

**Introduction to Granta Design
&
CES EduPack software for Teaching**

Lille, MMATENG Project, 29 May 2017



GRANTA
MATERIAL INTELLIGENCE

www.grantadesign.com



Founders



Prof. Mike Ashby Prof. David Cebon

Long-term stability

Supporters



Education Team



Passion for Education Specialist Knowledge

Academic Collaborators



Clients across Academia and Industry

Knowledge of the latest pedagogical trends
Feedback

Knowledge of the latest industrial trends
Case Studies



Our network: example partners and collaborations GRANTA

	<p>Owners</p>  UNIVERSITY OF CAMBRIDGE					
<p>Software</p>						
<p>Data</p>						
<p></p>					<p>Computation</p> 	
<p>Collaborations</p>				<p>Education</p> 		



What do we develop?

Materials education

Research and consulting

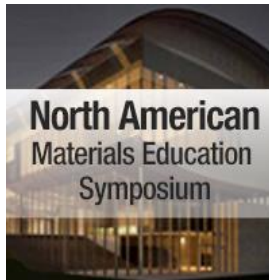
Materials information management



Teaching and Research

Research Labs and Industry





10th International Materials Education Symposium
University of Cambridge, UK, April, 2018

8th North American Materials Education Symposium
Massachusetts Institute of Technology, USA, August 24-25, 2017

3rd Asian Materials Education Symposium
Singapore University of Technology and Design, December, 2018

www.materials-education.com





Who uses CES EduPack?

GRANTA





What is CES EduPack?

GRANTA



Data for materials and processes



Tools to explore: Data
Selection
Eco-design
Design of hybrids (composites, sandwich panels ...)
Cost estimation



Teaching & Case Studies, PowerPoint units, White papers, Training ...

Learning resources: Exercises, Teach-yourself units, Interactive Glossary...



Material Data: reliable, relevant, comparable

Material attributes

- Images, Description
- General properties
- Mechanical
- Thermal
- Electrical
- Durability
- Environmental

Untitled - CES EduPack 2017 - [MaterialUniverse\Metals and alloys\Non-ferrous\Nickel and alloys]

Nickel-based superalloys

Datasheet view: All properties Show/Hide

Metals and alloys > Non-ferrous > Nickel and alloys >

Description

Image

Caption

1. Gas turbine. © Kawasaki Turbines 2. Single superalloy blade. © Kawasaki Turbines

The material

With a name like "superalloy" there has to be something special here. There is nickel-based, iron-based and cobalt-based alloys that combine exceptional high corrosion and oxidation resistance. Without them, jet engines would not be practical continuously at temperatures up to 1200 C. The nickel-based superalloys are those with a good slug of chromium and lesser shots of cobalt, aluminum, titanium, molybdenum, niobium, and tantalum. The data in this record span the range of high-performance nickel-based superalloys.

Composition (summary) ⓘ

Ni + 10 to 25% Cr + Ti, Al, Co, Mo, Zr, B and Fe in varying proportions.

General properties

Density	ⓘ	7.75e3	-
Price	ⓘ	* 15.5	-
Date first used	ⓘ	1944	-

Mechanical properties

Young's modulus	ⓘ	150	-
Shear modulus	ⓘ	55	-
Bulk modulus	ⓘ	110	-
Poisson's ratio	ⓘ	0.26	-
Yield strength (elastic limit)	ⓘ	300	-
Tensile strength	ⓘ	400	-
Compressive strength	ⓘ	300	-

Ready

Levels 1 and 2

- For 1st, 2nd year teaching

Environmental data

Geo-economic data for principal component

Annual world production, principal component	ⓘ	1.43e6	tonne/yr
Reserves, principal component	ⓘ	7.1e7	tonne

Primary material production: energy, CO2 and water

Embodied energy, primary production	ⓘ	* 232	MJ/kg
CO2 footprint, primary production	ⓘ	* 13.7	kg/kg
Water usage	ⓘ	* 345	l/kg
Eco-indicator 95	ⓘ	5.2e3	millipoints/kg
Eco-indicator 99	ⓘ	2.83e3	millipoints/kg

Material processing: energy

Casting energy	ⓘ	* 10.5	MJ/kg
Extrusion, foil rolling energy	ⓘ	* 8.42	MJ/kg
Rough rolling, forging energy	ⓘ	* 4.36	MJ/kg

