

Workshop on Policy Design for a Climate-Friendly Materials Sector

Granta Design Ltd.

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Brussels 16th of September 2016



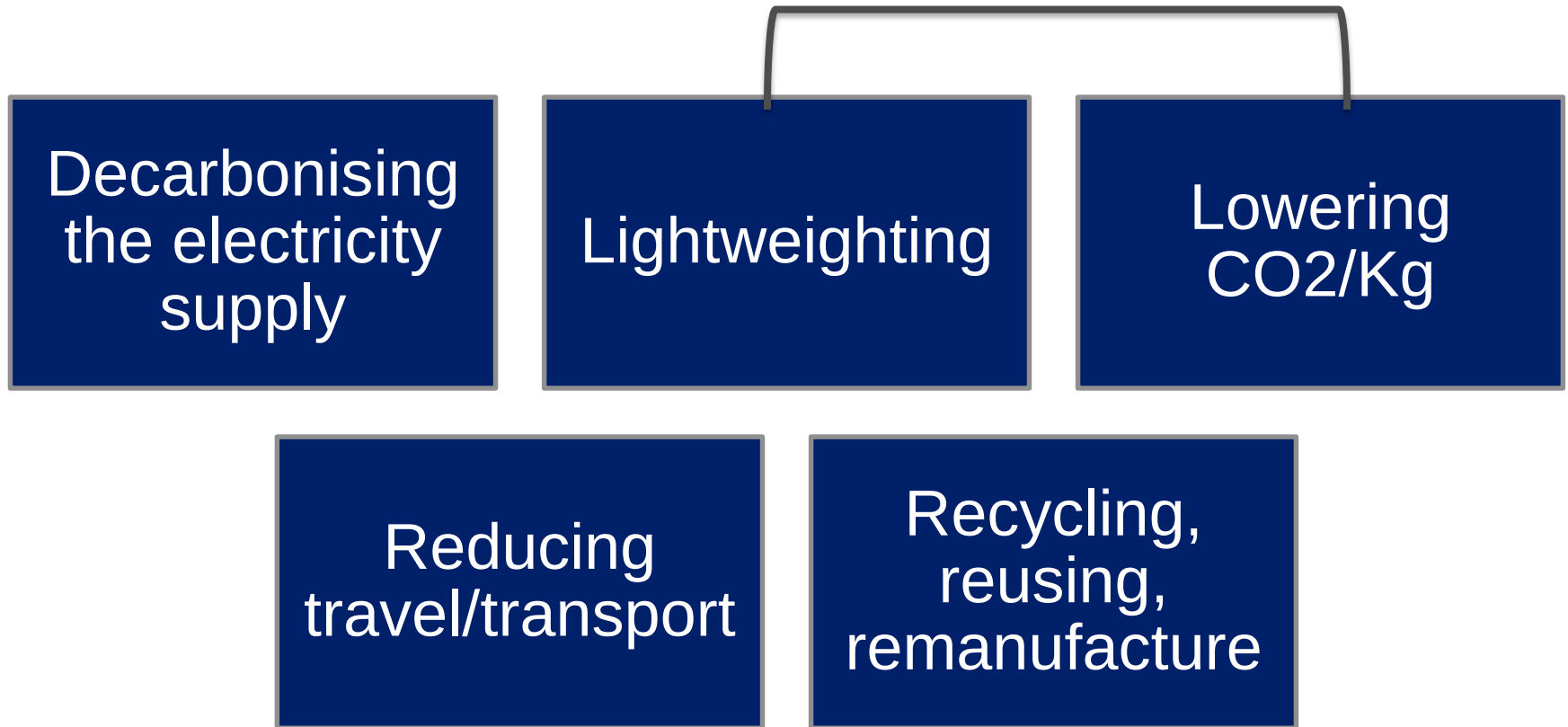
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MATERIAL INSPIRATION

