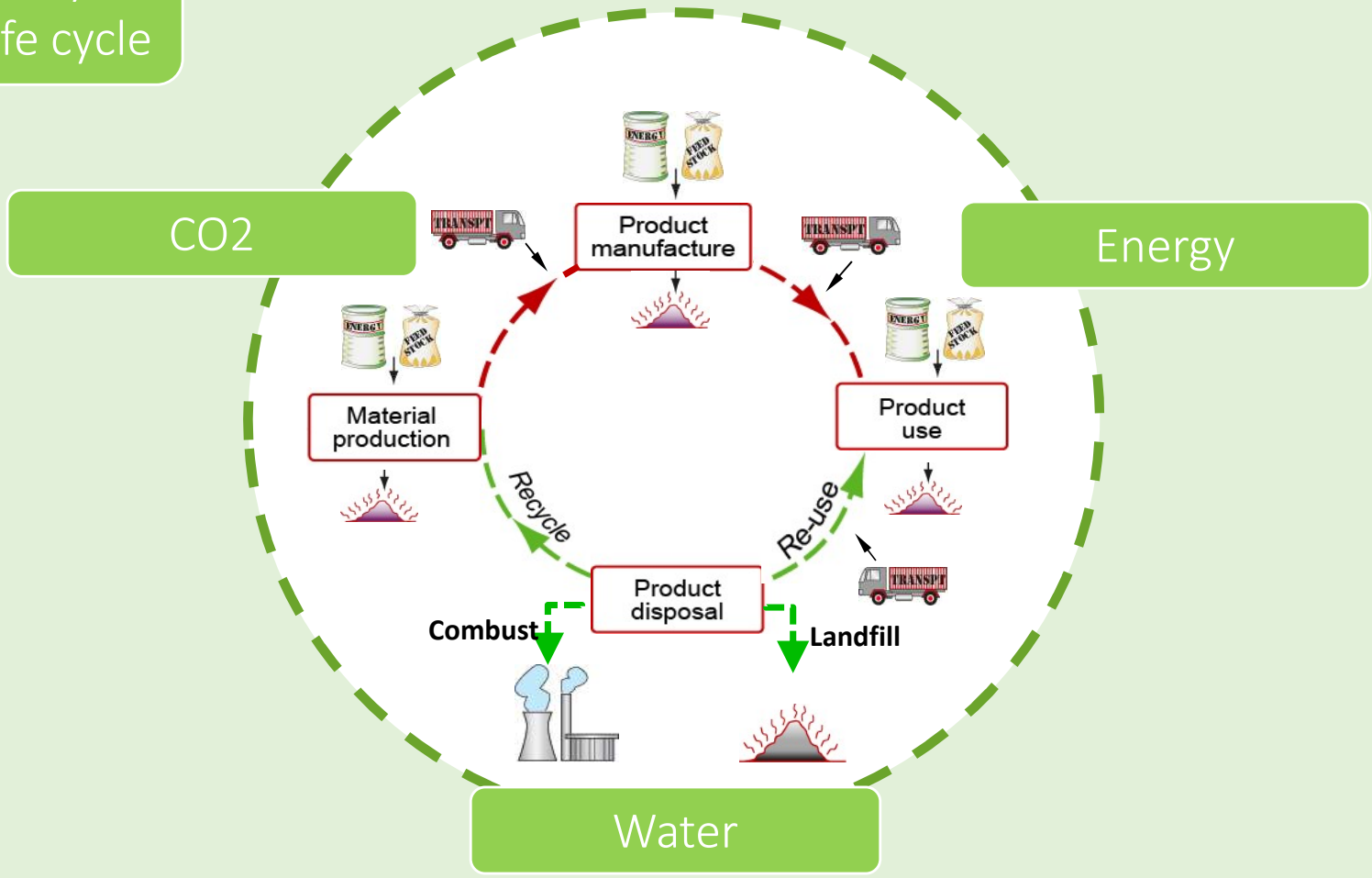
↑ Complexity

↑ Sustainability

Innovation and sustainability through product insight



Sustainability in product life cycle



Simulation Process Data Management

Material resources costs

Material
CO2, Energy, Water

Manufacturing
CO2, Energy, Water

Operational
CO2, Energy, Water

Disposal
CO2, Energy, Water

Optimization

Physics

- Maximum product efficiency
- Maximum production efficiency
- Maximum operation efficiency
- Maximum disposal efficiency
- Minimum material resource
- Minimum CO2 emission

CADFEM Workflow

Material resources costs

Material
CO2, Energy, Water

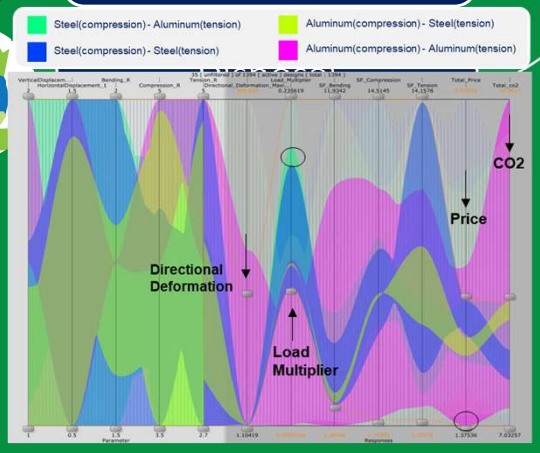
Manufacturing
CO2, Energy, Water

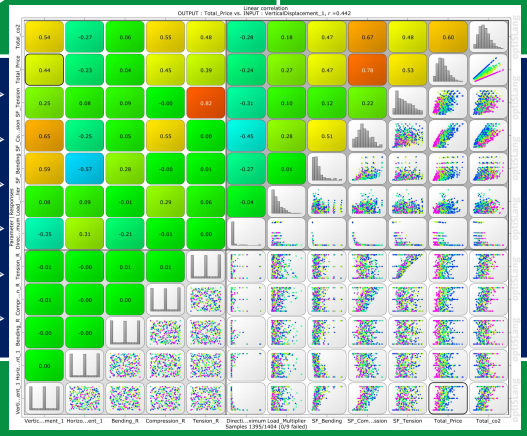
GRANTA

Operational
CO2, Energy, Water

Optimization
Ansys
OPTISLANG

Ansys Mechanical
Ansys Fluent
Ansys HFSS
Ansys Twinbuilder
Ansys Maxwell
...



