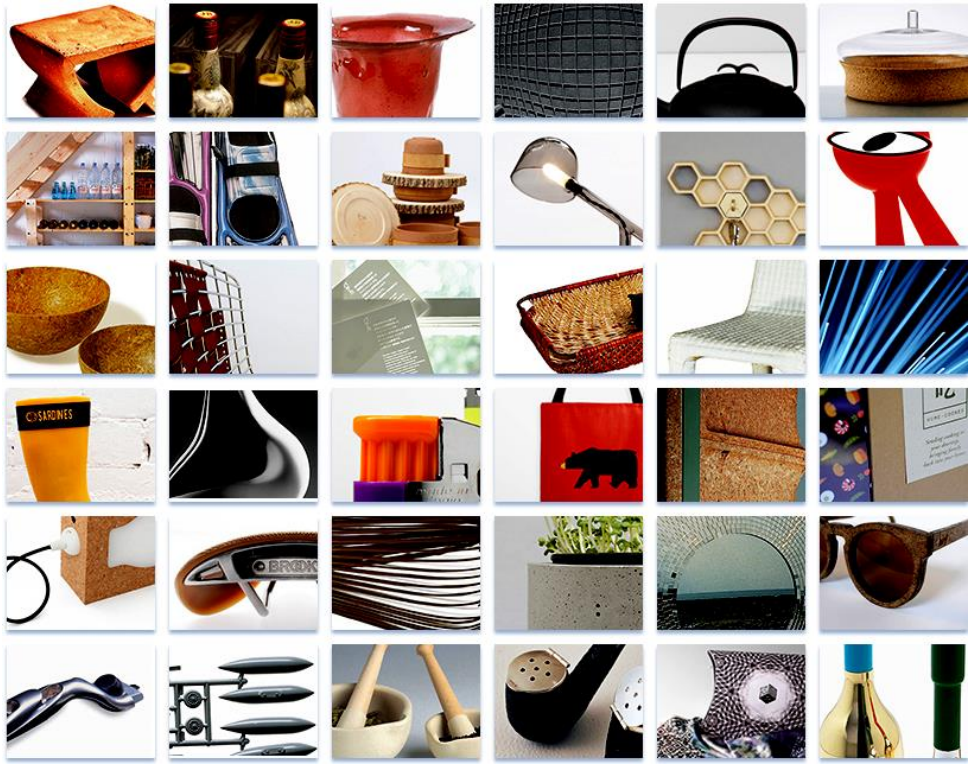
The Design database for products



Mike Ashby

Department of Engineering,

University of Cambridge

Learning objectives for this lecture unit

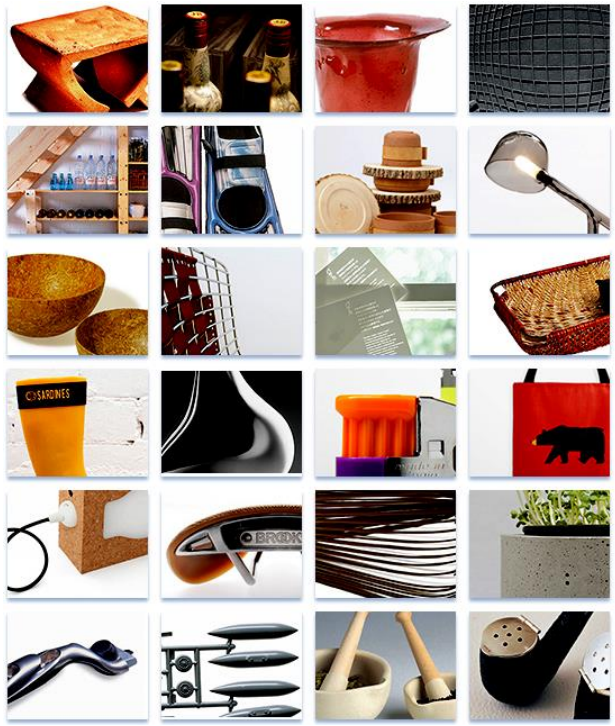
Ansys software mentioned	• Ansys Granta EduPack™, a teaching software for materials education

Intended Learning Outcomes	
Knowledge and Understanding	Understanding of materials and processes properties through products
Skills and Abilities	Ability to find design and engineering data from products
Values and Attitudes	Appreciation of the relationships between Products, Materials and Processes.

Resources

- **Text:** "Materials and Design: The Art and Science of Material Selection in Product Design", 3rd edition by M. Ashby and K Johnson, Butterworth Heinemann, Oxford, 2014
- **Paper:** The Design Database

Outline

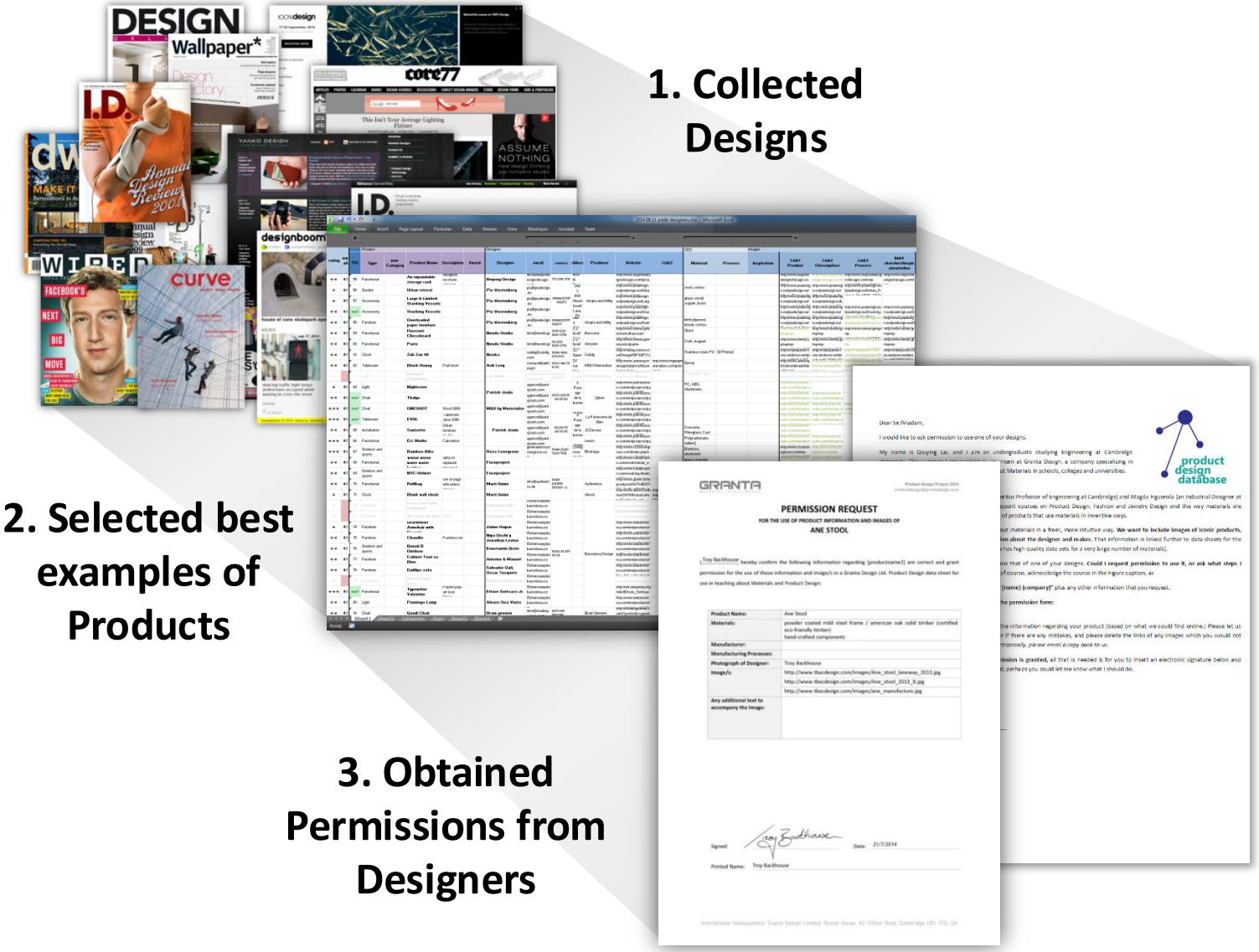


- **Why** a *Product-Centered* database
- **Products** at the center of attention
- **The Designer's** and **Engineer's view**
- The role of Materials in **Designs**
- **Aesthetic** properties

The design database: products, materials and processes

Products as gateway to innovation and design with materials and processes

How did we choose the products for the database?