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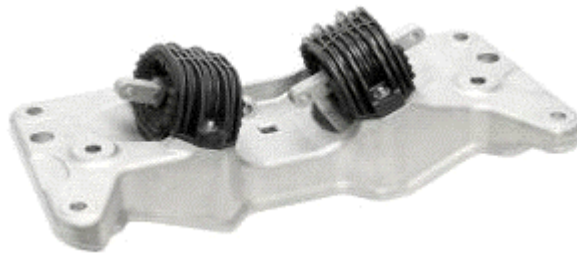
Agenda

- Substitution Case Study
- Trade-offs
- Barriers to change

Ways to reduce Carbon Footprint



Automotive transmission cross beam



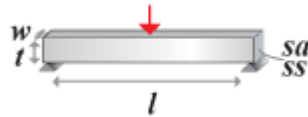
Materials

- Cast aluminium alloy
- ~2kg

Design Requirements

Function:

Automotive transmission cross beam



- Beam loaded in bending
- Strength-limited design
- Length, section shape specified
- Section area free



Current material:
Al 357-T6

Constraints:

- Adequate stiffness ($>12\text{GPa}$)
- Temperature resistance -40°C to $+100^{\circ}\text{C}$
- Resistant to: salt water, oil, fuel
- 3D complex shape

Objectives:

- Minimize mass
- Minimize cost
- Minimize Carbon Footprint



How we are going about it?

- Data on the properties of Materials and Processes
 - Our largest database has 88,000 different materials
- Software Selection Tools
 - CES Selector has been used in industry since 1994
- A methodology
 - Granta's co-founder Professor Michael F. Ashby wrote books on the topic of material selection and more
- Industrial consortia
 - Inputs on real life case studies, data and industrial challenges

Step 1. Apply Constraints

- CES Selector 2016 - [Stage 2: Young's modulus, Maximum service temperature, Minimum service temperature, Water (salt), Organic solvents]

File Edit View Select Tools Window Feature Request Help

Browse Search Chart/Select Tools Solver Eco Audit Synthesizer Search Web Help

Selection Project Selection Project x

1. Selection Data

Database: All Editions Database: All Editions Change...

Select from: MaterialUniv Select from: MaterialUniverse: All bulk materia

Reference: Aluminum Reference: Aluminum, 357.0, Set...

2. Selection Stages

Chart/Index Limit Tree

☒ Stage 1: Mass per ☒ Stage 1: Mass per unit of strength (relative

☒ Stage 2: Young's ☒ Stage 2: Young's modulus, Maximum service

☒ Stage 3: Casting, ☒ Stage 3: Casting, Injection molding (thermo

3. Results: 533 of 3074

Show: Pass all Stage Show: Pass all Stages

Rank by: Stage 1: Cost Rank by: Stage 1: Cost per unit of strength

Name Cost

☐ Stainless steel, m... 0.62

☐ Stainless steel, m... 0.66

☐ PA66 (60% glass 0.68

☐ Stainless steel, m... 0.75

☐ Stainless steel, m... 0.79

☐ Stainless steel, m... 0.80

☐ PA66 (60% long g 0.87

☐ PBT (50% glass fi 0.89

☐ PA66 (50% glass 0.89

☐ PA66 (50% glass 0.89

4. Report

Comparison... Selection...

Ready Done

Home Stage 3 Comparison - MaterialUniverse Stage 1 Stage 2 x

Young's modulus, Maximum service temperature, Minimum service temperature, Water (salt), Organic solvents

Properties Apply Clear

Maximum service temperature	100	°C	150	-	170
Minimum service temperature		-40	°C	-273	
Thermal conductivity			W/m.°C	145	- 157
Specific heat capacity			J/kg.°C	944	- 982
Thermal expansion coefficient			µstrain/°C	20.9	- 21.9

Electrical properties

Magnetic properties

Optical properties

Bio-data

Critical materials risk

Processing properties

Durability

Reference

Water (fresh)	Excellent
Water (salt)	Acceptable, Excellent
Weak acids	Excellent
Strong acids	Excellent
Weak alkalis	Acceptable
Strong alkalis	Unacceptable