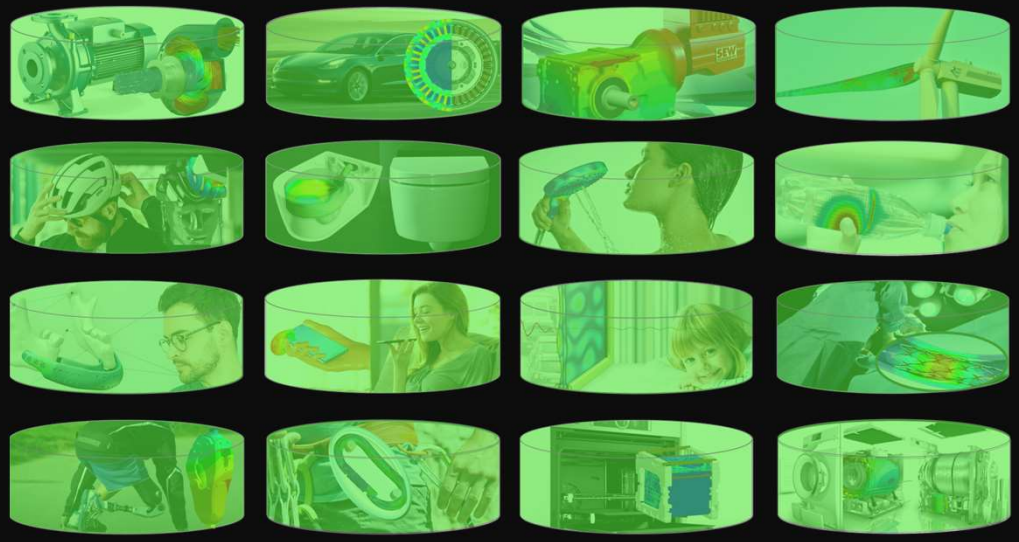


What if and trade off studies

- What is po
- What is i
- What is
- What is
- Where is t
- Where is the potential

Innovative products today

Sustainable Products tomorrow

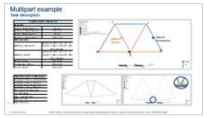


Innovation and sustainability through product insight

Simple parametric system in OptiSLang

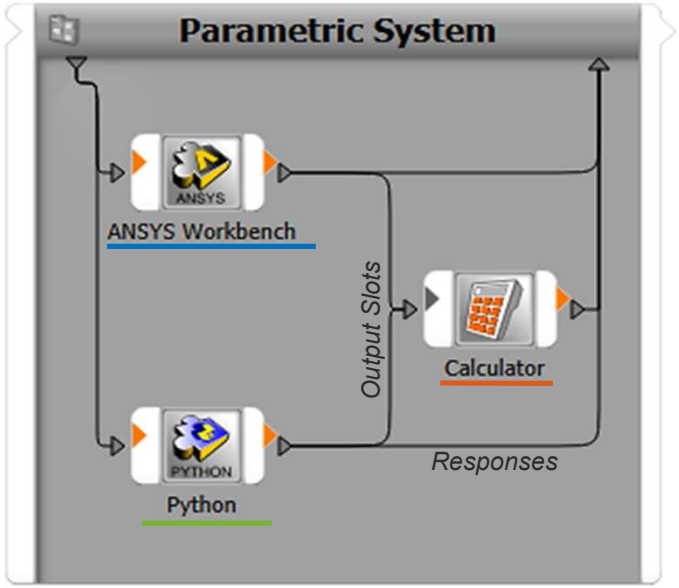
- **Materials name**
- Geometry parameters
  - Mass of the part
  - Evaluations: Max equivalent stress, Load Multiplier

Ansys / MECHANICAL



- **Materials Name**
  - CO2/kg per Material
  - Price/kg per Material
  - Yield strength per Material

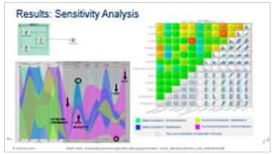
Ansys / GRANTA



Results for sensitivity analysis and optimization:

- Total_Price= Mass*Price
- Total_co2= Mass*CO2
- SF= Yield strength / Equivalent_stress

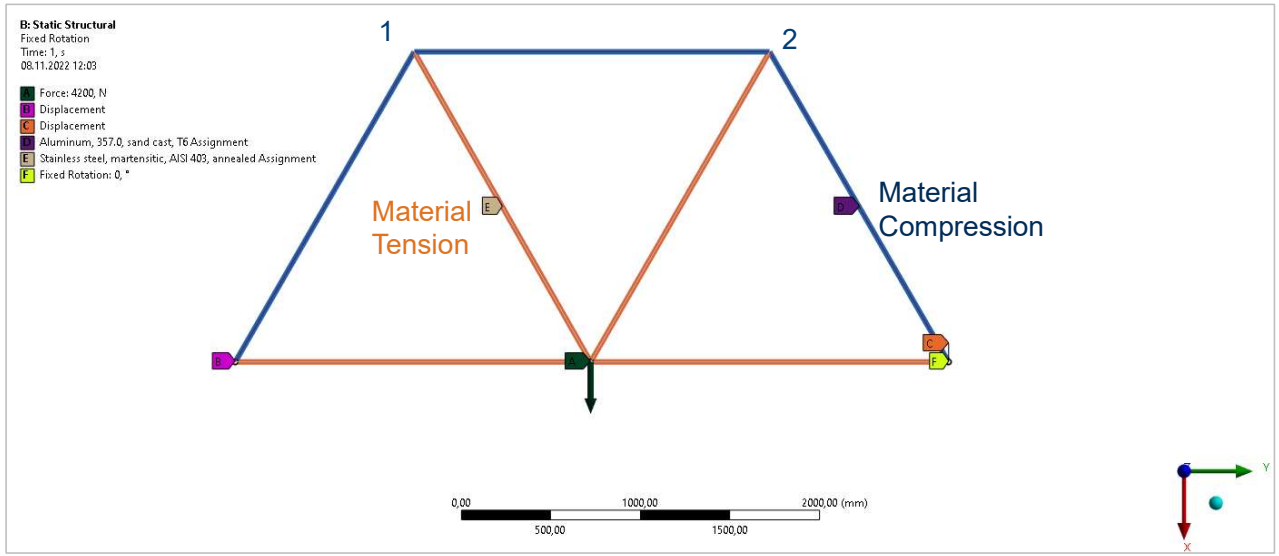
Ansys / OPTISLANG



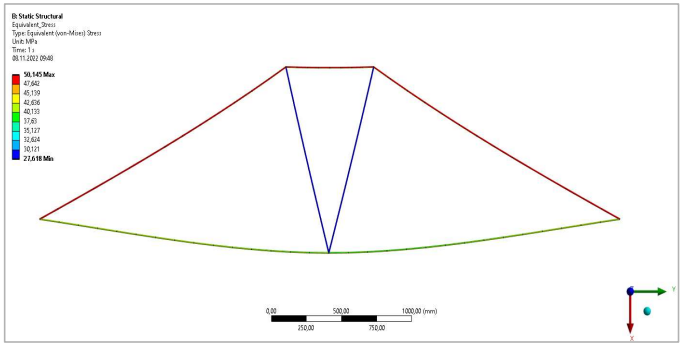
Multipart example

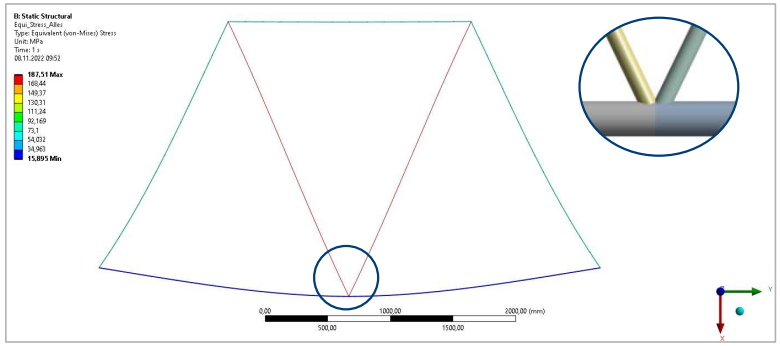
Task description

Input Parameters-Mechanical	
Geometry	
Vertical_Displacement_1	1m-2m
Horizontal_Displacement_1	0.5m-1.5m
Vertical_Displacement_2	1m-2m
Horizontal_Displacement_2	0.5m-1.5m
Static Structural	
Material_Compression	Aluminum,357.0, sand cast, T6 - Stainless steel, martensitic, AISI 403, annealed
Material_Tension	Aluminum,357.0, sand cast, T6 - Stainless steel, martensitic, AISI 403, annealed
Bending_Radius	1mm-6mm
Compression_Radius	1mm-6mm
Tension_Radius	1mm-6mm