Material processing: CO2 footprint

Casting CO2	ⓘ	* 0.786	kg/kg
Extrusion, foil rolling CO2	ⓘ	* 0.632	kg/kg

Material recycling: energy, CO2 and recycle fraction

Recycle	ⓘ	✓	
Embodied energy, recycling	ⓘ	* 38.2	MJ/kg
CO2 footprint, recycling	ⓘ	* 3	kg/kg
Recycle fraction in current supply	ⓘ	23.9	%
Downcycle	ⓘ	✓	
Combust for energy recovery	ⓘ	✗	
Landfill	ⓘ	✗	
Biodegrade	ⓘ	✗	
Toxicity rating	ⓘ	Slightly toxic	



Process Data: reliable, relevant, comparable

Process attributes

- Images, Description
- Compatible materials
- Shape
- Economics, with cost model

Untitled - CES EduPack 2017 - [ProcessUniverse\SHAPING\Additive manufacturing\Deposition meth...]

Laser powder forming

Image

The process

LASER POWDER FORMING (LPF) is an additive manufacturing technique in which wire or powder is fed into a melt pool created by a laser. The laser is scanned across the surface to add material to one layer at a time. When used as an alternative to machining from a block, a simple geometry is printed which requires milling to give the desired finish. As with other additive manufacturing processes, a CAD solid model of the part is used to create the code to guide the laser.

The process is also known as blown powder additive manufacturing, laser beam metal deposition, directed light fabrication, 3D laser cladding, laser generation, laser-based metal deposition, laser freeform fabrication, laser direct casting, laser consolidation or direct metal deposition. A variation on this method is wire fed plasma arc.

Tradenames

LaserCast, LasForm, Laser-Engineered Net Shaping (LENS)

Material compatibility

Metals - ferrous	i	✓
Metals - non-ferrous	i	✓

Shape

Circular prismatic	i	✓
Non-circular prismatic	i	✓
Flat sheet	i	✓
Dished sheet	i	✓
Solid 3-D	i	✓
Hollow 3-D	i	✓

Economic compatibility

Economic batch size (units)	i	1	-	10
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Physical and quality attributes

Mass range	i	0.1	-	15	kg
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Process characteristics

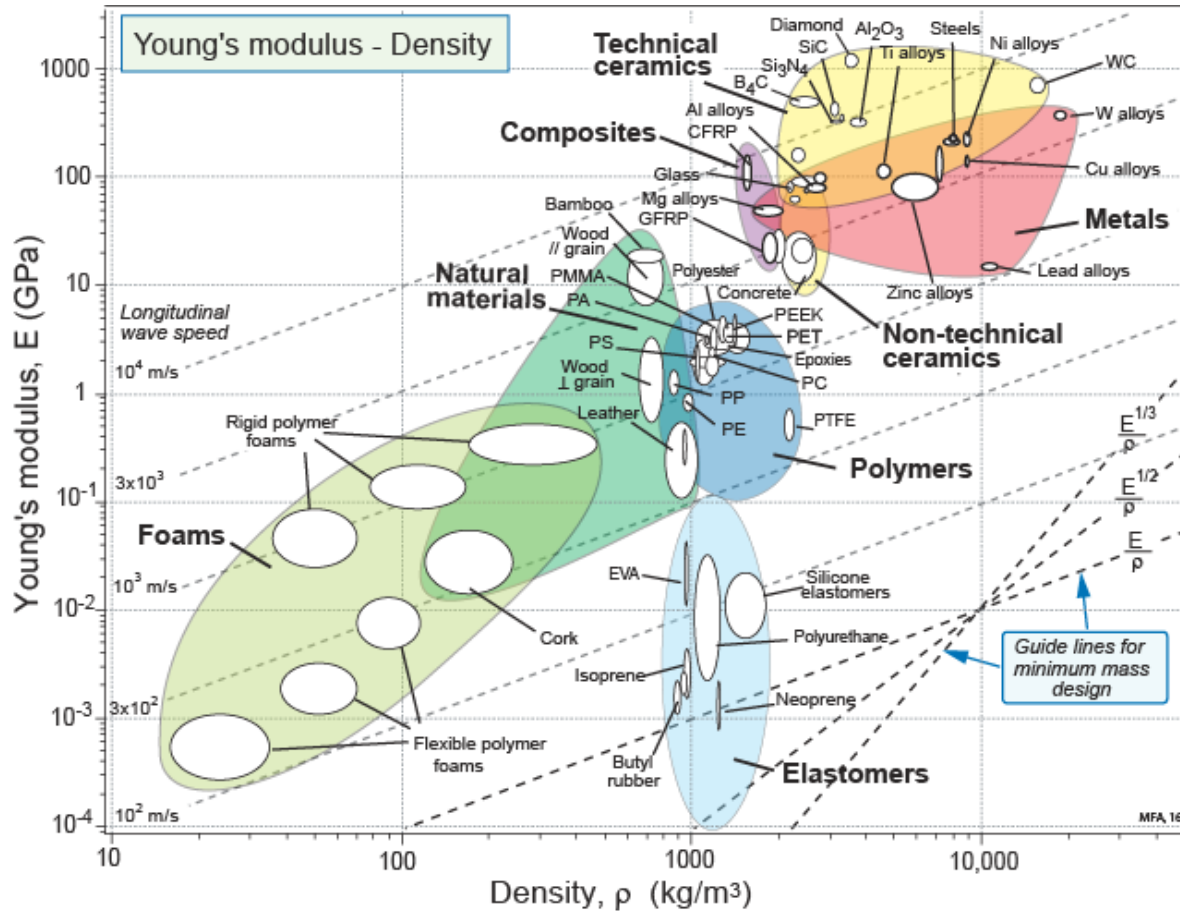
Primary shaping processes	i	✓
Discrete	i	✓
Prototyping	i	✓