NUM

Step 2. Work out the Performance Indices

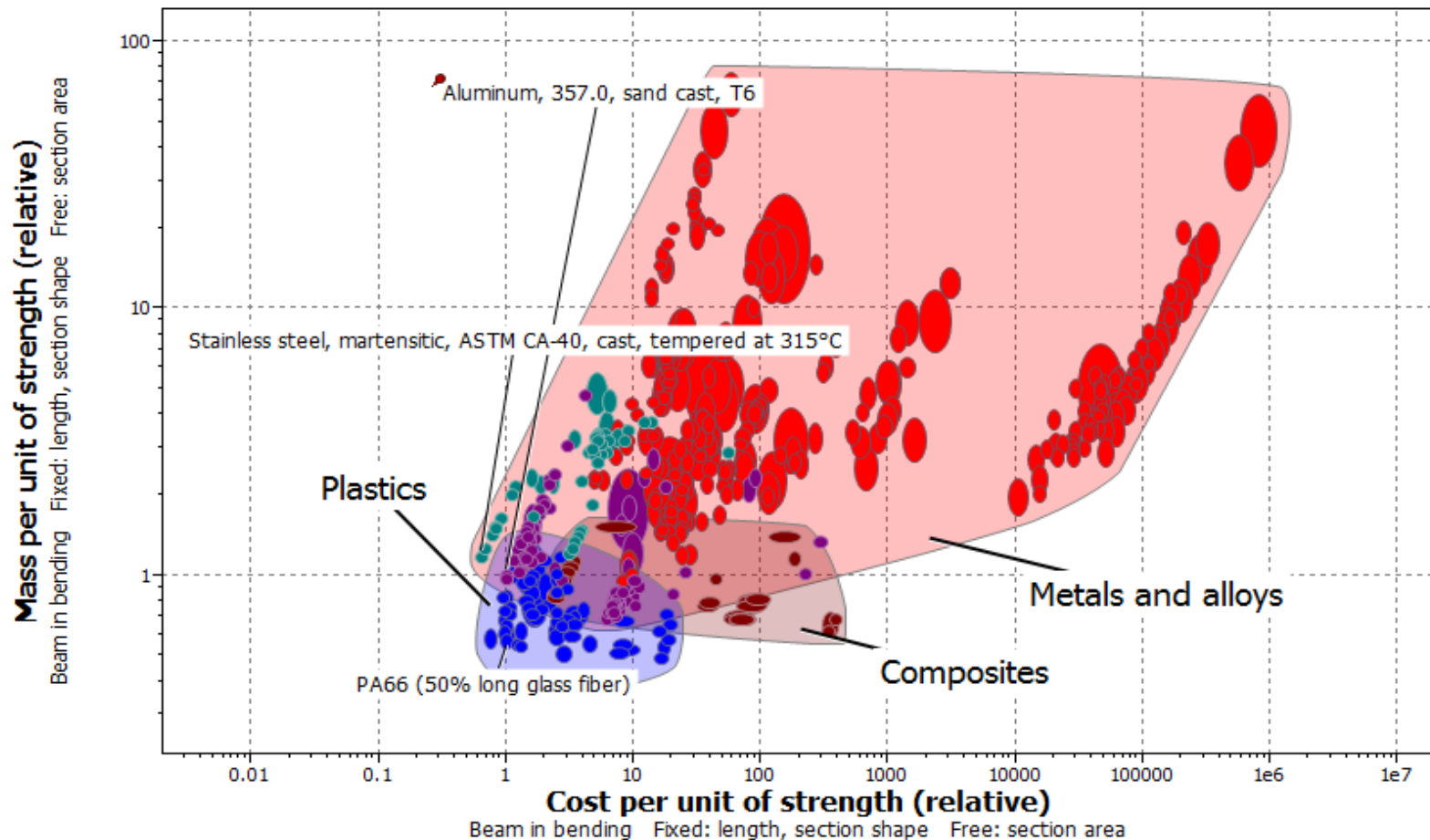
- Relative performance of materials for:

- Weight $\sigma_f^{2/3} / \rho$

- CO2 $\sigma_f^{2/3} / \text{CO}_2 \rho$

- Cost $\sigma_f^{2/3} / C_m \rho$

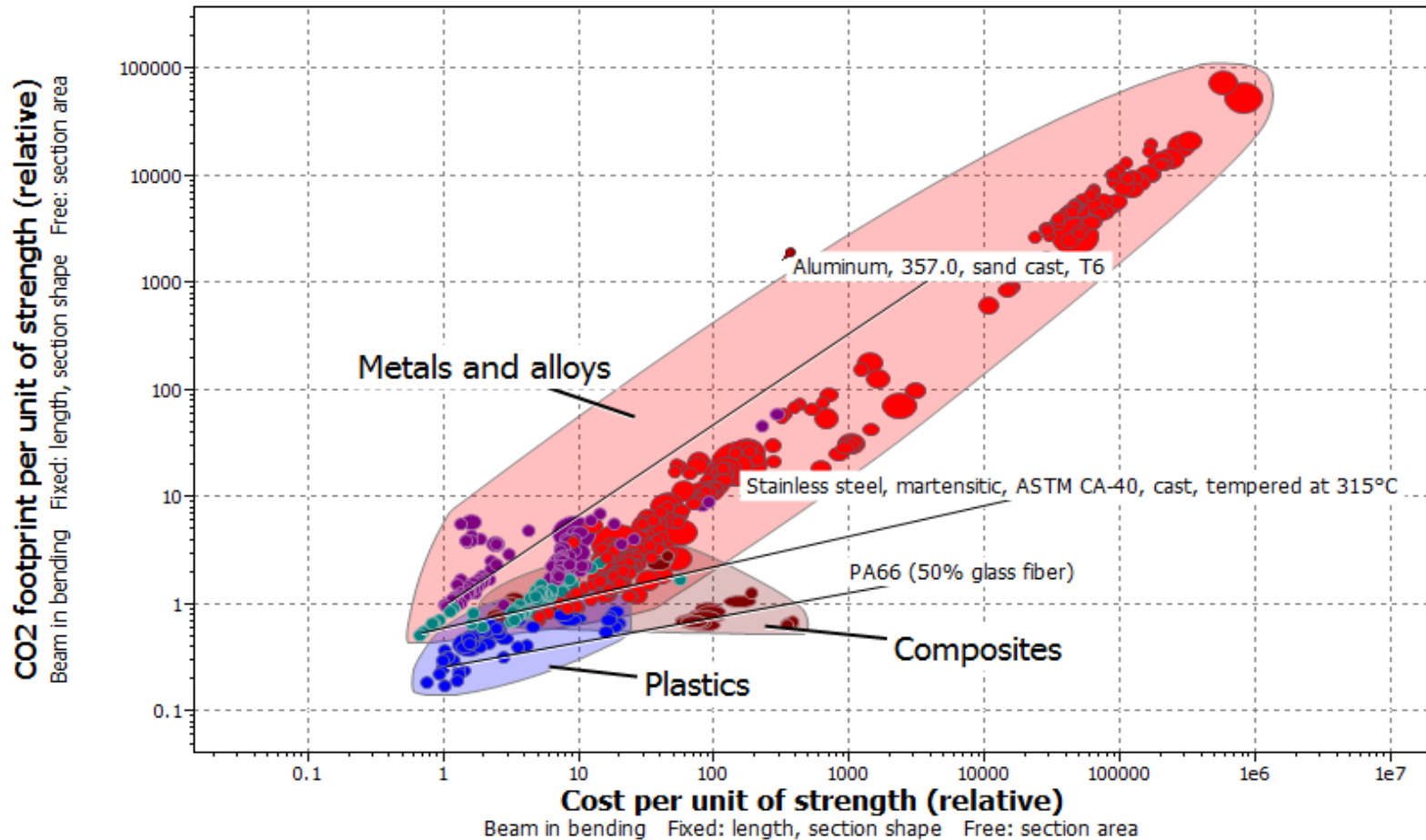
Step 3. Look at the trade-offs



We can work out the penalty per unit of function

There are methods for multi-objective optimization

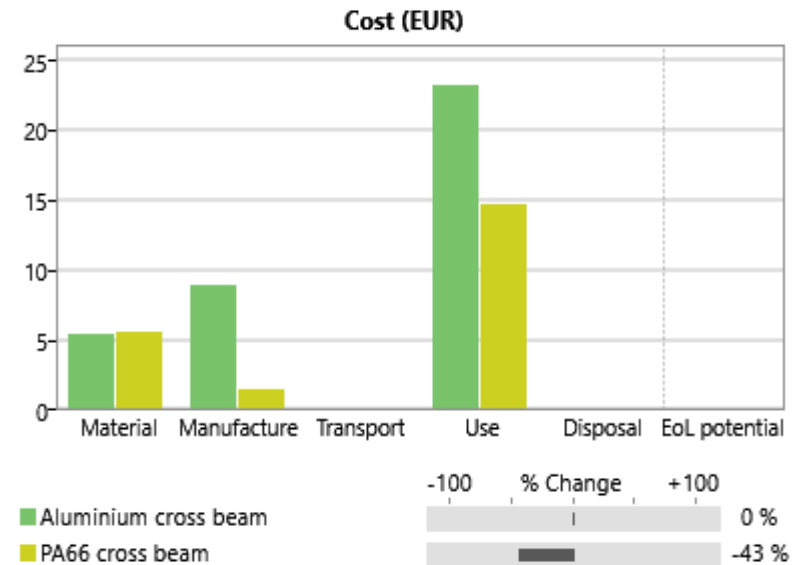
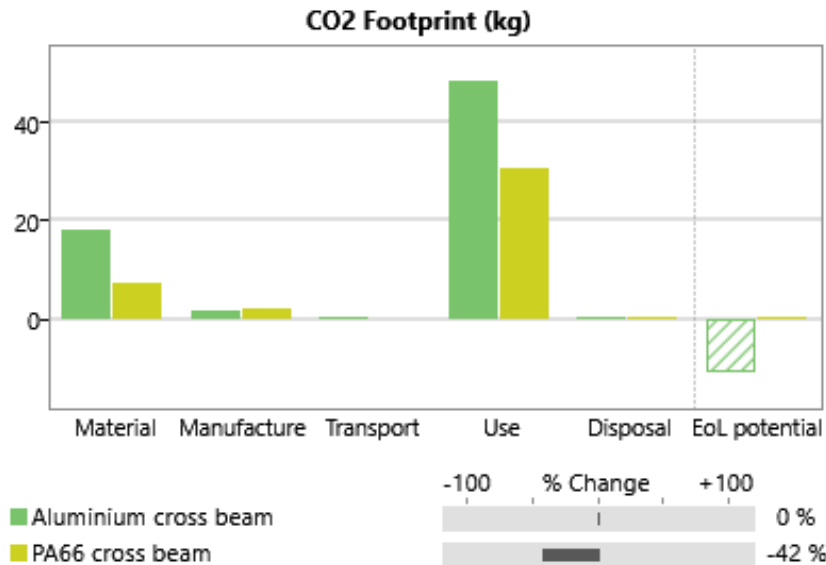
Step 3. Look at the trade-offs



We can work out the penalty per unit of function

There are methods for multi-objective optimization

Step 4. But what about the whole life cycle of the product?



A higher carbon price will make the trade off look better

CES Eco Audit Tool estimates Energy, CO2 and Cost at the design stage

Step 5. But what other barriers are there to change?