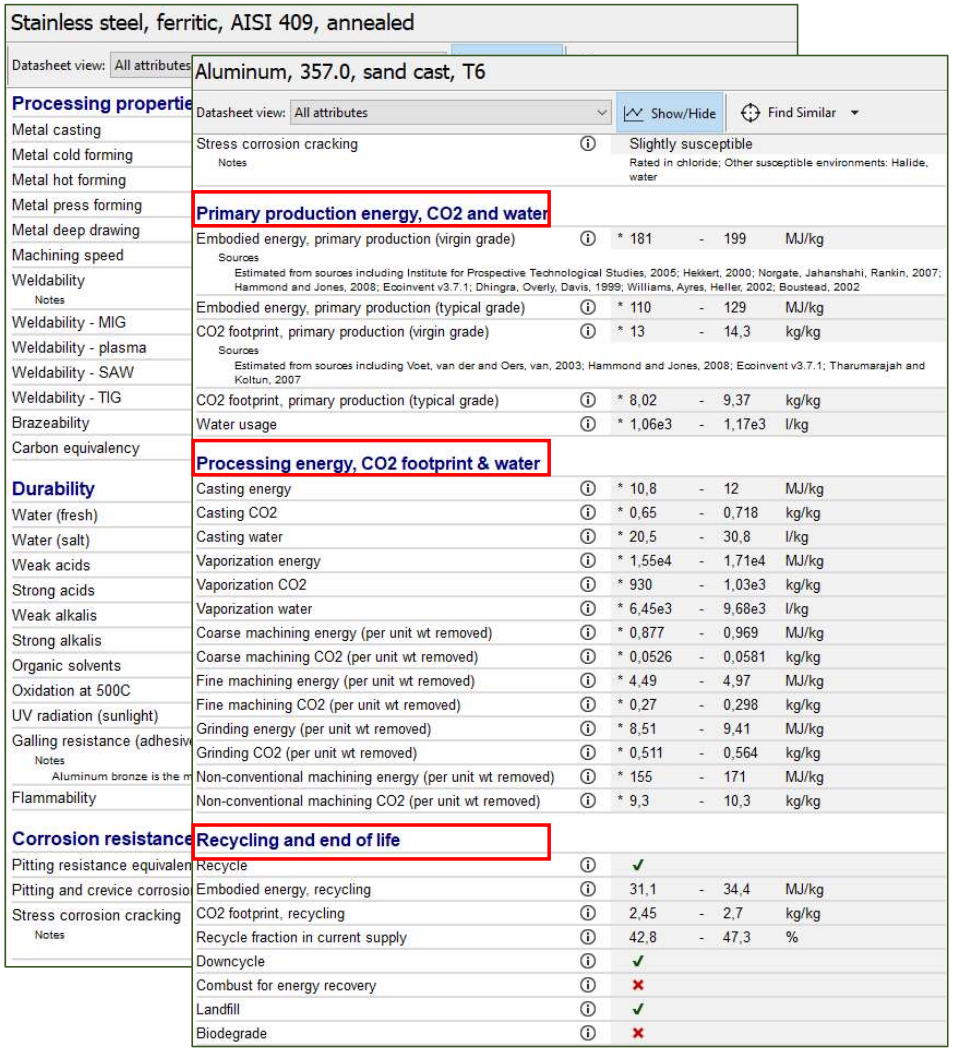


Output Parameters-Mechanical
Equivalent_Stress_Compression
Equivalent_Stress_Tension
Equivalent_Stress_Bending
Directional_Deformation
Load Multiplier
Mass_Compression
Mass_Tension
Mass_Bending