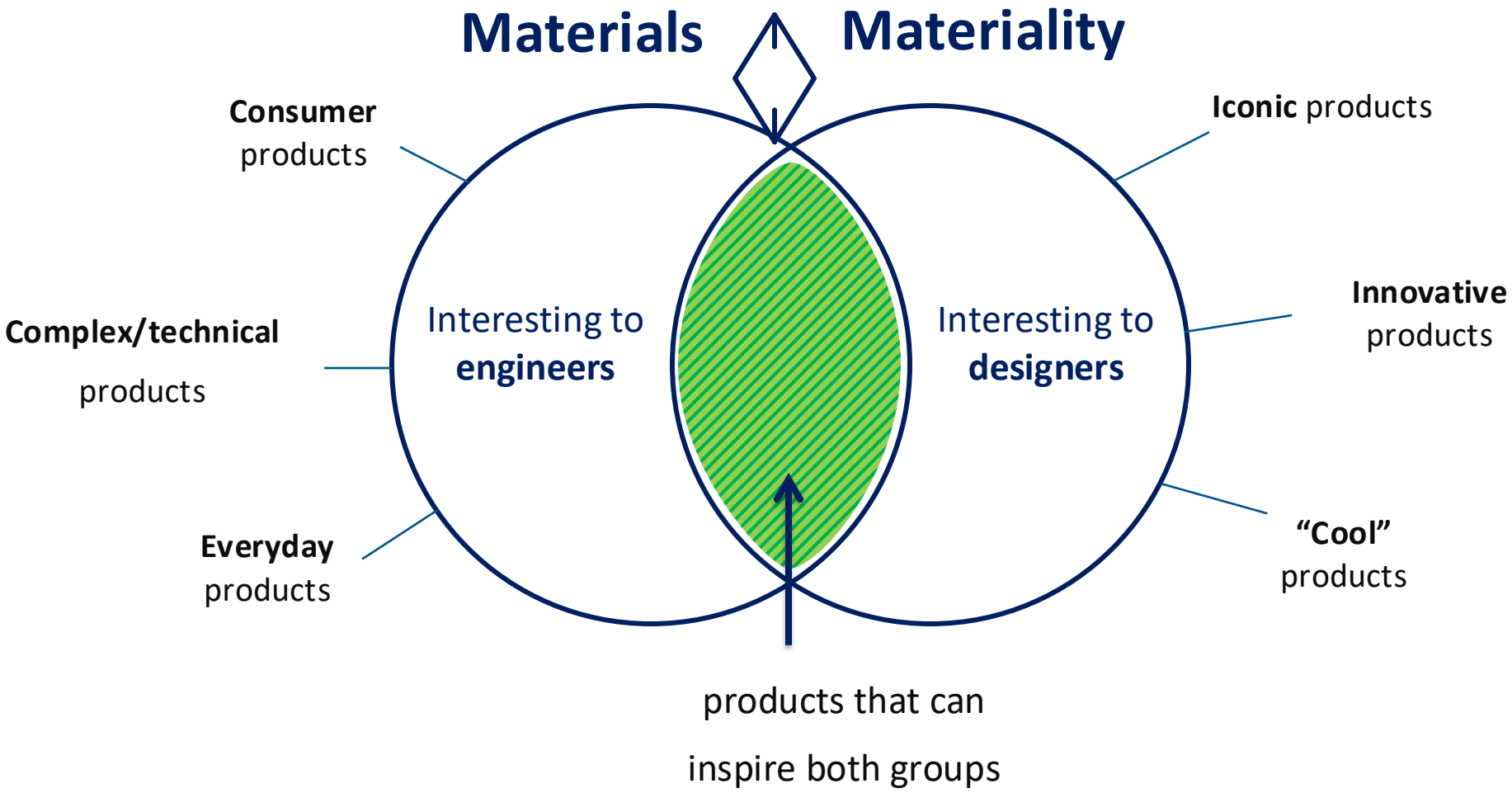


1. Collected Designs

2. Selected best examples of Products

3. Obtained Permissions from Designers

Finding products to engage across disciplines

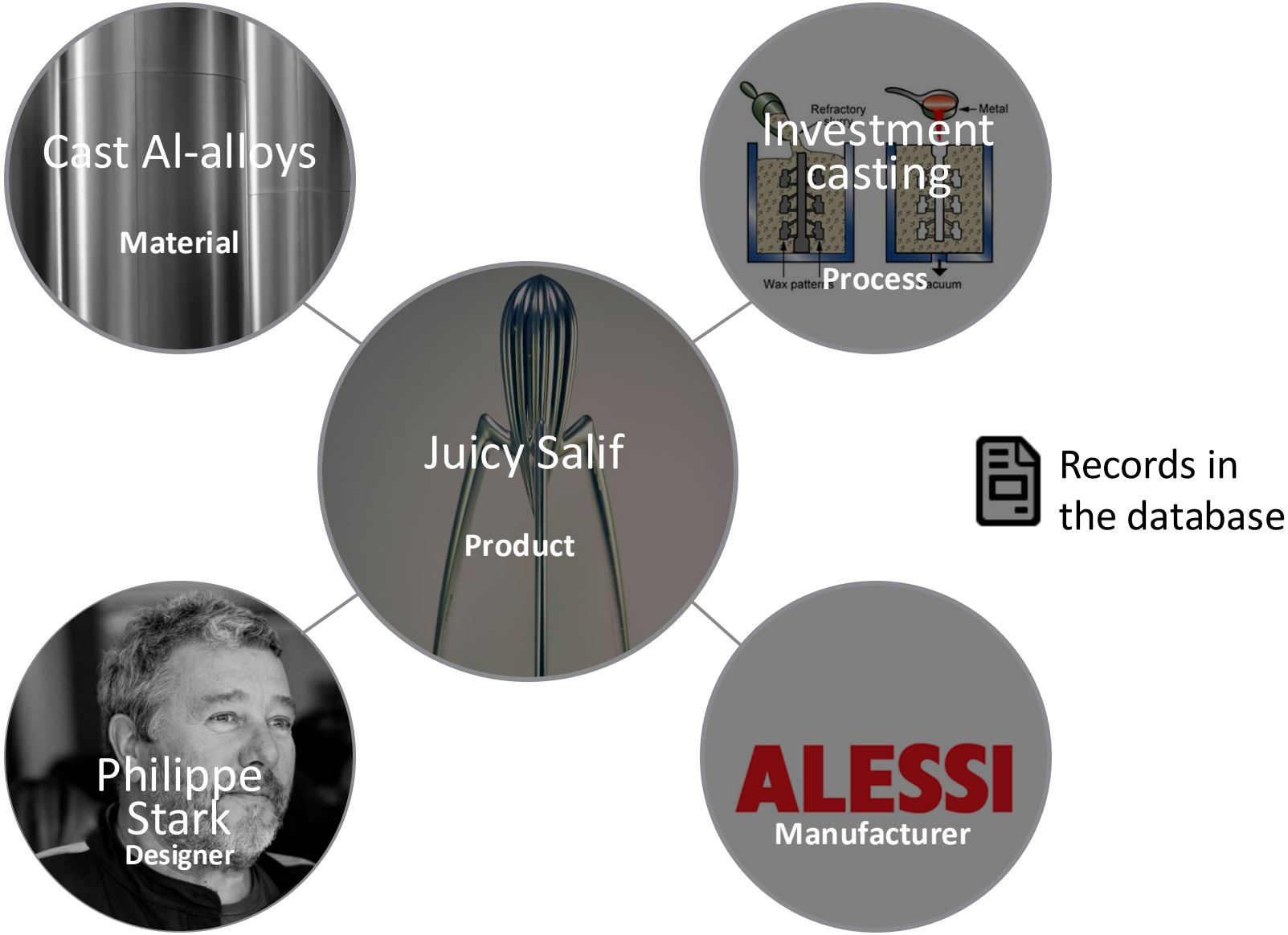


The Design Database

What can you do with it?

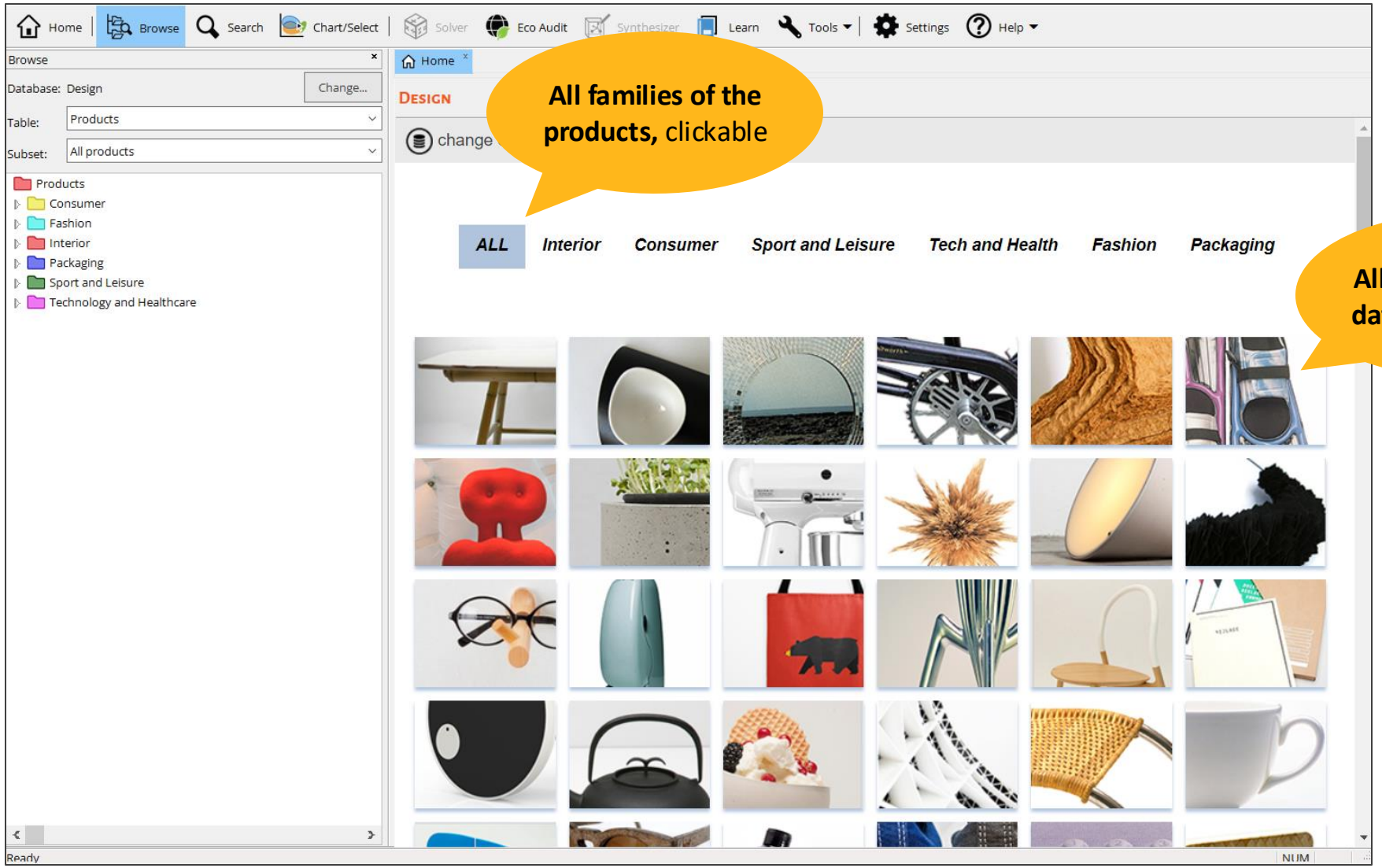
- Engage in the visual, material and manufacturing aspects of products and industrial design.
- Visualize how materials create product character, desirability.
- Show how new materials stimulate innovation: the evolution of materials in products.
- Excite interest in materials through products.
- Understand how products and their components are manufactured.