All levels

- > 100 shaping, joining and finishing processes
- Schematics and images
- Links to records for compatible materials

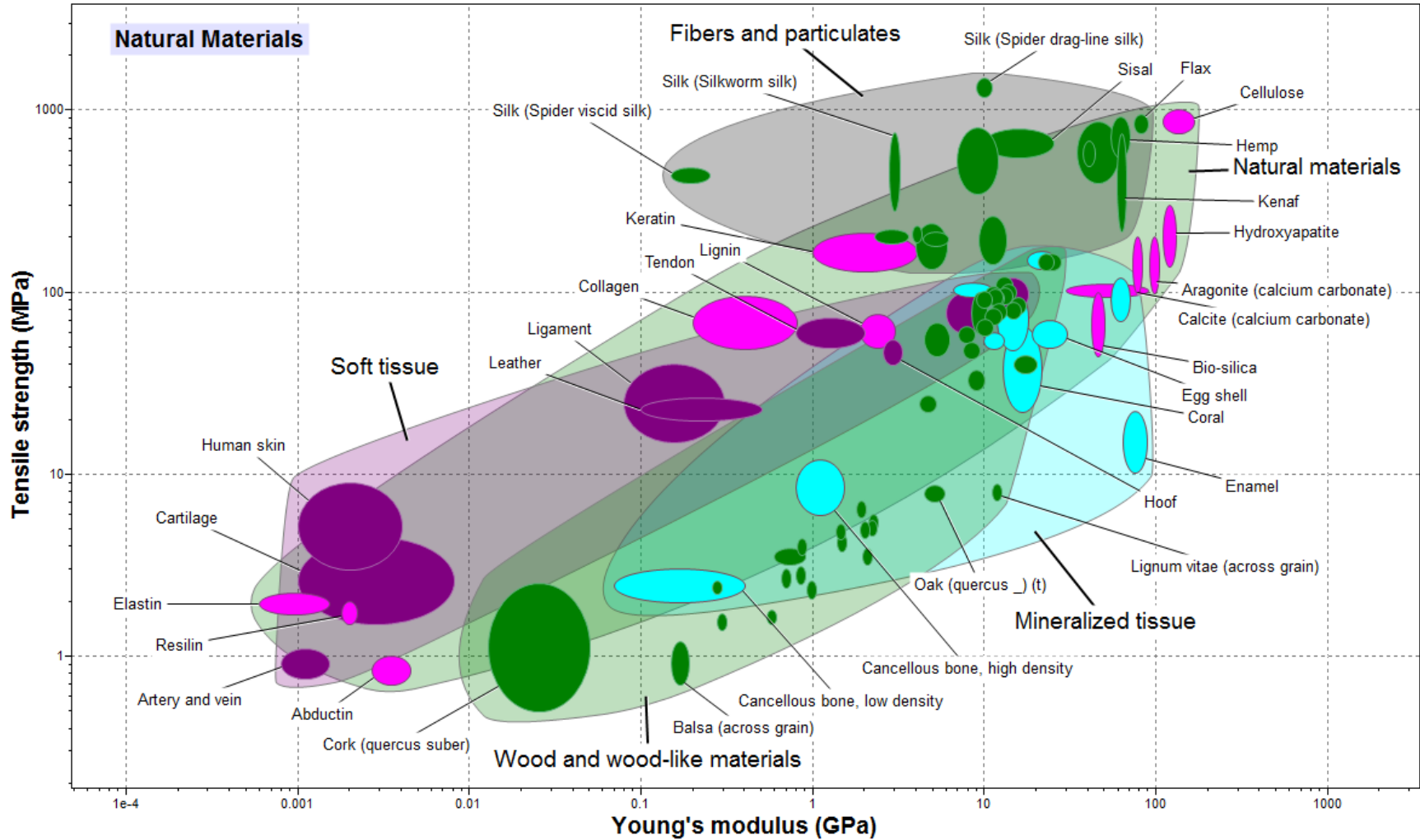


Create Interactive Charts



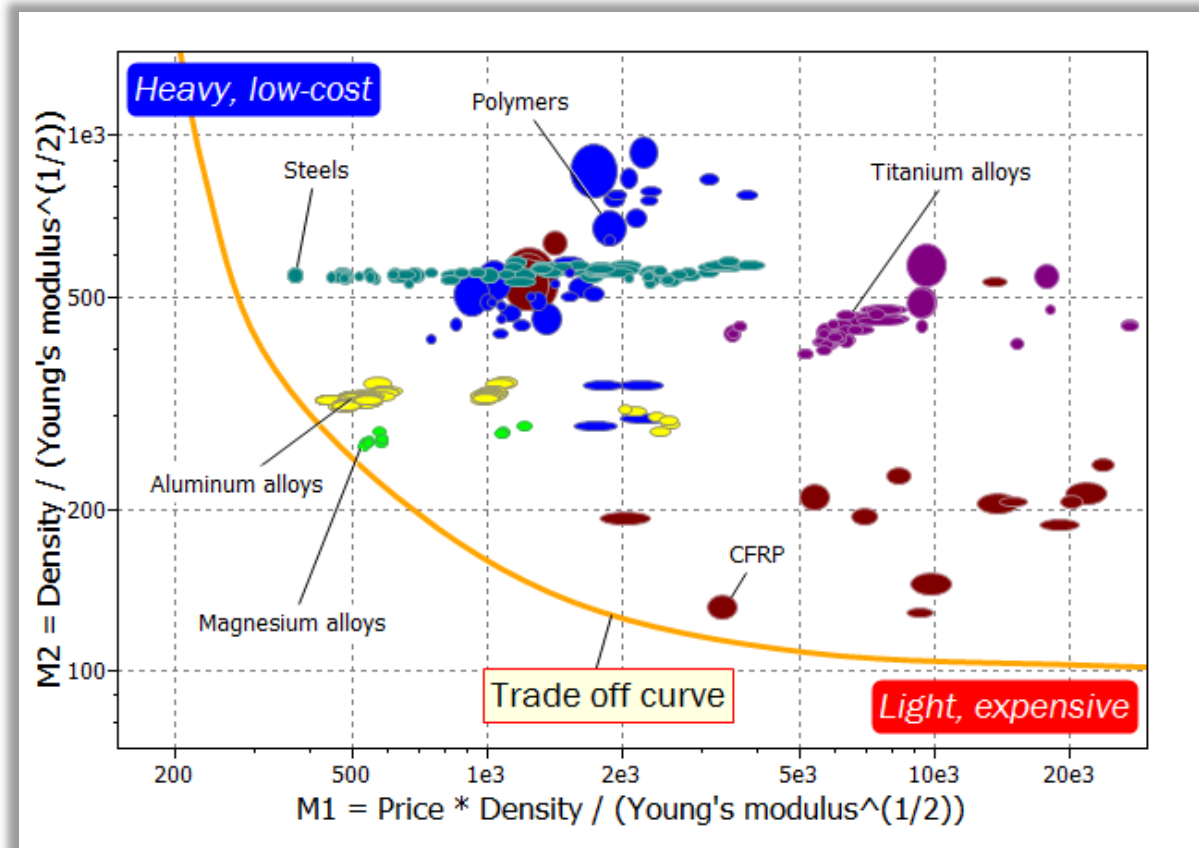


Example of materials in Bioengineering





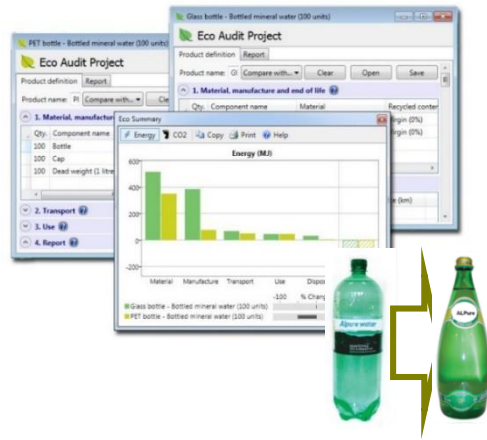
Explore trade offs





Eco-Audit Tool

Introduces the students to key concepts in Eco-Design
(quickly calculates the energy and carbon footprint of products)

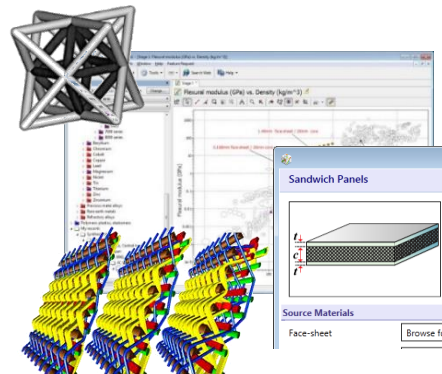


Available in all levels except Bio Engineering

Synthesizer Tool

Hybrid Synthesizer

Estimate the properties of composites and hybrid materials
(sandwich panels, cellular structures and composites)

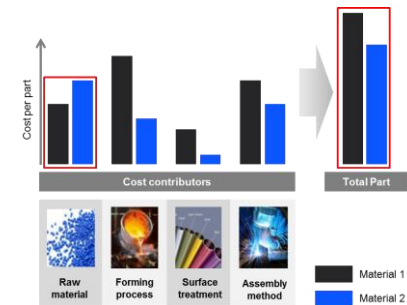


Only available in Level 3: Aerospace, Polymer, Energy, Eco Design, and Sustainability

Part Cost Estimator