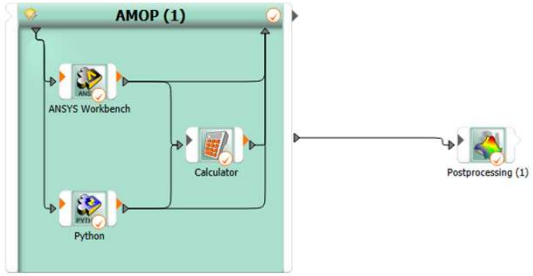


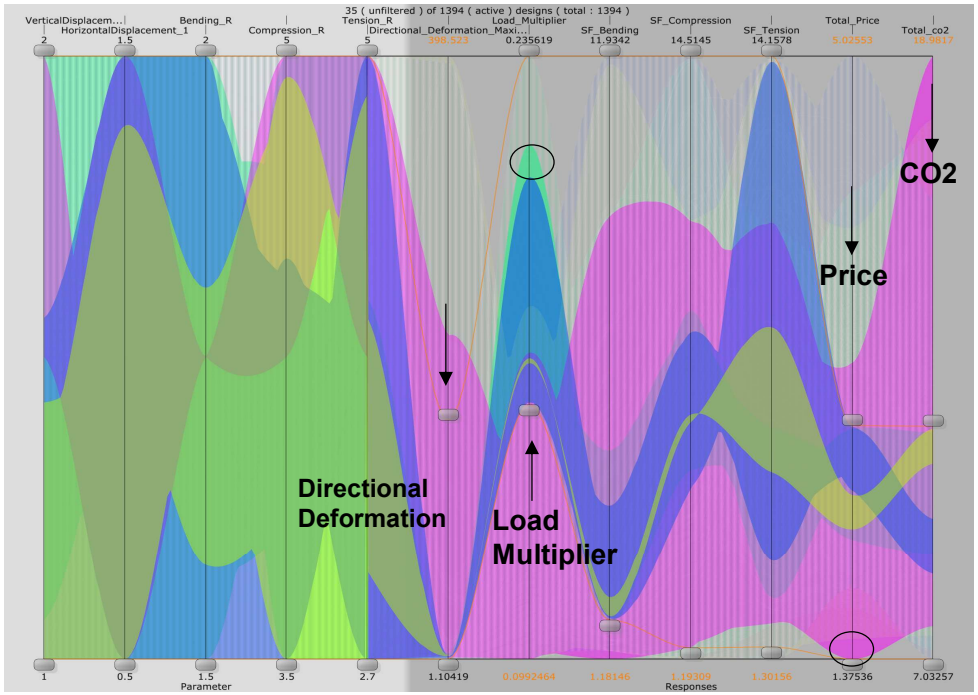


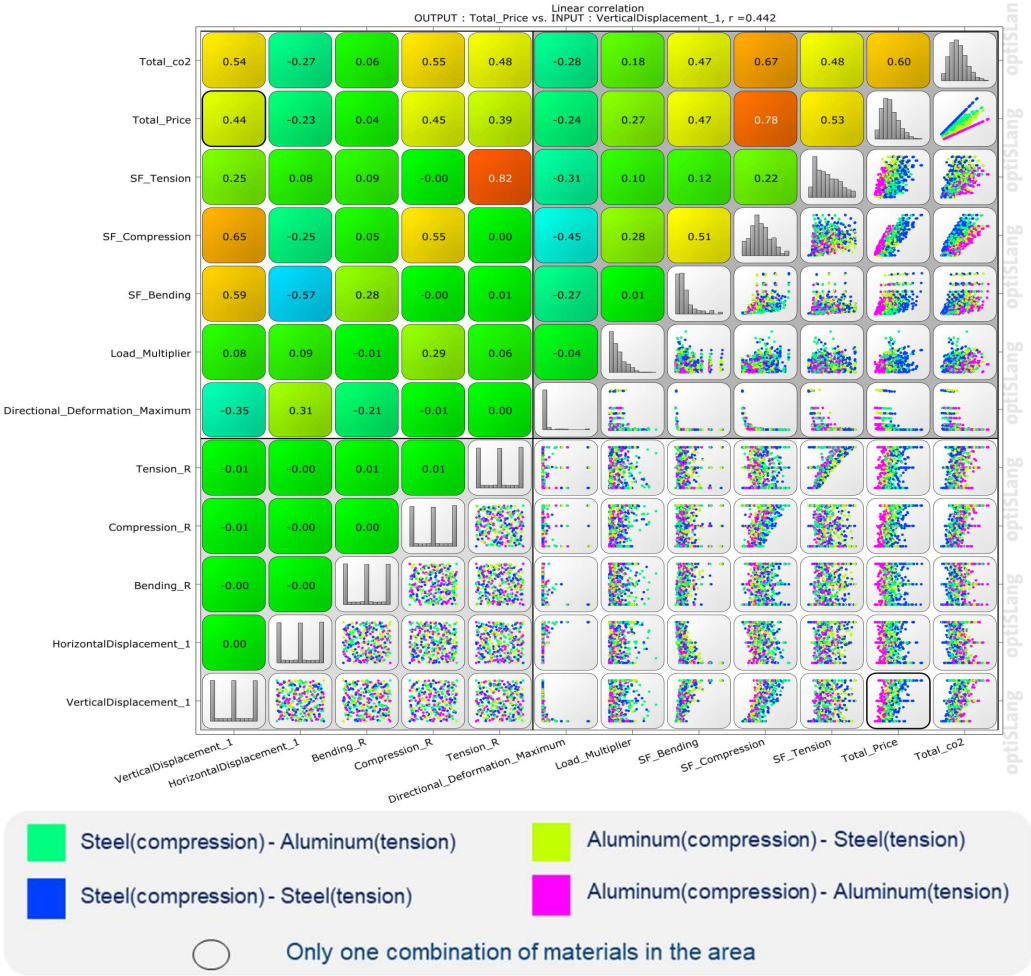
Material data



Results: Sensitivity Analysis







Steel(compression) - Aluminum(tension)

Aluminum(compression) - Steel(tension)

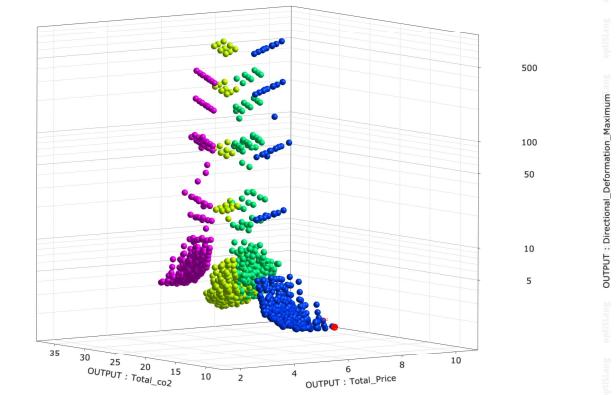
Steel(compression) - Steel(tension)

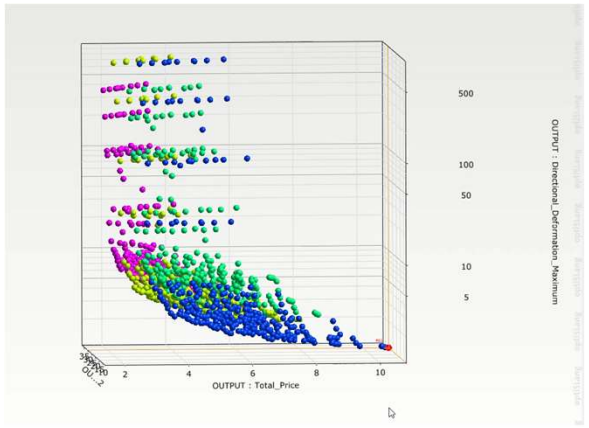
Aluminum(compression) - Aluminum(tension)

Only one combination of materials in the area

Results: Sensitivity Analysis

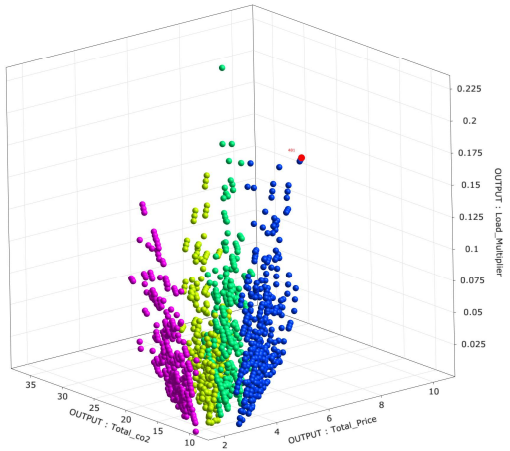
Total Price vs. Total CO2 vs.
Directional Deformation Max

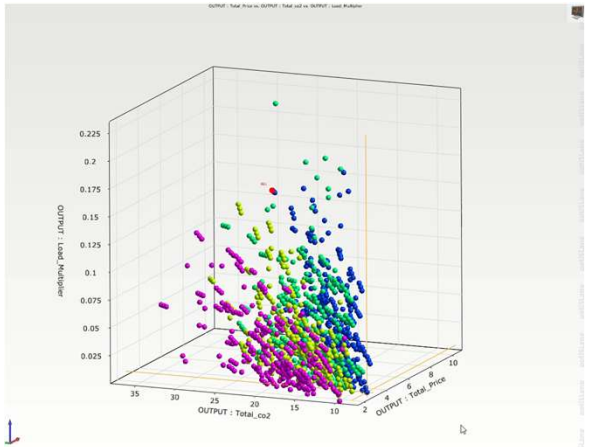




- Steel(compression) - Aluminum(tension)
- Steel(compression) - Steel(tension)
- Aluminum(compression) - Steel(tension)
- Aluminum(compression) - Aluminum(tension)