Product-centred structure of the database



Records in the database

Starting the Design database: the Home page



All families of the products, clickable

All products in the database, clickable

Ansys / GRANTA EDUPACK

Product datasheet

iMac G3

by Jonathan Ive for Apple

Designer	Jonathan Ive
Manufacturer	Apple
Materials	Polycarbonate (PC)

Description

The iMac was dramatically different from any previous mainstream computer. It was made of translucent "Bondi Blue"-colored plastic and was egg-shaped around a 14-inch (35.5 cm) CRT display. The keyboard and mouse were redesigned for the iMac with translucent plastics and a Bondi Blue trim.

Designer's description

Tags

Consumer, household, home, kitchenware, food, washing up, clean, hygiene, designer, classic.

Links

- Materials
- Processes
- Designer
- Manufacturers

Links to further data-tables

Insights directly from the designer

Courtesy of Apple Inc

Name	Jonathan Ive
Studio	Apple
Education	Industrial Design, Northumbria University

Description

Sir Jonathan Ive is an English designer and was the Senior Vice President of Design at Apple Inc.

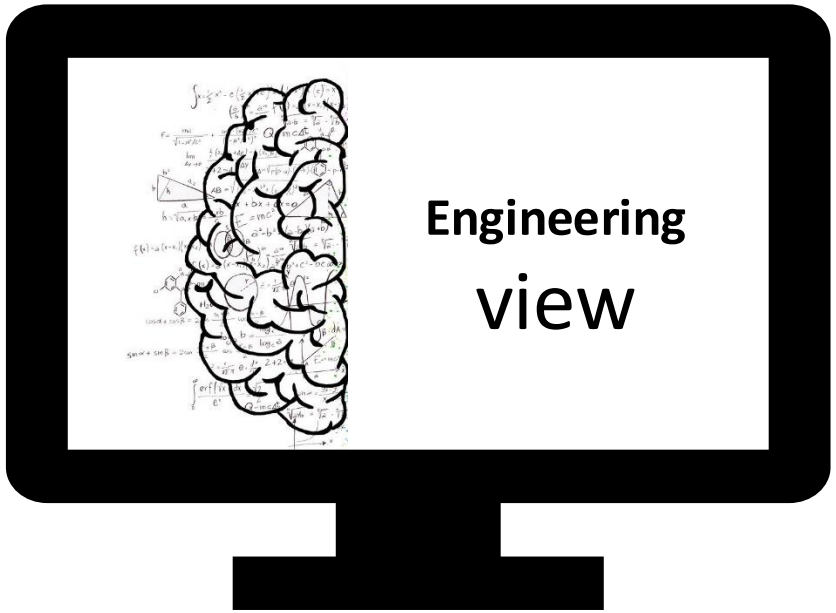
Links

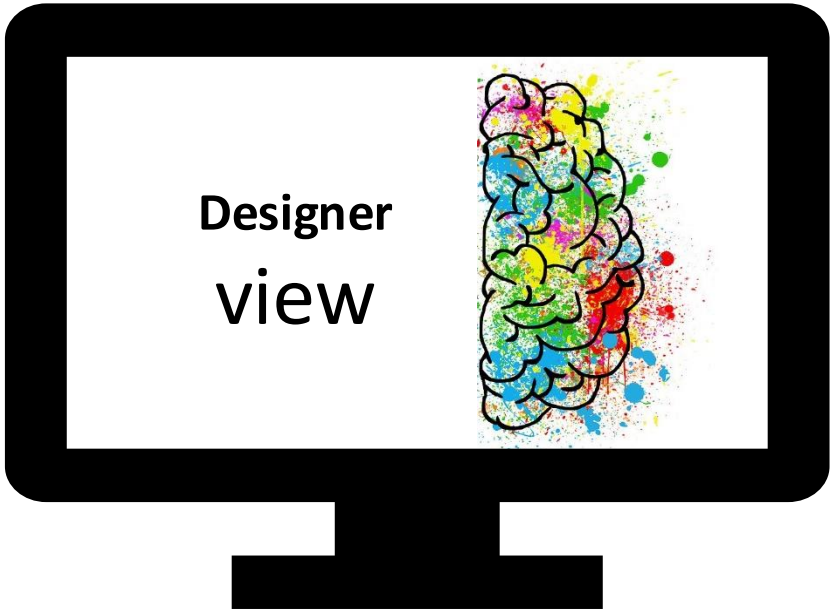
Products

Inspiring background information adds to the understanding

The materials data-table: catering for dual needs

*Alternative **Materials** views*





Typical material record: designer's view

Thermoplastic Vulkanite (TPV)

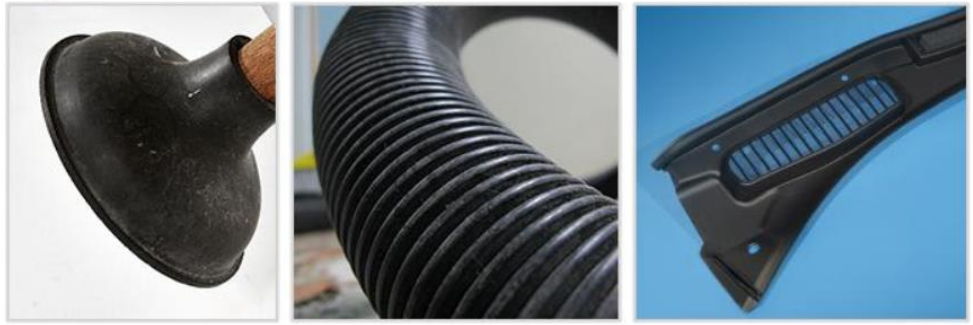
Datasheet view: Designer's view | Show/Hide | Find Similar

<All Alphabetical>
Designer's view
Engineer's view

Polymers and

General information

Image



Caption

(1) Plunger © Jes at flickr (CC BY 2.0) (2) Hose © John Loo at flickr (CC BY 2.0) (3) Direct extrusion of bulb seal on Automotive cowls, Santoprene® 121 50E500 TPV © Spe.Automotive at flickr (CC BY 2.0)

The material

Dynamic vulcanization (TPV, EDPM and TPOs) allows for new materials to be prepared from existing polymers, avoiding entirely different processes and feedstocks and excessive extra capital costs. The strengths include: improved tensile strength and fatigue resistance compared with TPOs. Lower permanent set, lower swelling in oils, higher melt strength, more reliable melt processing characteristics and improved utility at elevated temperatures (e.g. smaller decrease in modulus with temperature) compared with TPOs. Residual elasticity and strength at melting point of resin (e.g. PP component).

General properties

Density		939	-	981	kg/m^3
Price		* 3.48	-	3.49	GBP/kg
Date first used		1981			

Aesthetic attributes

Tactile Warmth (Warm 0 - Cool 10): 1
Touch (Soft 0 to Hard 10): 0
Pitch (Low 0 to High 10): 0
Tone (Muffled 0 to Ringing 10): 0
Flex (Bendy 0 to Stiff 10): 0
Resilience (Brittle 0 to Tough 10): 8
Scratch Resistance (Low 0 to High 10): 3
Light but Stiff (Poor 0 to Good 10): 2
Light but Strong (Poor 0 to Good 10): 2

Aesthetic data

Sustainability attributes

Climate change (CO2-eq) (Low 0 to High 10): 6
Current Recycling Percentage: 1

Biodegrade	✗				
Embodied energy, primary production (virgin grade)	* 116	-	127	MJ/kg	
Embodied energy, recycling	* 57.7	-	63.7	MJ/kg	
Landfill	✓				

Sustainability data

Processability

Typical uses

Automotive applications, hose, tubing, sheet, mechanical rubber goods, consumer goods, architectural, construction, electrical and electronic applications, medical and food contact applications, CVJ boots, power tool handles, camera and device coatings/grips, syringe seals.