Quickly estimate the cost to manufacture a component

Compare different classes of materials and processing routes





Learning resources to engage students

The image displays the GRANTA EduPack software interface. At the top, a navigation bar includes icons for Home, Browse, Search, Chart/Select, Eco Audit, Synthesizer, **Learn** (highlighted with a red box), Tools, Settings, and Help. Below this, the main window is split into two panes. The left pane shows the 'CES EduPack 2017 Help' window with a table of contents on the left and a central area with icons for 'Table of Performance Indices', 'Science Notes', 'Selection Methodology', 'Learn Online', and 'Case Studies'. A red arrow points from the 'Learn' icon in the top bar to the 'Learn Online' icon in this pane. The right pane shows the 'Learn Online' web page, which has a red header and a search bar. A left sidebar lists various learning resources such as 'Getting Started', 'Video Tutorials', 'Learning Tools', 'Case Studies', 'Booklets', 'Material Property Definitions', 'Data for Engineering Materials', 'Solutions to Standard Problems', 'How to Write a Paper', 'Teach Yourself', 'Reference', 'Science Notes', 'Performance indices', 'White Papers', 'Conversion of Units', 'Case Studies', and 'Frequently Asked Questions'. The main content area of the web page features several categories: 'Getting Started with CES EduPack 2017', 'Learning Tools', 'Getting Started Guides', 'Charts', 'Video Tutorials', 'Glossary', 'Booklets', 'Material Property Definitions', 'Data for Engineering Materials', 'Solutions to Standard Problems', and 'How to Write a Paper'. A red arrow points from the 'Learn Online' icon in the left pane to the 'Material Property Definitions' link in the right pane's sidebar.