Total Price vs. Total CO2 vs.
Load Multiplier





Sustainability in product life cycle

Resources

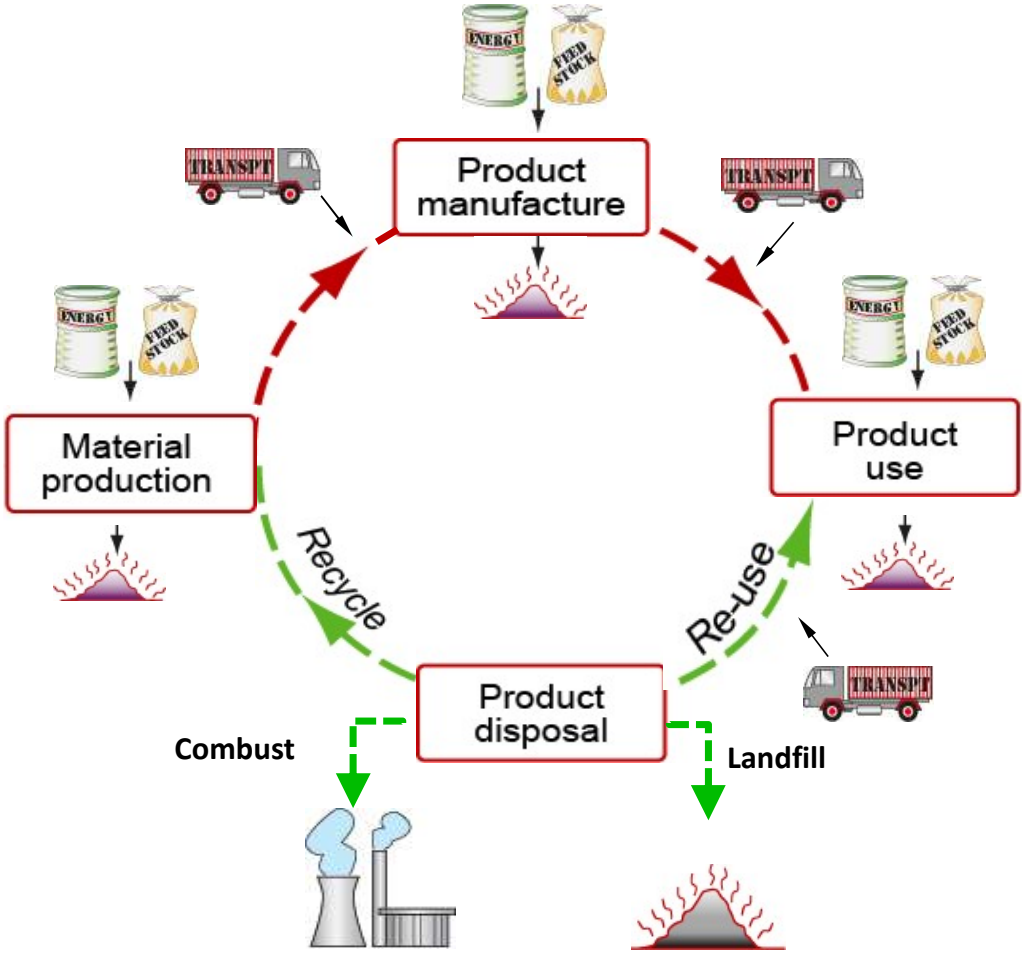
Energy

Feedstocks

Transport

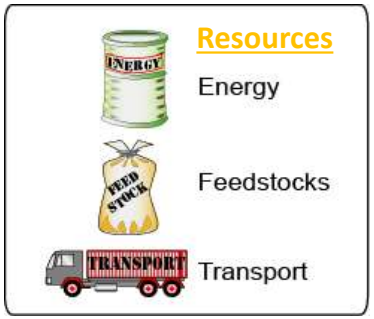
Emissions and waste

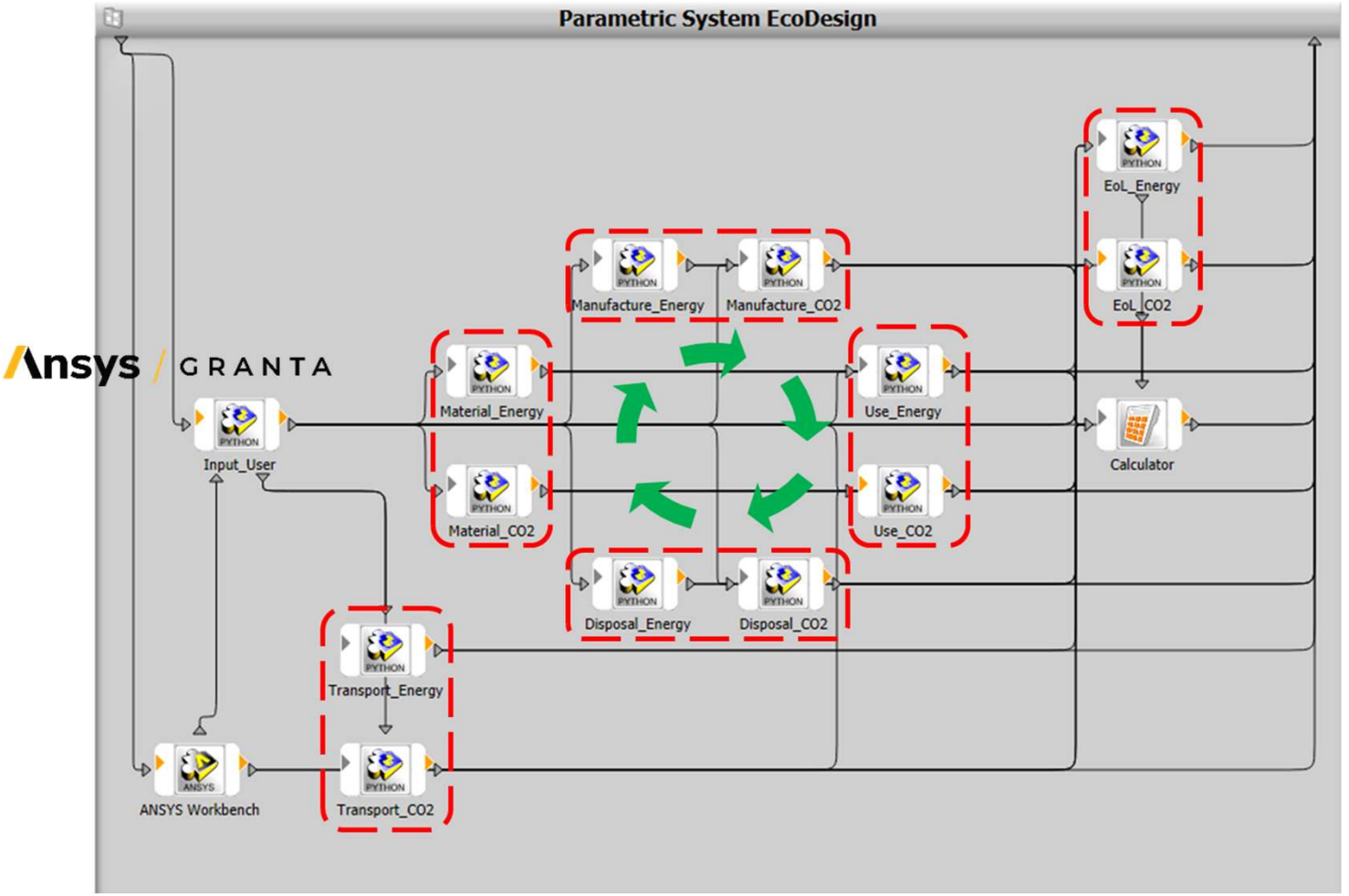
- CO_2, NO_x, SO_x
- Liquid waste
- Solid waste