Notes

Tradenames

Santoprene, TPV, EDPM and TPOs

General text + data

Links

ProcessUniverse
Products

Typical material record: engineer's view

Thermoplastic Vulkanite (TPV)

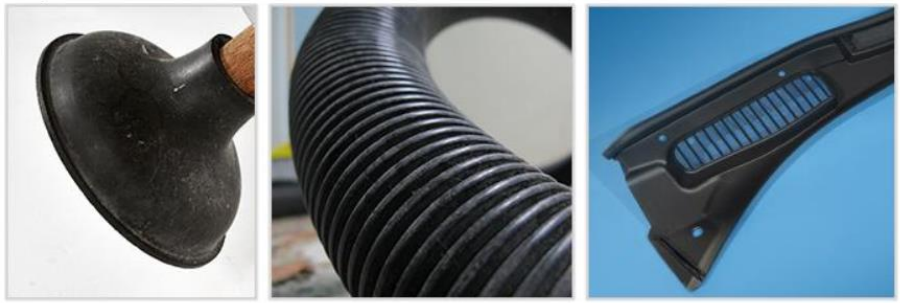
Datasheet view: Engineer's view | Show/Hide | Find Similar

<All Alphabetical>
Designer's view
Engineer's view

Polymers and

Description

Image



Caption

(1) Plunger © Jes at flickr (CC BY 2.0) (2) Hose © John Loo at flickr (CC BY 2.0) (3) Direct extrusion of bulb seal on Automotive cowls, Santoprene® 121 50E500 TPV © Spe.Automotive at flickr (CC BY 2.0)

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General properties

Density		939	-	981	kg/m^3
Price		* 3.48	-	3.49	GBP/kg
Date first used		1981			

Aesthetic properties

Tactile Warmth (Warm to Cool)		1.3	-	1.4	
Touch (Soft to Hard)		0.1			
Pitch (Low to High)		0.3			
Tone (Muffled to Ringing)		0.3			
Flex (Bendy to Stiff)		0.4			
Resilience (Brittle to Tough)					
Scratch Resistance (Low to High)					
Light but Stiff (Poor to Good)					
Light but Strong (Poor to Good)					

Mechanical properties

Young's modulus		0.0158	-	0.0162	GPa
Shear modulus		* 0.00525	-	0.00551	GPa
Poisson's ratio		* 0.48	-	0.495	
Yield strength (elastic limit)		3.9	-	4.1	MPa
Tensile strength		6.31	-	8.95	MPa
Compressive strength		* 4.57	-	5.04	MPa
Elongation		428	-	550	% strain
Hardness - Vickers		1			HV
Fatigue strength at 10^7 cycles		* 2.53	-	3.58	MPa
Fracture toughness		0.405	-	0.462	MPa.m^0.5
Mechanical loss coefficient (tan delta)		0.08	-	0.1	

Thermal properties

Maximum service temperature		130	-	140	°C
Minimum service temperature		-66.2	-	-56.2	°C
Thermal conductor or insulator?		Good insulator			
Thermal conductivity		* 0.118	-	0.128	W/m.°C

Durability: fuels, oils and solvents

Amyl acetate		Limited use
Sodium hydroxide (60%)		Excellent

Combust for energy recovery		✓
Landfill		✓
Biodegrade		✗

Links

ProcessUniverse
Products

Full engineering property data

Links to related data records

Ansys / GRANTA EDUPACK

Manufacturing processes of products

Silk screen printing

Image Caption

(1) Poster production by silk-screen printing © U.S. National Archives and Records Administration at Wikimedia Commons [Public domain] (2) Screen print squeegee hand bench © Scrud123 at Wikimedia Commons (CC BY-SA 3.0) (3) T-Shirts design patters © Survivor at Pixabay

The process

Silk screen printing has its origins in Japanese stenciling. During the First World War in America screen printing took off as an industrial printing [illegible] was the invention of the photographic stencil in the 1930s tha[illegible] process. It is now a $5 billion per year industry.

General text + data

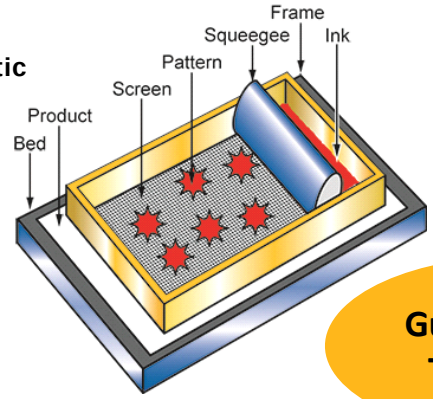
Physical and quality attributes

Processing temperature	26.9	-	46.9	°C

Process characteristics

Discrete	✓

Process schematic



Guidelines and Typical uses

Design guidelines

The process can be applied to polymers, glass, metals, wood, textiles and of course paper and board. Flat and cylindrical objects can be printed. Multiple colors can be printed, but each requires a separate screen.

Typical uses

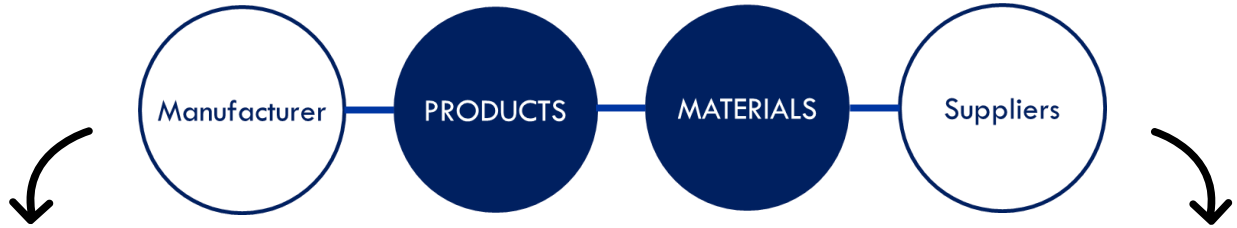
Posters, stickers, ticketing, shelf strips, banners, exhibition panels, ring binders, mouse-mats, site boards, signs, T-shirts, control panels and badges for computers.

Links

MaterialUniverse	
Products	
Reference	

Manufacturers and suppliers

Important auxiliary information adds to the **realism in projects**



Normann Copenhagen

Datasheet view: Manufacturers of products | Show/Hide | Find Similar

M - P >

Basic information

Manufacturer Logo

normann COPENHAGEN

Manufacturer Name	Normann Copenhagen
Area of Specialisation	household accessories, tableware, kitchenware, furniture
Founded in	1999

Contact details

Company HQ Location	Copenhagen, Denmark
Company Website	http://www.normann-copenhagen.com/

Further information

Information Access Date	15/08/2014

Links

Products

Thermoplastic Rubber Systems, Inc.

Datasheet view: Producers | Show/Hide | Find Similar

Polymers >

Organisation Details

Company name

Solvay Engineered Polymers, Inc.

Website	http://polymers.lyondellbasell.com/portal/site/basell/

Materials and tradenames

NexPrene(tm) : Fully Vulcanized EPDM/PP based TPV
NexFlex(tm) : SEBS/PP based TPE
NexLink(tm) : Fully Vulcanized EPDM/SEBS/PP based TPV
NexTrile(tm) : Fully Vulcanized NBR/PP based TPV

Other notes

Solvay Engineered Polymers acquires Thermoplastic Rubber Systems Inc in 2004. LyondellBasell completes acquisition of Solvay Engineered Polymers, Inc in 2008

Producer status	Active
Information confirmation date	23/03/2012

Links

MaterialUniverse

Product **manufacturer ≠** Material **suppliers!**

Using the database

The tool buttons

Browse to explore products

Browse

Tree

Browse

Database: Design

Table: Products

Subset: All products

- Products
  - Consumer
  - Fashion
  - Interior
  - Packaging
  - Sport and Leisure
    - B2O Velo Bamboo Bicycle by Fritsch Durisotti
    - Bamboo Longboard by Good Design Collective
    - Bicycle seat by Selle Royal
    - Boneshaker Bicycle by Pierre and Ernest Michaux
    - Cambium Bicycle Saddle by IDEO for Brooks England
    - Cannondale ST500 bike by Cannondale
    - Fab Force diving fins by Bob Evans
    - Heart rate monitor Polar S810i by Polar
    - Itera Bicycle by Itera Development Center AB
    - Kirk Magnesium Bicycle by Frank Kirk
    - La Siesta Water Bottle
    - Leaf Swing by VMD
    - Lotus Sport 110 Bicycle by Mike Burrows
    - Rudge Whitworth Bicycle by Dan Rudge
    - Sintra Series by Rado
    - Smart City-Coupé from Daimler Chrysler
    - Thunderer whistle by ACME Whistles
    - Traffic cone by Swintex
  - Technology and Healthcare
    - Apple iPhone by Steve Jobs
    - Apple Macintosh by Hartmut Esslinger and Frog Design
    - Beolit 12 by Cecilie Manz for Banq&Olufsen

Browse

Database: Design

Table: Materials

Subset: All materials

- Materials
  - Ceramics and glasses
  - Hybrids: composites, foams, natural materials
  - Metals and alloys
    - Ferrous
    - Non-ferrous
  - Polymers and elastomers
    - Elastomers
      - Butyl rubber (IIR)
      - Ethylene vinyl acetate (EVA)
      - Natural rubber (NR)
      - Polychloroprene (Neoprene, CR)
      - Polyisoprene rubber (IIR)
      - Polyurethane (elPU)
      - Silicone elastomers (SI, Q)
      - Styrene butadiene rubber (SBR)
      - Thermoplastic Vulkanite (TPV)
    - Polymers
      - Thermoplastics
        - Acrylonitrile butadiene styrene (ABS)
        - Cellulose polymers (CA)
        - Ionomer (I)
        - Polyamides (Nylons, PA)
        - Polybutylene Terephthalate (PBT)
        - Polycarbonate (PC)
        - Polyetheretherketone (PEEK)
        - Polyethylene (PE)
        - Polyethylene terephthalate (PET)

Search on keywords

Search

Database: Design

Search string

Furniture AND Wood

- Designers (2)
- Manufacturers (1)
- Materials (19)
- Processes (3)
- Products (12)

Records found

Full text search of entire database:
Not case-sensitive
but sensitive to spelling