Education Hub – Hundreds of Teaching Resources GRANTA

Paper: The Elements Database

Claes Fredriksson, Kyozo Arimoto, Mike Ashby | Granta Design

Download icons: document, download, star

Exercises: Sustainable Development (Lecture Unit: "What is a Sustainable development")

Mike Ashby | Granta Design

Exercises

Download icons: document, download, star

Case Studies: Sustainable Development Project - Electric Cars

Problem-based learning resources

Download icons: document, download, star

Paper: Teaching Materials with CES EduPack

Hannah Melia, Magda Figuerola, Claes Fredriksson | Granta Design

Download icons: document, download, star

Video

Why is Materials Education important?

Videos

Download icons: play, download, star

Video: CES EduPack Training Session 1 - Getting Started

Hannah Melia | Granta Design

Download icons: play, download, star

Paper: Manipulating Properties: Charts, microstructure and processing

Hugh Shercliff, Mike Ashby | Dept of Engineering, Cambridge University

Papers

Download icons: document, download, star

Exercises: Bio Engineering (Lecture Unit: "Teaching resources for Bioengineering")

Mike Ashby, Ana Pereira | Granta Design

Download icons: document, download, star

Glossary

Student resources

Download icons: document, download, star

Video: CES EduPack Training Session 4 - Trade-offs

Claes Fredriksson | Granta Design

Advanced Training

Download icons: play, download, star

Contributed Lecture: Materials for Turbochargers

Dr John Robertson-Begg | University of Derby

Case Studies

Download icons: document, download, star

Case studies: CES Selector - Rational Material Selection for a Medical Forceps

Sarah Egan, Jorge Sobral | Granta Design

Download icons: document, download, star



Advanced Industrial Case Studies




Case Studies: Aerospace Pressure Vessels

Claes Fredriksson, Luca Masi | Granta Design






Case Studies: Suture Anchor Implant

Claes Fredriksson, Philippa Newby | Granta Design





More Advanced Case Studies 2017

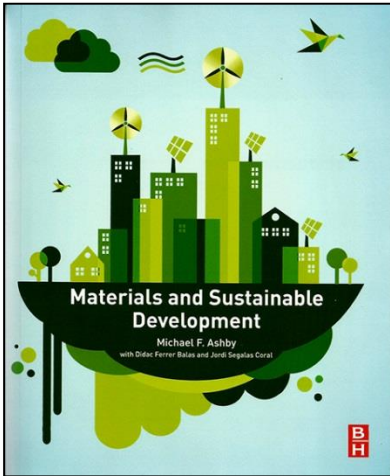
Planned: Mars Lander, Bone Porosity, ...