Sustainability in product life cycle

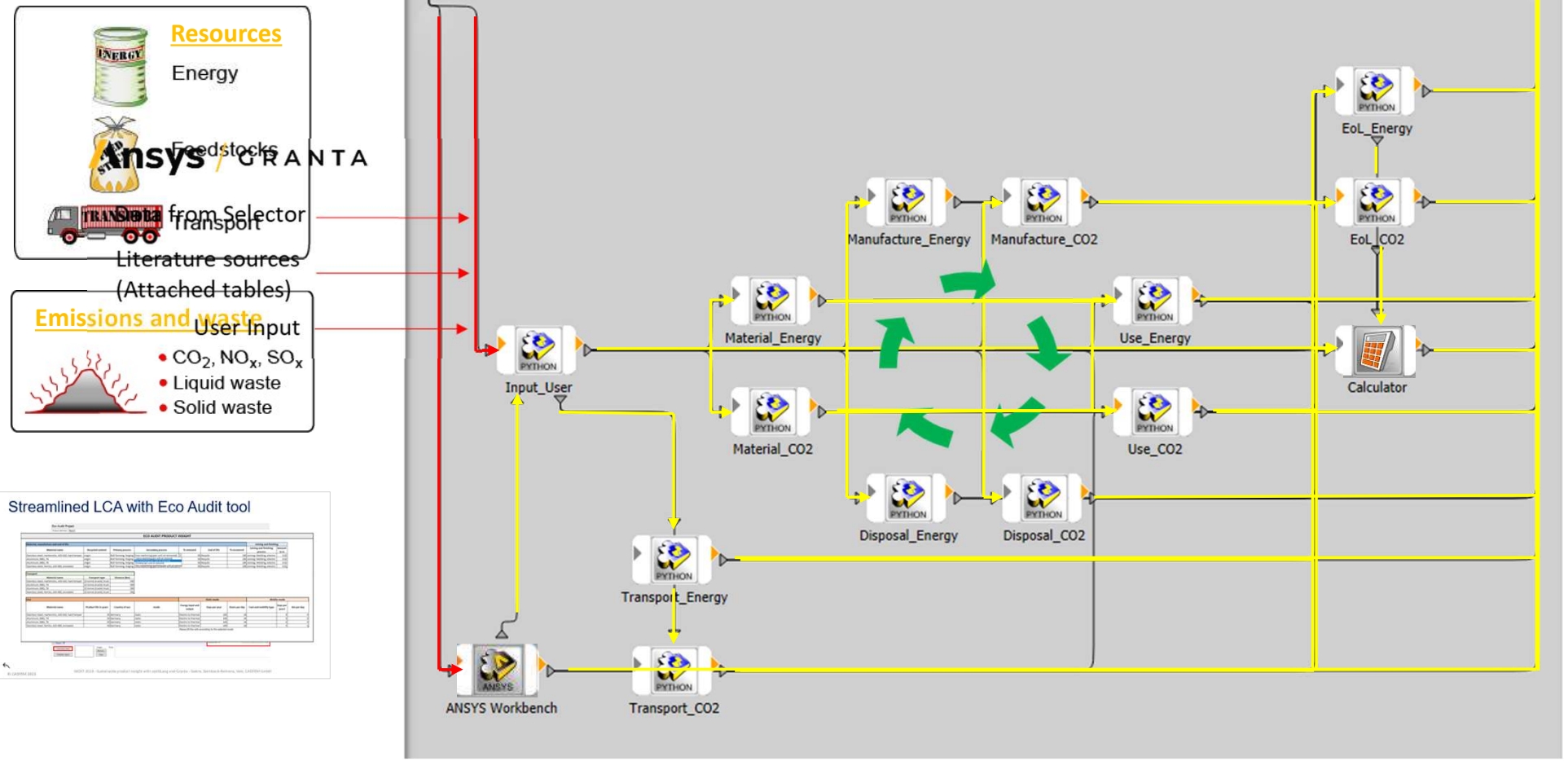
Ansys / OPTISLANG





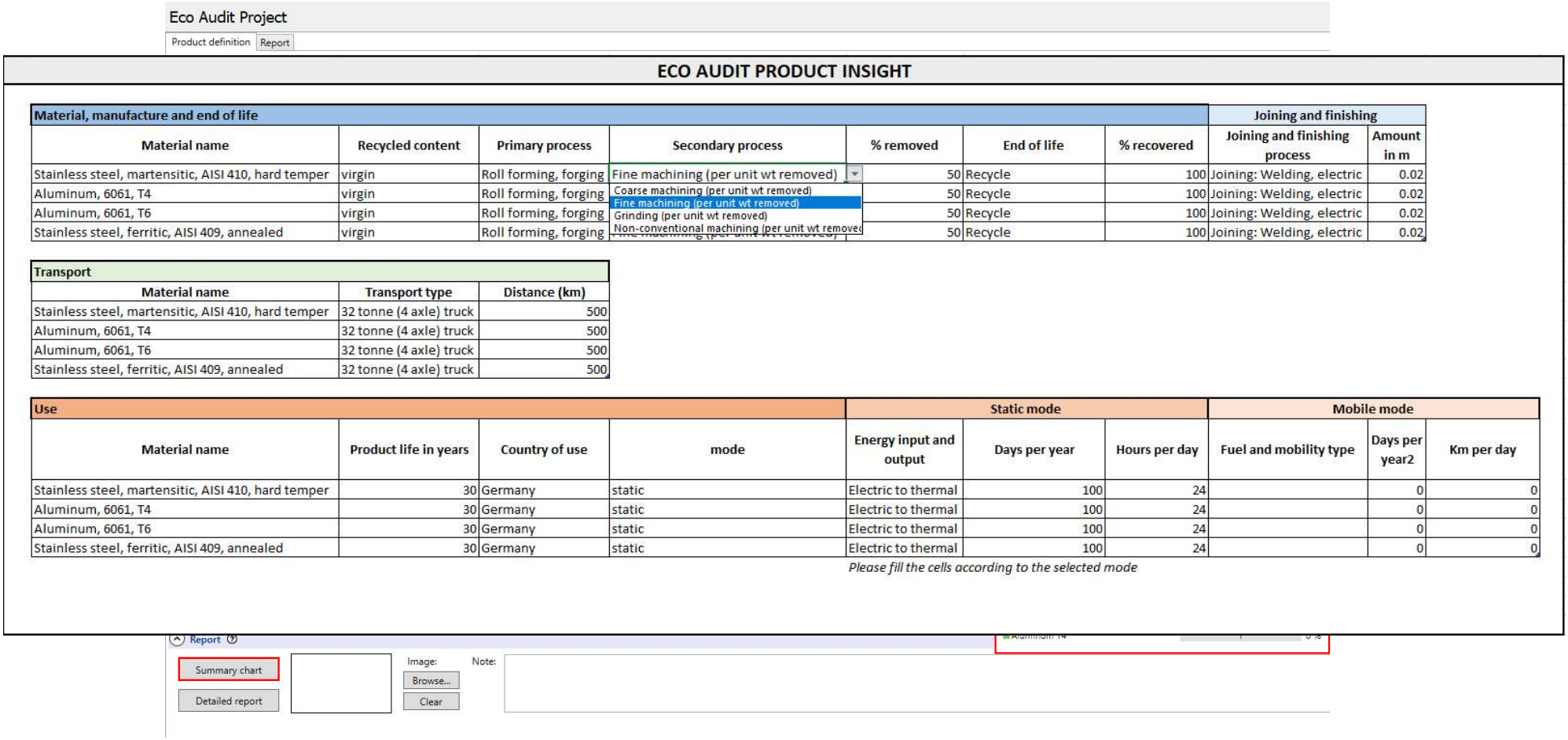
Sustainability in product life cycle

Ansys / OPTISLANG



Ansys / MECHANICAL

Streamlined LCA with Eco Audit tool

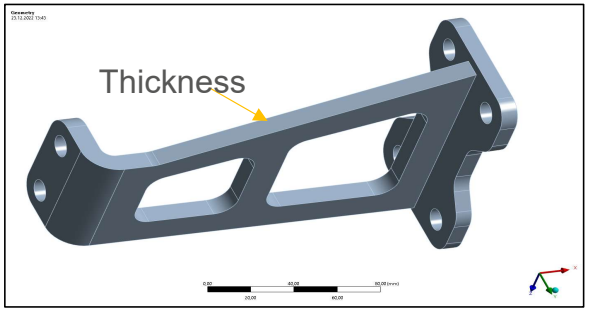


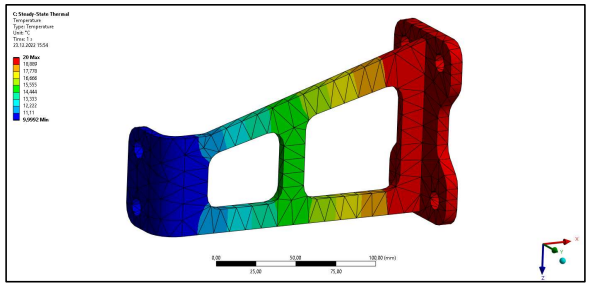
Single part example

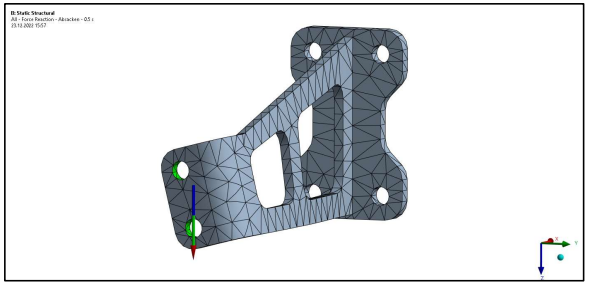
Task description

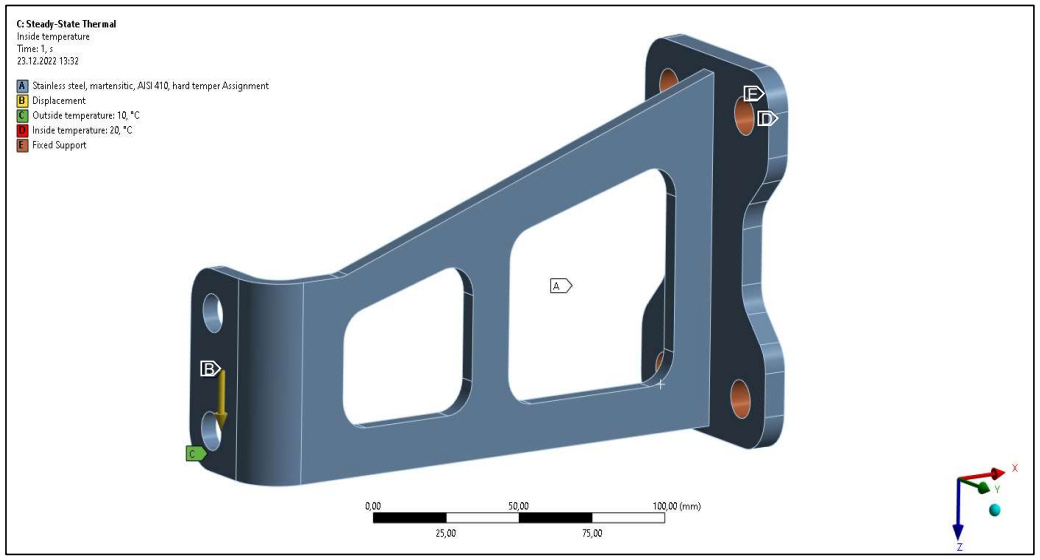
Input Parameters	
Geometry	
Thickness	5mm-10mm
Static structural	
Material	Stainless steel, martensitic, AISI 410, hard temper
	Stainless steel, ferritic, AISI 409, annealed
	Aluminum, 6061, T4
	Aluminum, 6061, T6

Output Parameters
Heat [w]
Mass [kg]
Force reaction-0.5s-Z axis [N]