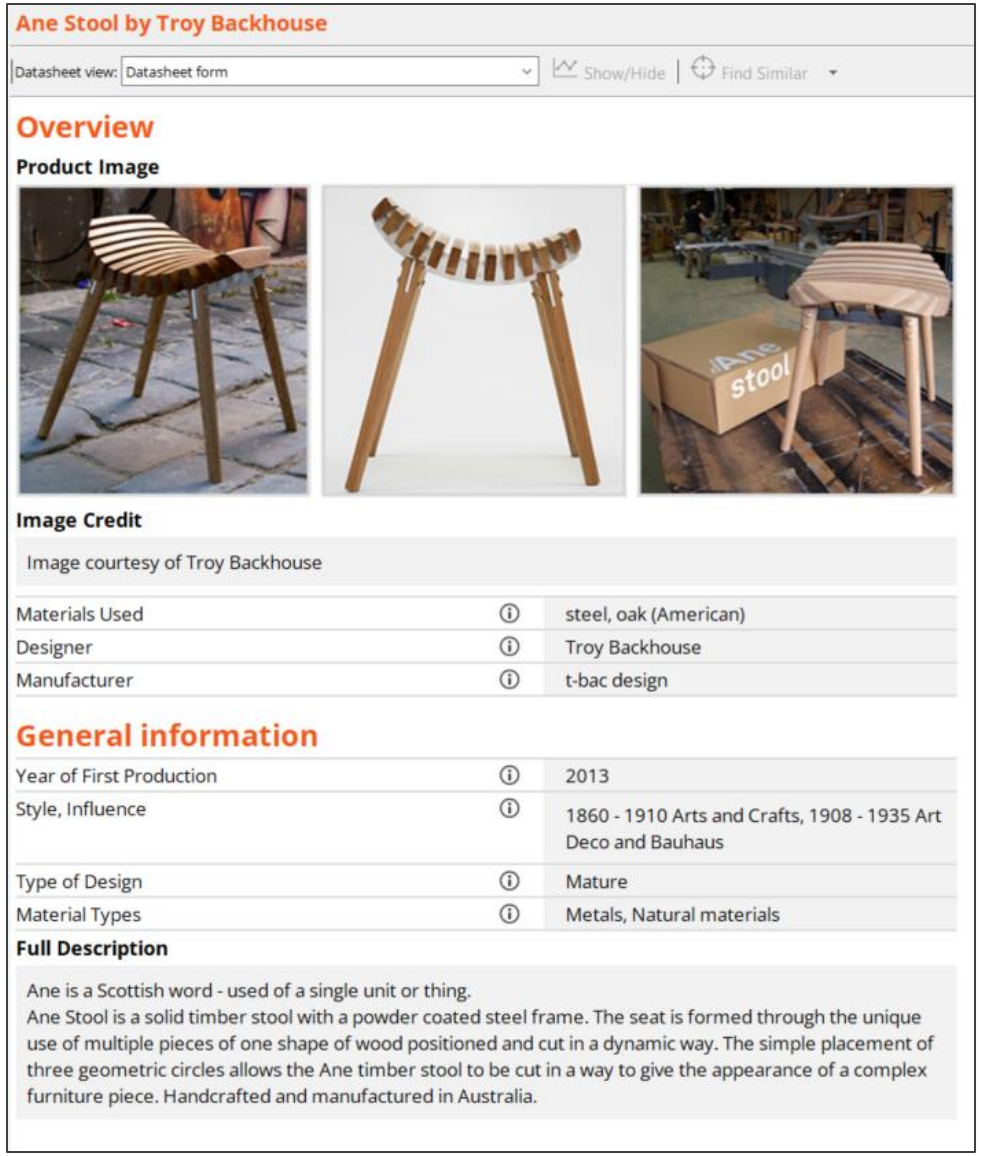
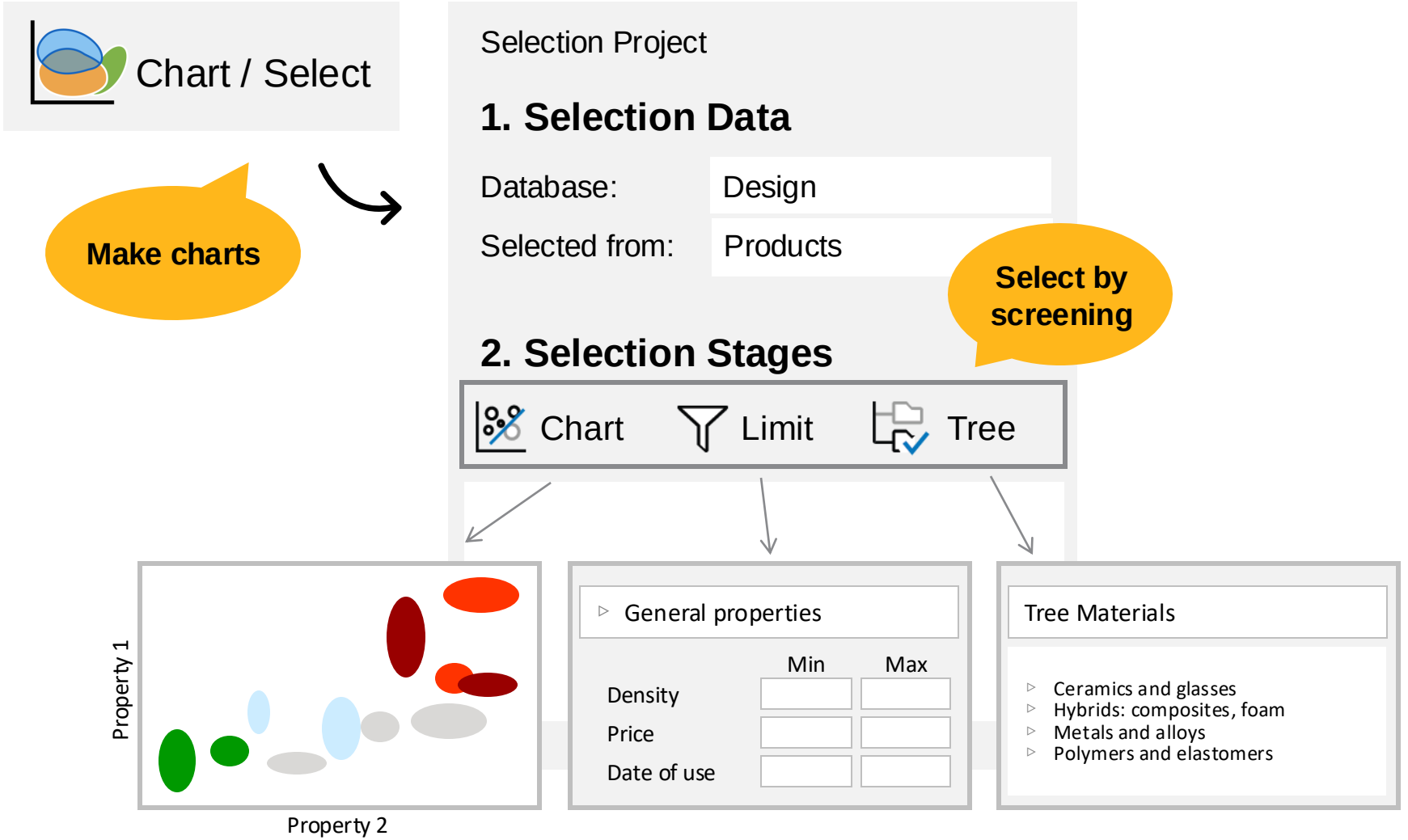
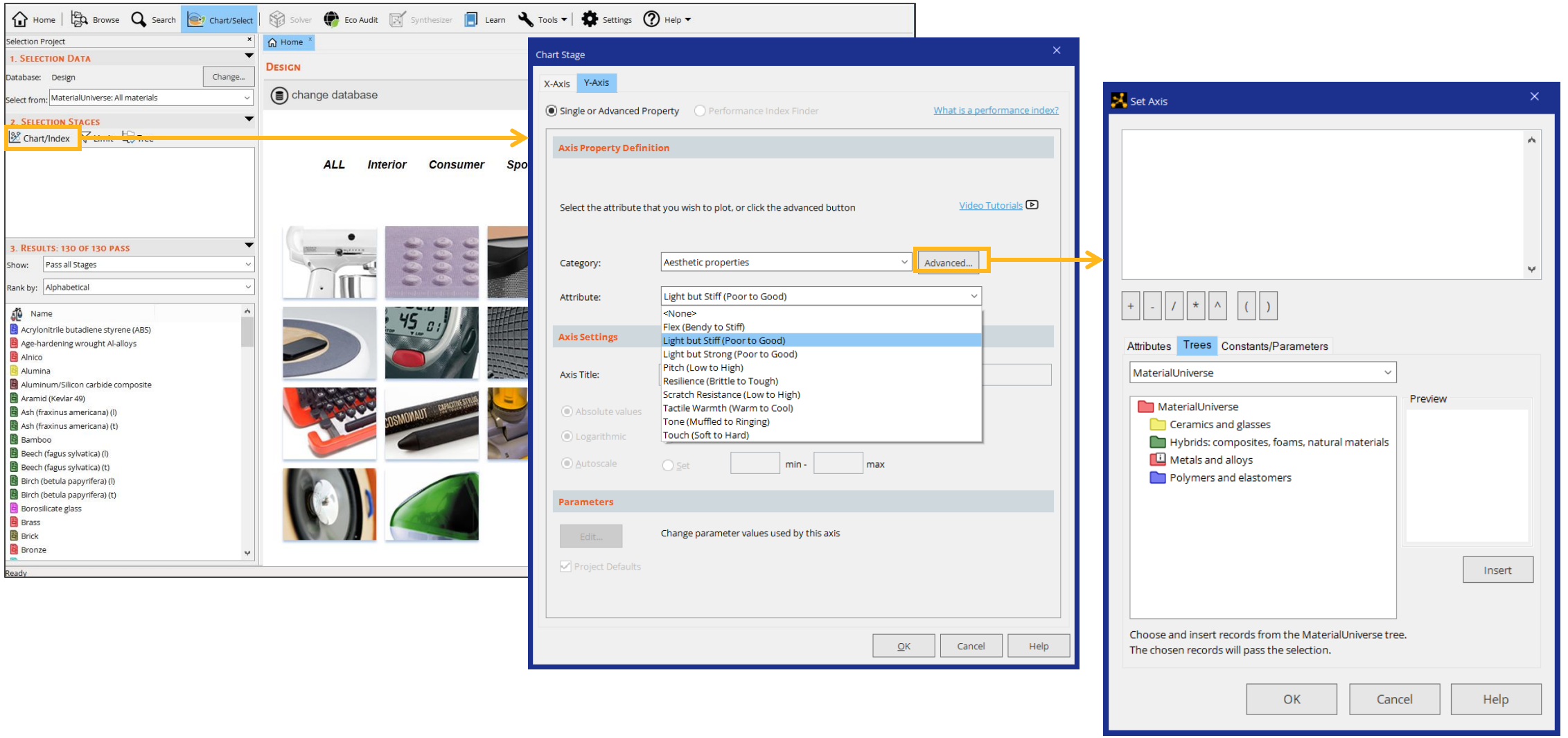