Granta's Sustainability Teaching Resources

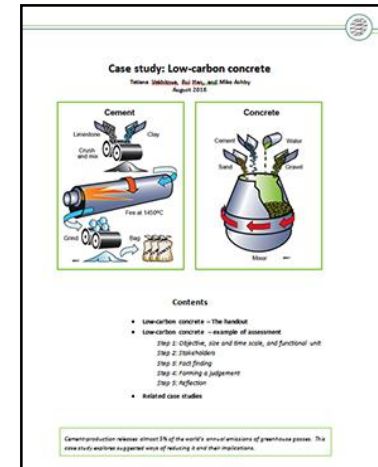
GRANTA



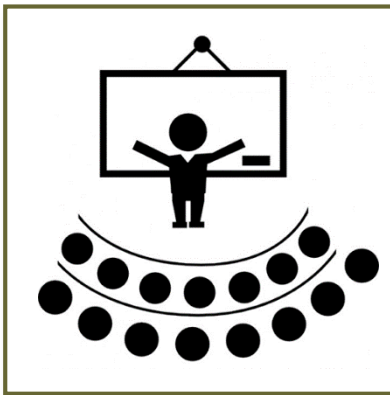
Teaching text



Teaching resources



8 Case studies



Webinars, Workshops



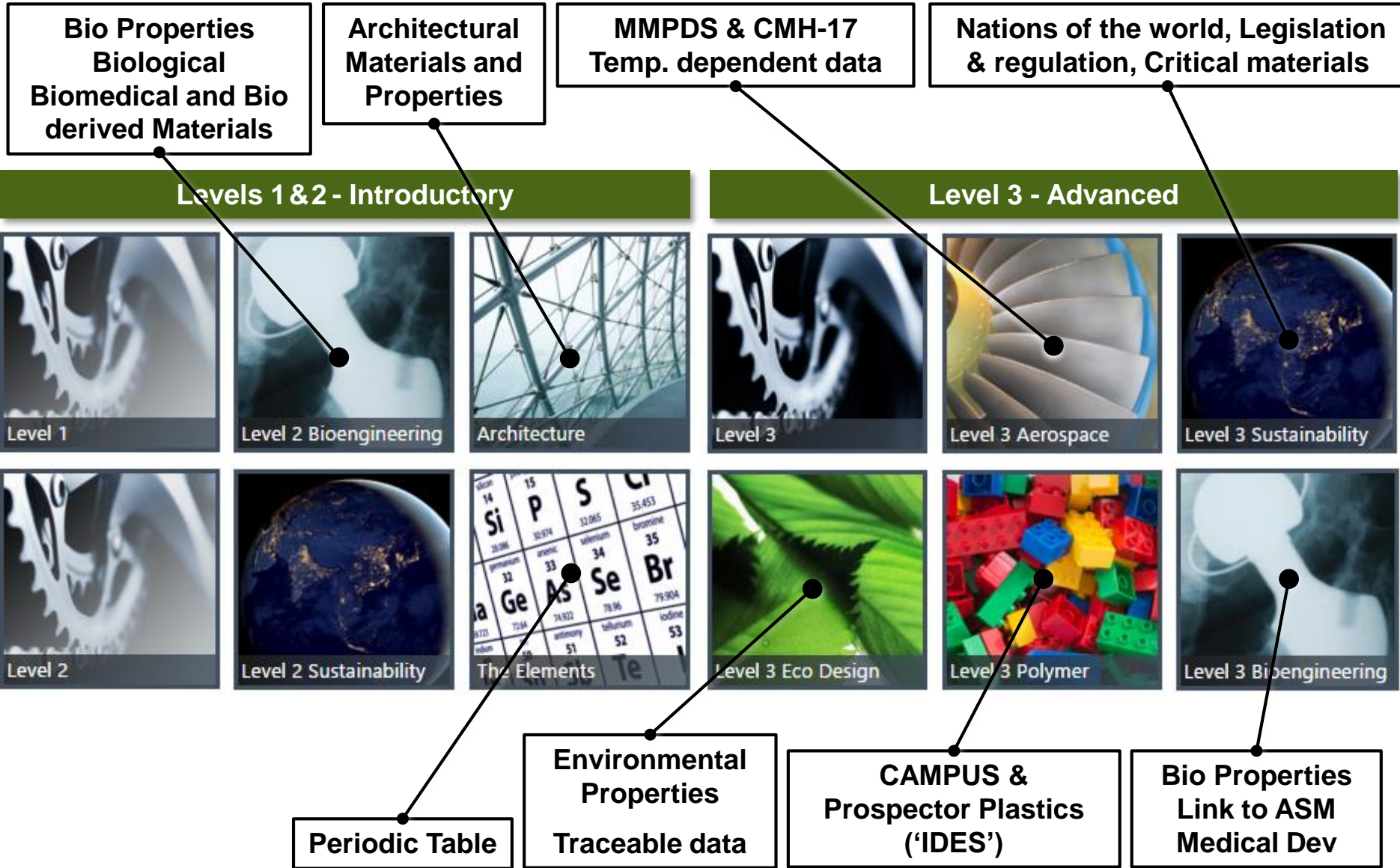
Database



Handouts, Projects



Advanced Databases





- **Special agreement, allowing the access to teaching software CES EduPack to Universities – MMATENG participants from Russia, Ukraine and Israel for 3 years.**
- **Provision of trainings for academics from the participating Universities:**
 - Project's meeting in Leuven
 - Project's meeting in Krakow
 - Project's meeting in Kiev (on-line presentation)
 - Monthly on-line Webinars for users of CES EduPack
 - Access to 350+ Teaching Resources on Granta's Education HUB on-line: <https://teachingresources.grantadesign.com/>
- **Special offers for software renewal & participation in Materials Education Symposia (Europe, USA, Asia)**



Feedback Form/Stay in Touch:

- KIT short course 27 July 2017:

<http://www.grantadesign.com/education/events/2017/KIT2017/index.htm>

Code for your **KITEARLY**

- Cambridge Materials Education Symposium APRIL 12-13, 2018

<https://www.materials-education.com/2018/cambridge/index.htm>

Loyalty discount upon request

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