Force reaction-1s-Z axis [N]
Load increase[N]
Load increase percent









Additional calculations

- Direct output per part from mechanical node

Force reaction 0.5s Z Axis

- Direct output per part from product cycle

Material energy
Material CO2
Material cost
Transport energy
Transport CO2
Manufacture energy
Manufacture CO2
Use energy
Use CO2
Use cost
EoL energy
EoL CO2
Disposal energy
Disposal CO2

- Indirect outputs per part

Total energy full cycle
Total CO2 full cycle
Total cost (material+use)

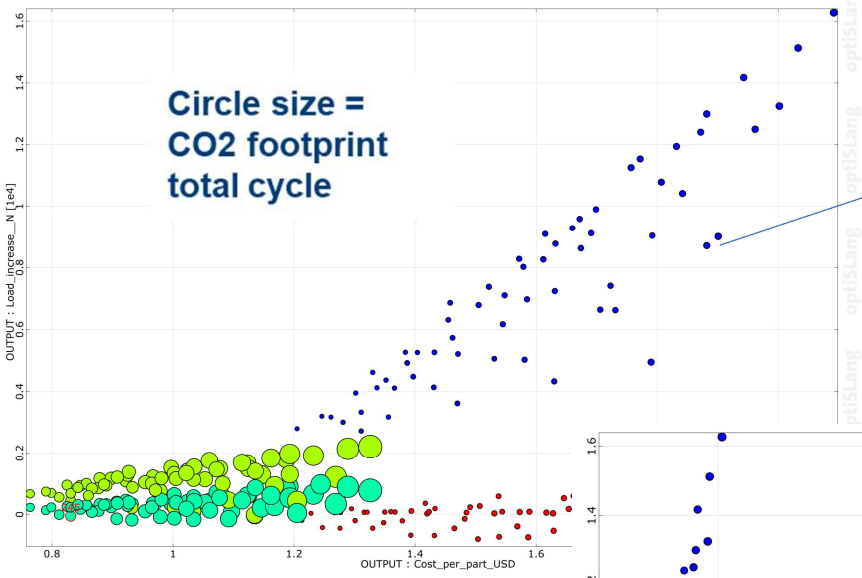
- Indirect outputs per design performance

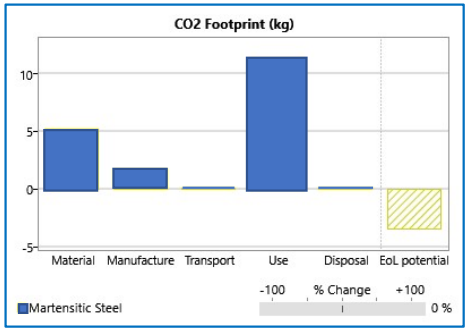
Performance per load capacity
Material energy
Material CO2
Material cost
Use energy
Use CO2
Use cost
Total energy
Total CO2
Total cost