Internal inertia

- No experience of manufacturing with new material
- Bulk purchasing arrangements
- Industry standards

Supply chain risk

- Critical materials
- Restricted Substances

Social acceptability & Legislation

- Social anxiety e.g. driverless cars
- Regulations
- Social, Environmental and Economic impact in materials producing countries

Infrastructure

- Electricity Supply
- Trade agreements
- Transport links

Solving one problem and creating another

- The use of composite materials has an impact on recycling
- The use of biopolymers has an impact on land and water

Granta Design

- Helps members of industry and engineering students to understand wider impact and trade-offs of their decisions

Through:

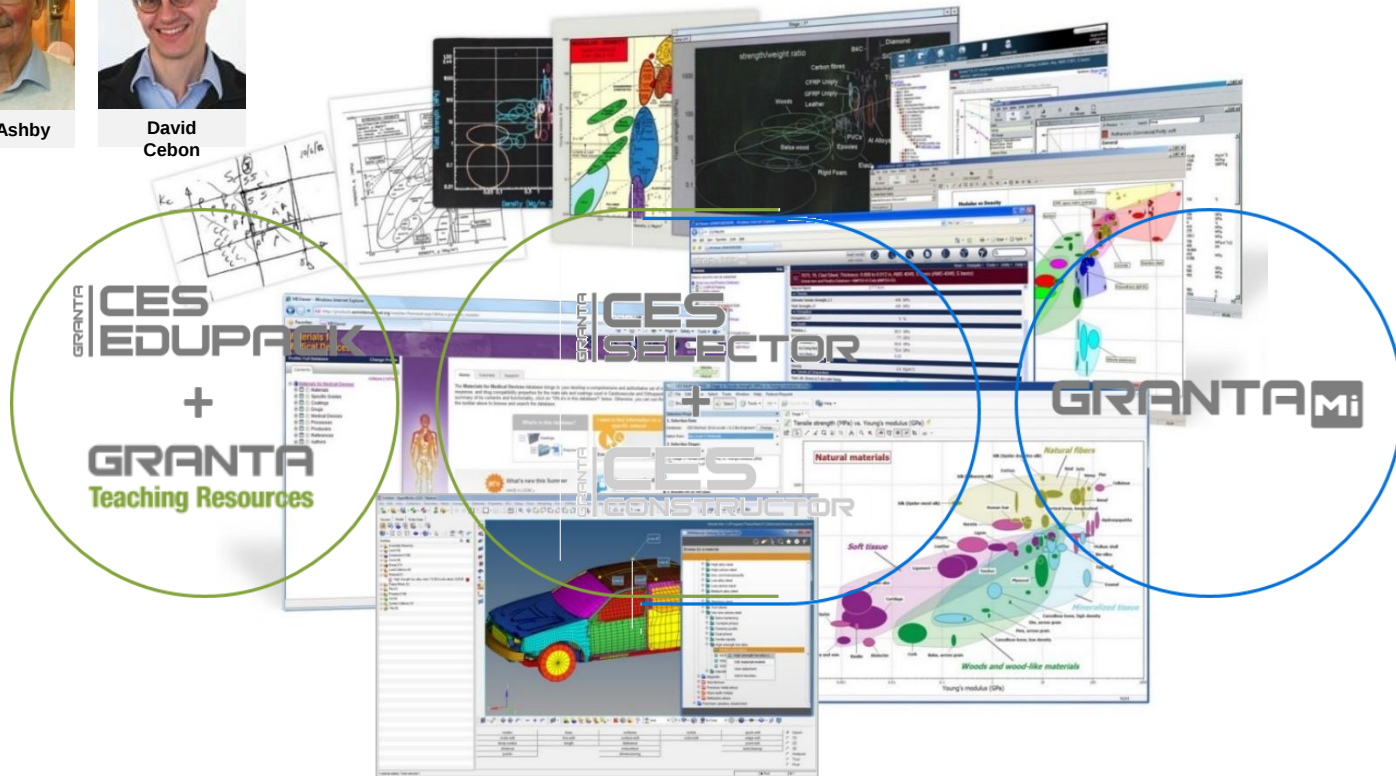
- Data
- Tools & Educational resources
- Methodologies
- Industrial Consortia & Academic Networks Interactions



Mike Ashby

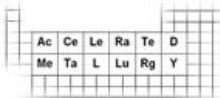


David Cebon



Management of knowledge about materials and processes

Our network: example partners and collaborations

	Owners					
	 UNIVERSITY OF CAMBRIDGE					
Software						
Data						
						Computatio 
Collaboration					Education 	

Questions / Comments

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