Chart / Select to plot and screen data

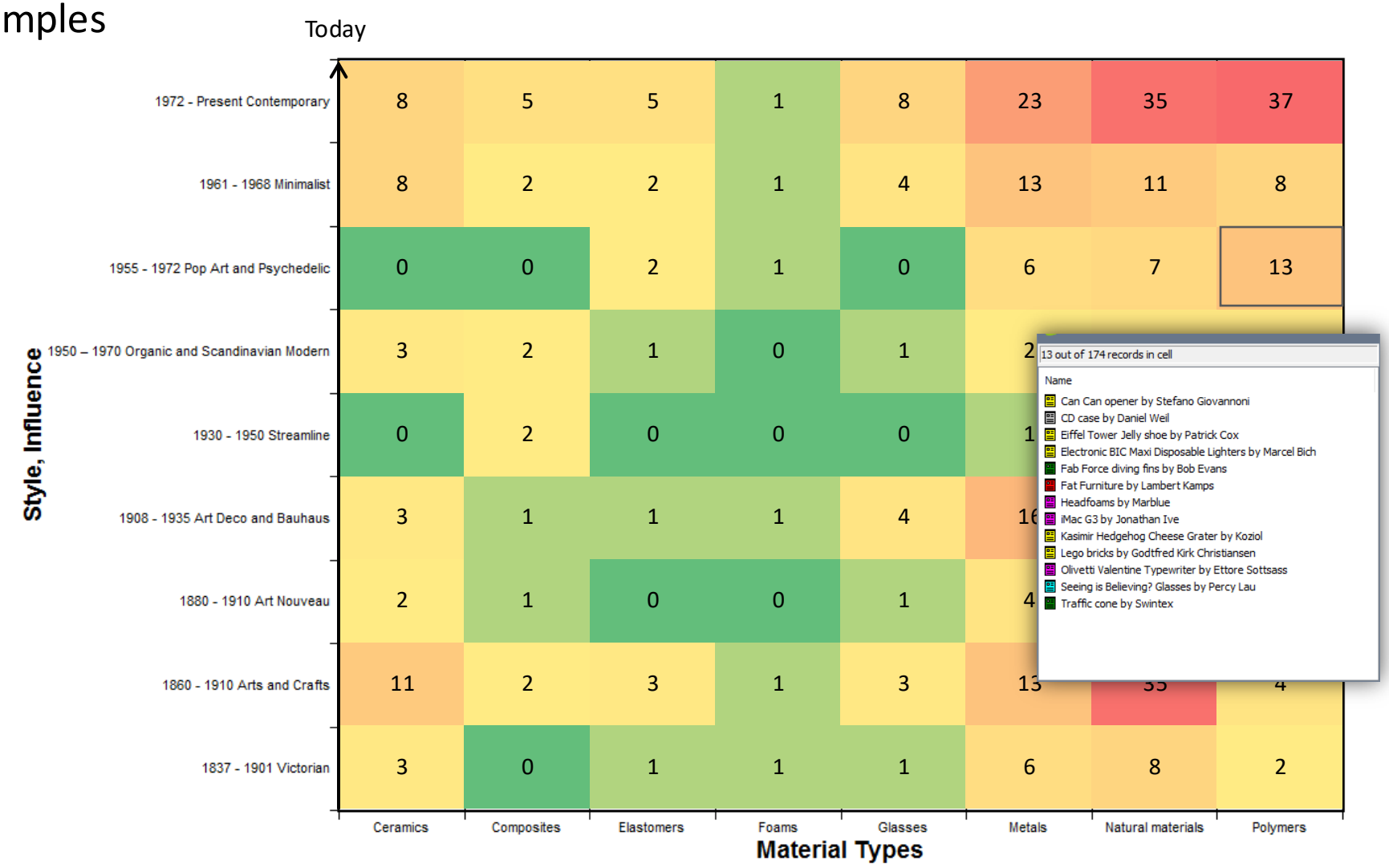


Making advanced product chart – combining stages



Examples of Product Charts

Examples



Other charts – products over time

Examples

New materials and processes enable new designs

Ash, Iron,
Sawn, forged
1862

Mild steel
Rolled, brazed
1900

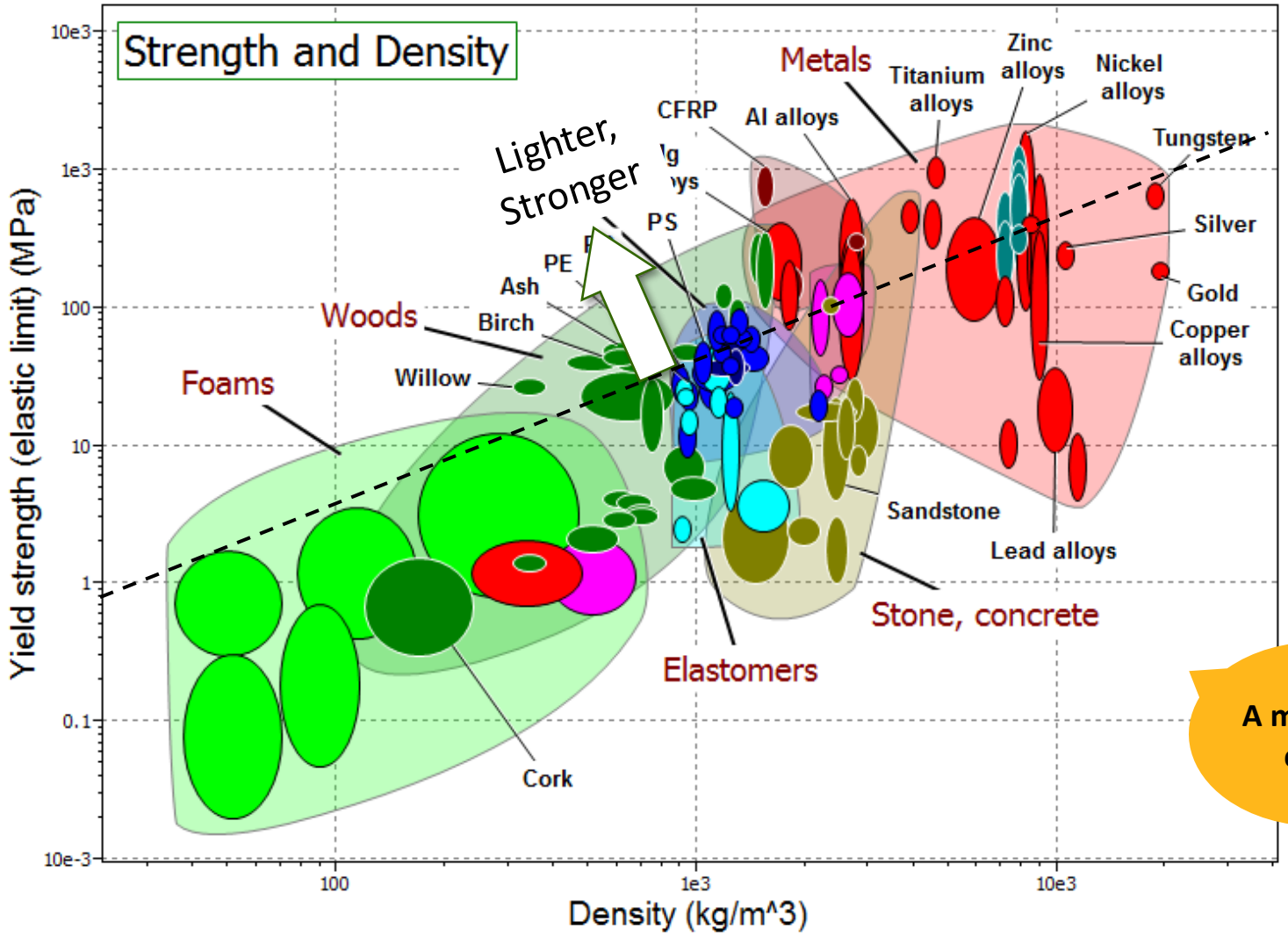
Aluminum,
Heat treated
1983

Plastic,
Molded
1983

Magnesium,
Die cast
1986

Carbon,
Lay-up
1992

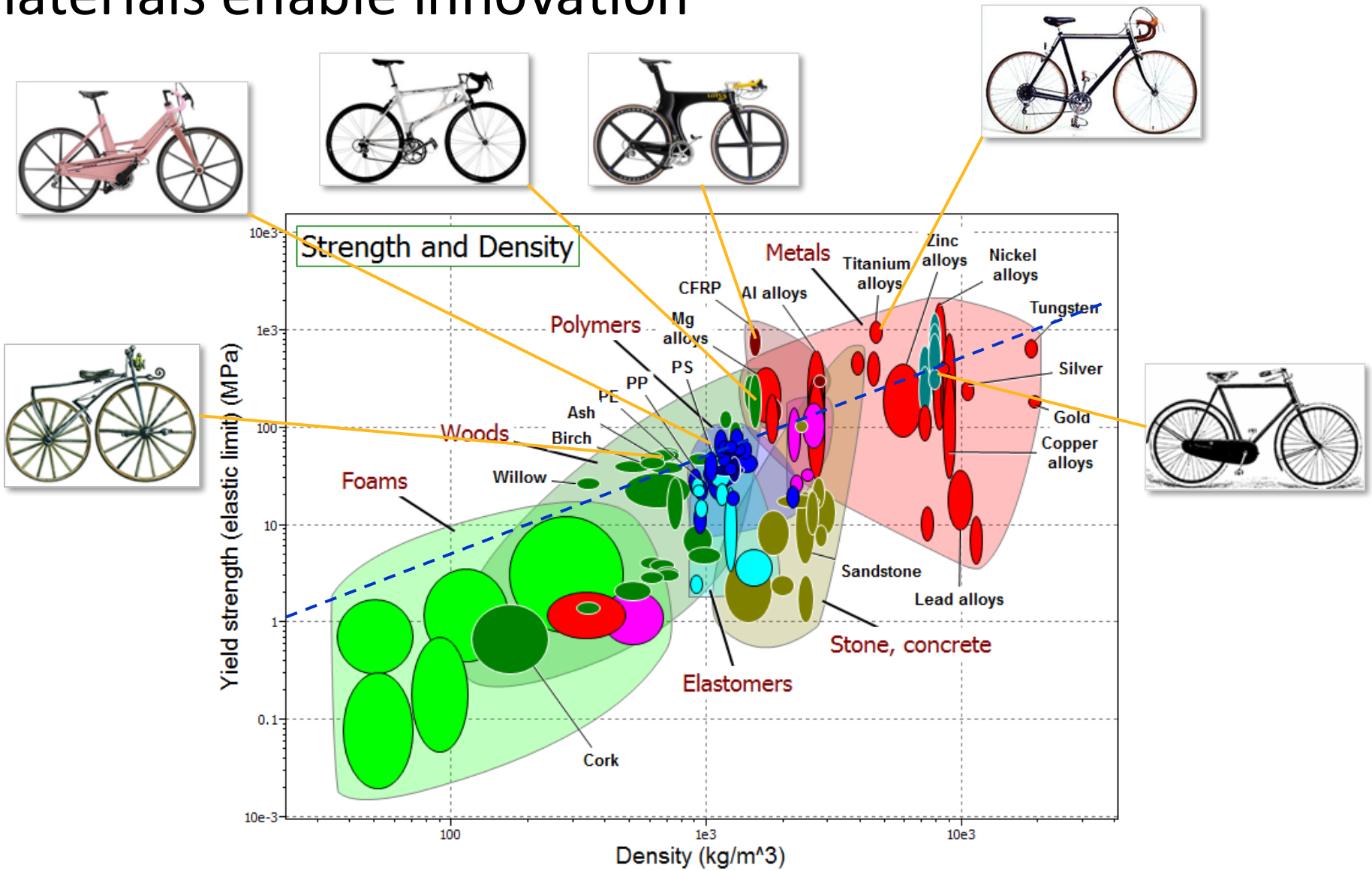
Chart / Select on material properties



Index Line = Relation between
Density/ Yield strength

A materials chart

New materials enable innovation



Materials influence both style and shape

Chair

- Designers (8)
- Manufacturers (2)
- Materials (7)
- Processes (2)
- Products (21)

Tom-Vac chair stacking chair by Ron Arad
Chair Electron by Konstantin Achkov
Owl Chair by Satoshi Itasaka
Pack chair by Francoise Azambourg
Layer Chair by Jorrit Taekema
Loop Chair by Willy Guhl
Voido chair by Ron Arad
Sling Chair by Joe Doucet
Gaudi Chair by Bram Geenen
Chair n° 14 by Michael Thonet
Well Tempered Chair by Ron Arad
Miss Blanche chair by Shiro Kurumata
Customized Harry Bertoia Wire Chair by Darlene Molnar
Kartell Louis Ghost Chair by Phillipe Starck
Barcelona chair by Mies van der Rohe
Nasa Chair by Kaleb J Cardenas Z
Fantastic Plastic Elastic chair by Ron Arad
Power Play Chair and Ottoman by Frank Gehry

One product, different materials

Beech
craftsmanship, quality

Polyethylene
exuberant, pop-arty

Cardboard
gentle

Carbon fiber
space-age

Materials and product character

Lamp

- Designers (2)
- Manufacturers (1)
- Materials (9)
- Processes (2)
- Products (10)

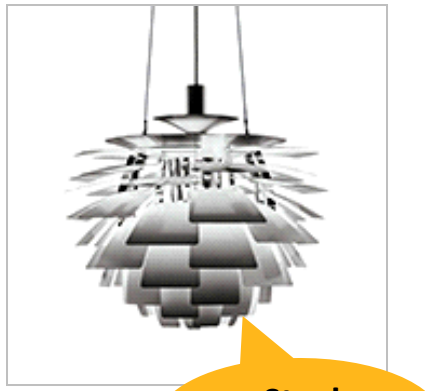
- Labo Lamp by Something.
- Iris Lamp by Lightexture
- Amonita Lamp by Hugo Ribeiro
- Task Lamp by Owen Read
- Artichoke Lamp by Louis Poulsen
- (De)Light Lamp by Cristina Ferraz
- Cork Lamp by Goncalo Lozano for Casal Vadio
- Cell Desk Lamp by Cameron Fry & Pete Jones for Liqui Design
- Bullet Lamp by I. Bar-On & O. Webman
- Lampalumina by Ronan & Erwan Bouroullec