- Indirect outputs for all required parts

Total cost (material+use)
Number of parts

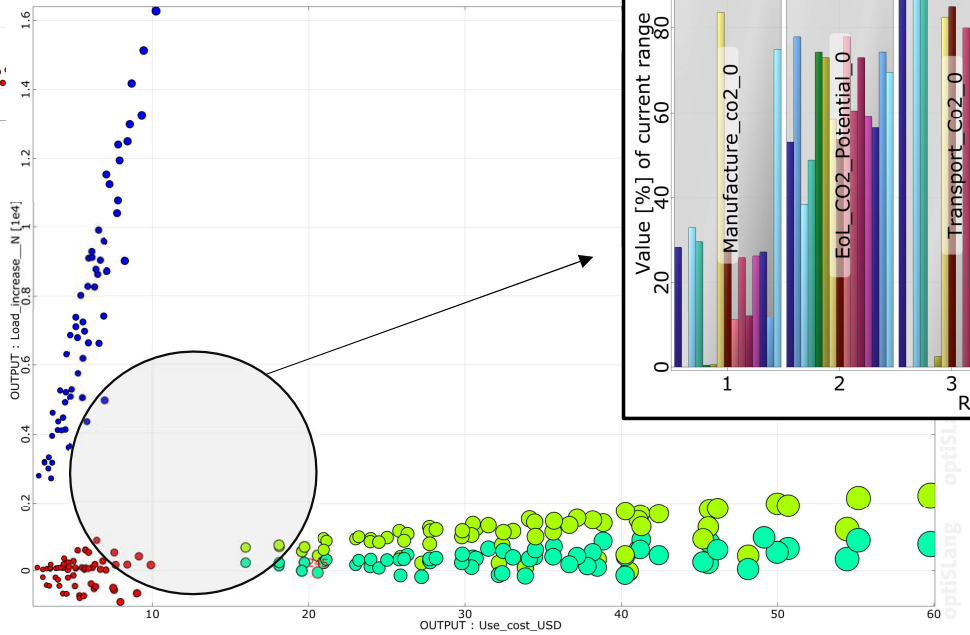
Results: Sensitivity Analysis

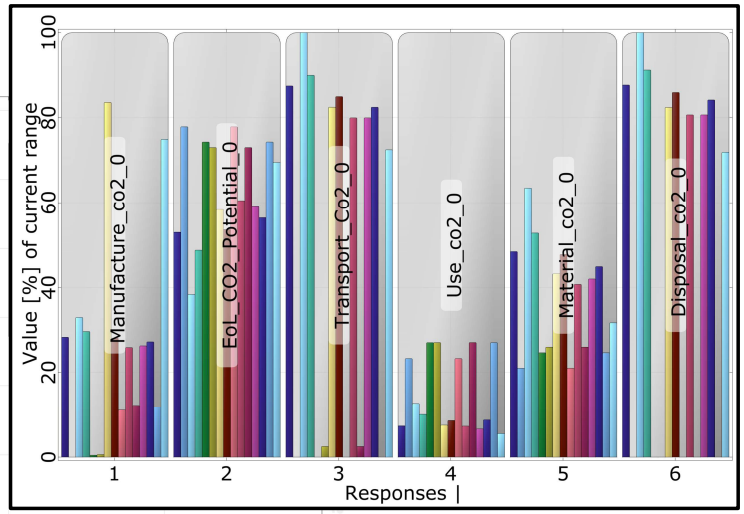




Eco Audit inside Granta

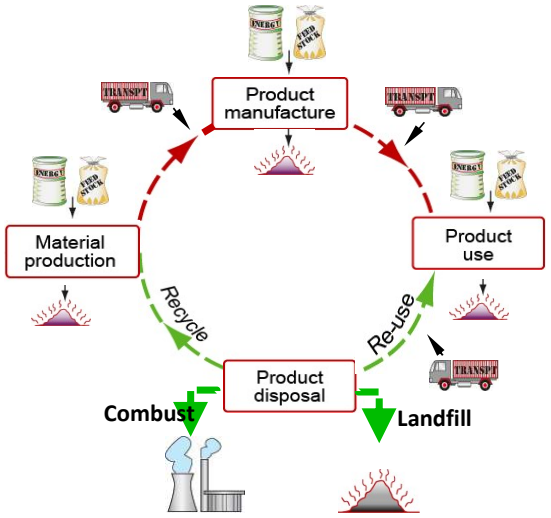
Martensitic steel
Ferritic steel
Aluminium T6
Aluminium T4





Eco Audit inside OptiSLang

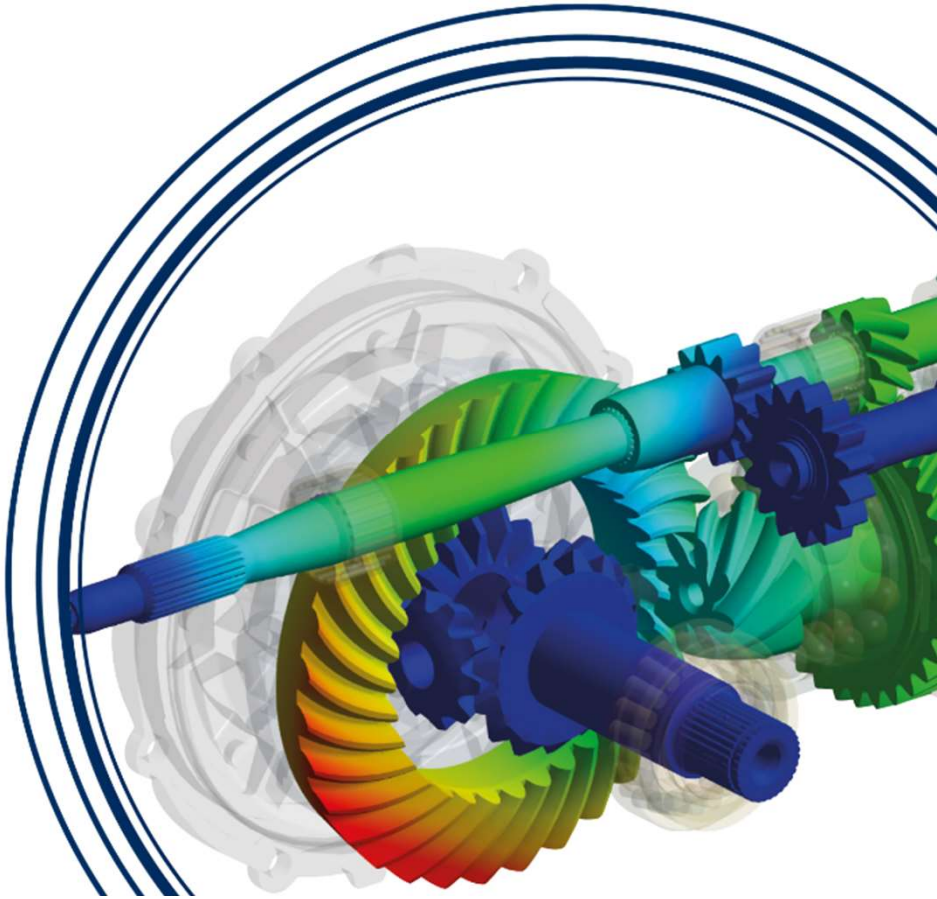
Tool comparison and conclusion



	Concept assessment	Sustainability insight	Full LCA
Design phase	Early – Late	Early – Late	Early – Late
Time needed	Day – Months	Day – Months	Day – Months
Environmental expertise	Low – High	Low – High	Low – High
Analysis' costs	Low – High	Low – High	Low – High
Ecodesign opportunities	Low – High	Low – High	Low – High
Environmental indicators	1 – > 20	1 – > 20	1 – > 20
Physics simulation	n.a.	Low – High	n.a.
Costs estimate	n.a.	Early – Late	Early – Late
Design optimization	n.a.	Low – High	n.a.
Tool used	**Granta Eco Audit**	**Granta + OptiSLang + Physics**	**Full LCA software**

CADFEM

Simulation is more than Software



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