Another product search, **different materials**

Ceramic cold, technical

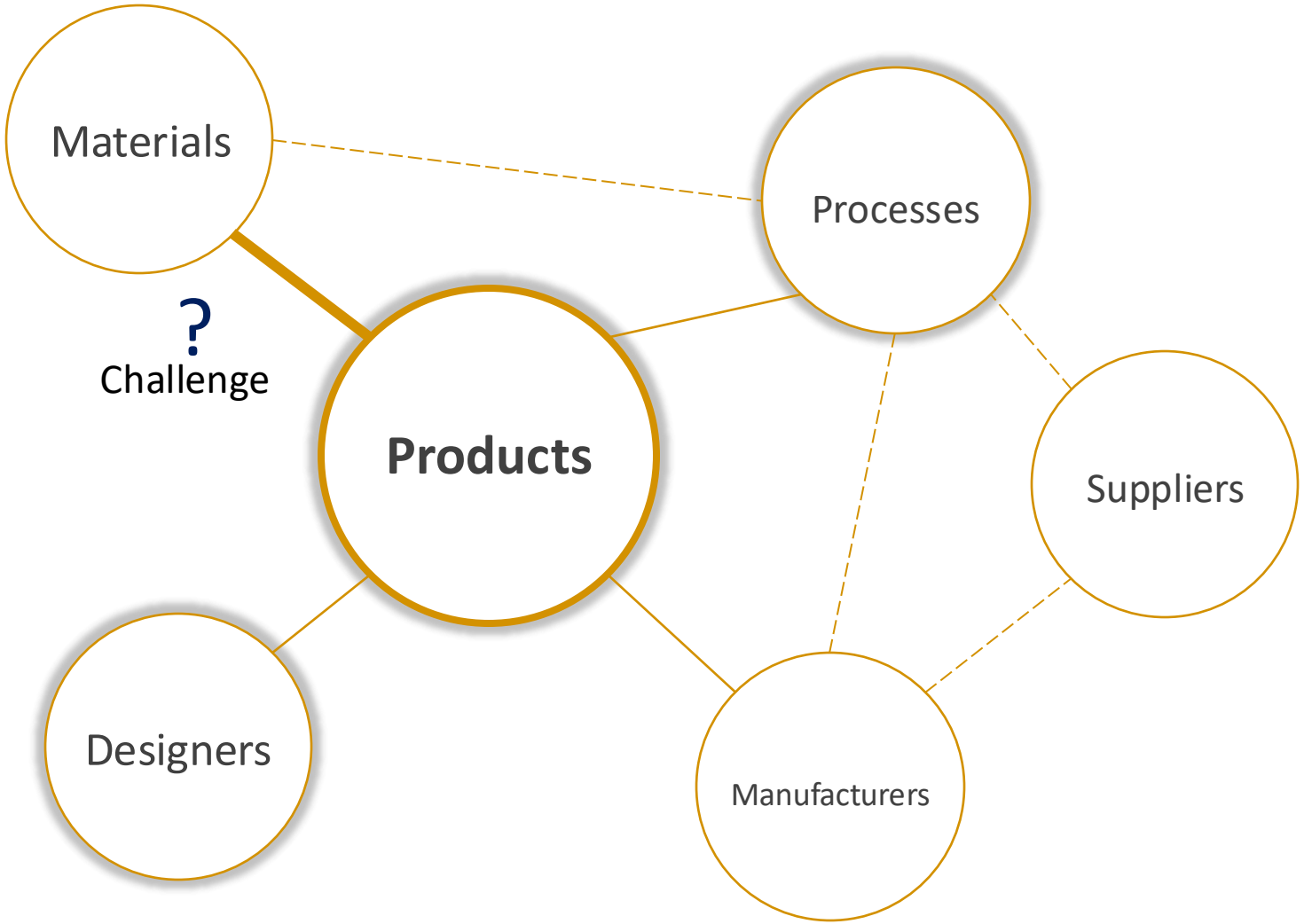
Glass clinical

Wood stylish, crafted

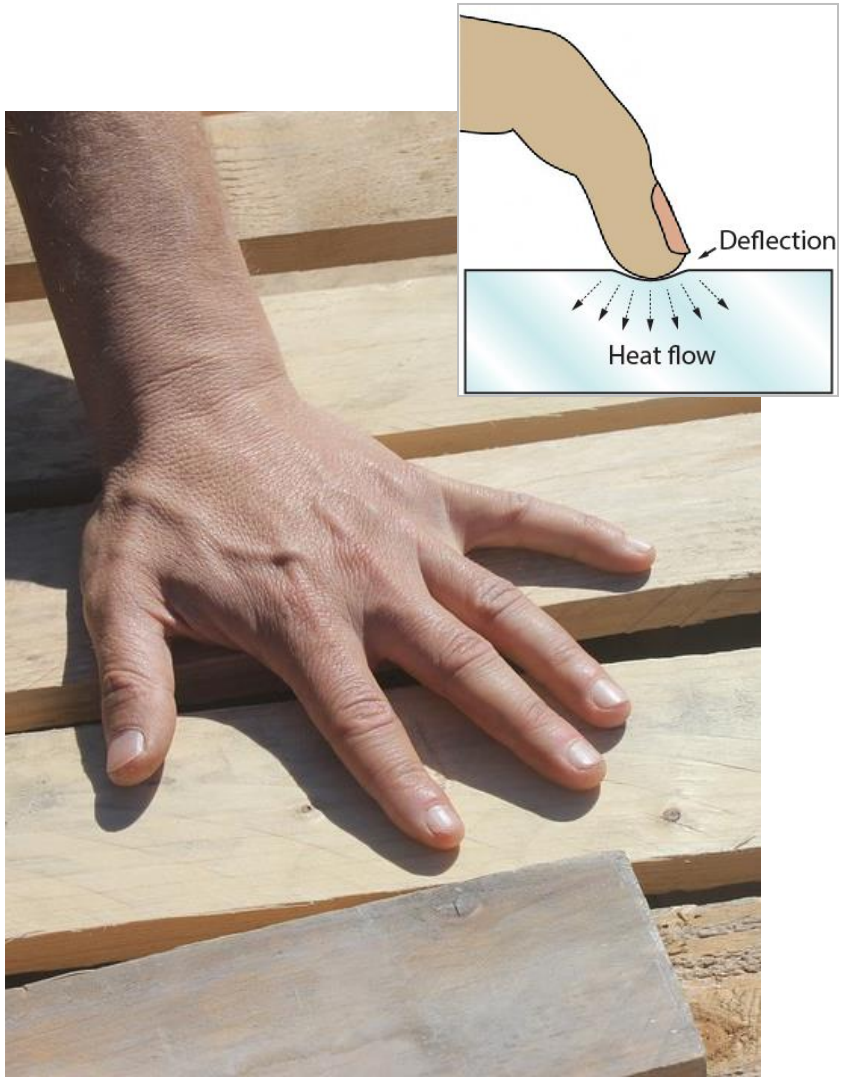


Steel engineered

The Structure



Aesthetic properties



Warm / Cold

$$\text{Heat drain } Q = \sqrt{\rho\ \lambda\ C_p}$$

Density

Thermal conductivity

Specific heat

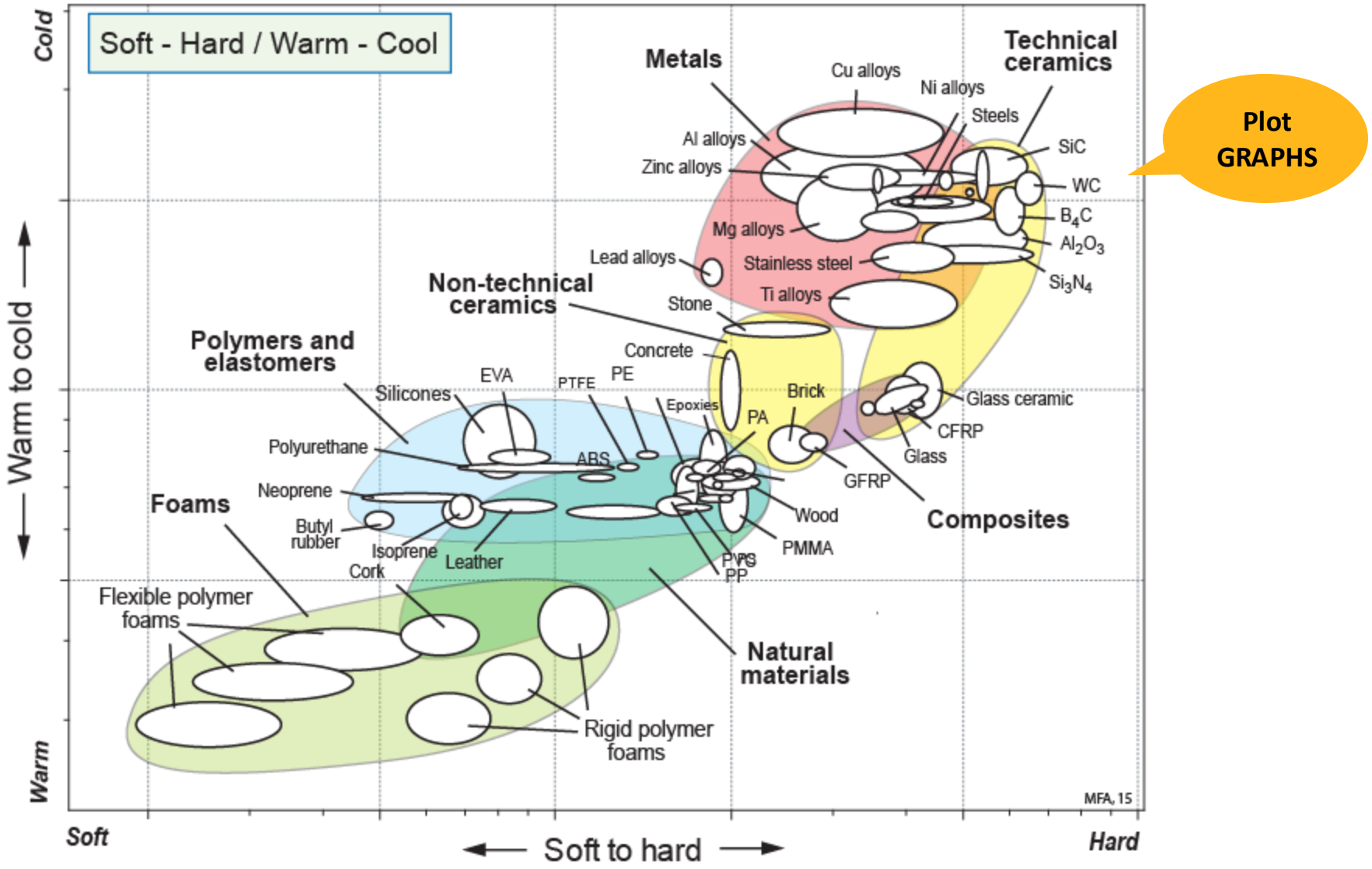
Soft / Hard

$$\text{Soft/Hard } S = \sqrt{E\ H}$$

Modulus

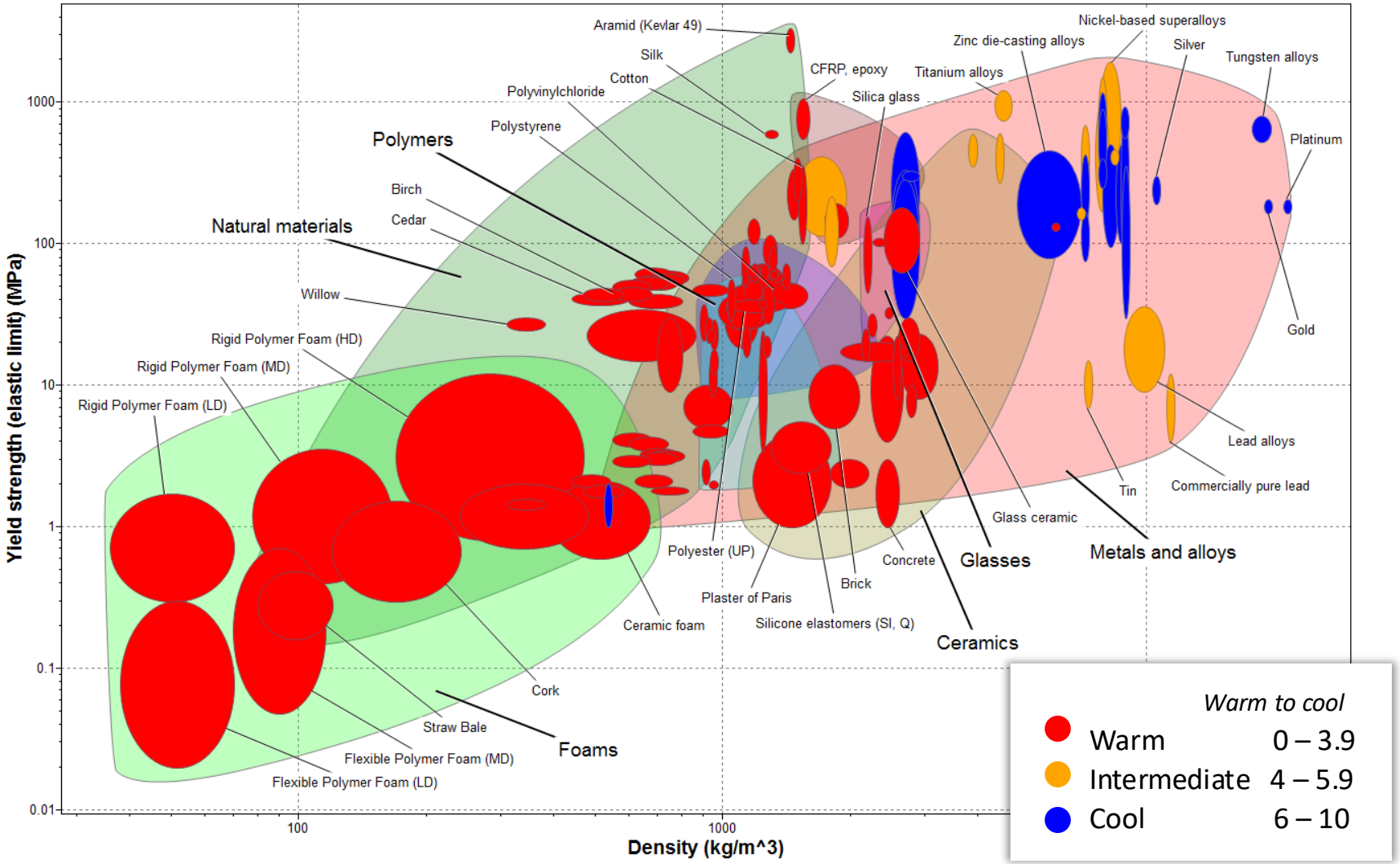
Hardness

Aesthetic properties

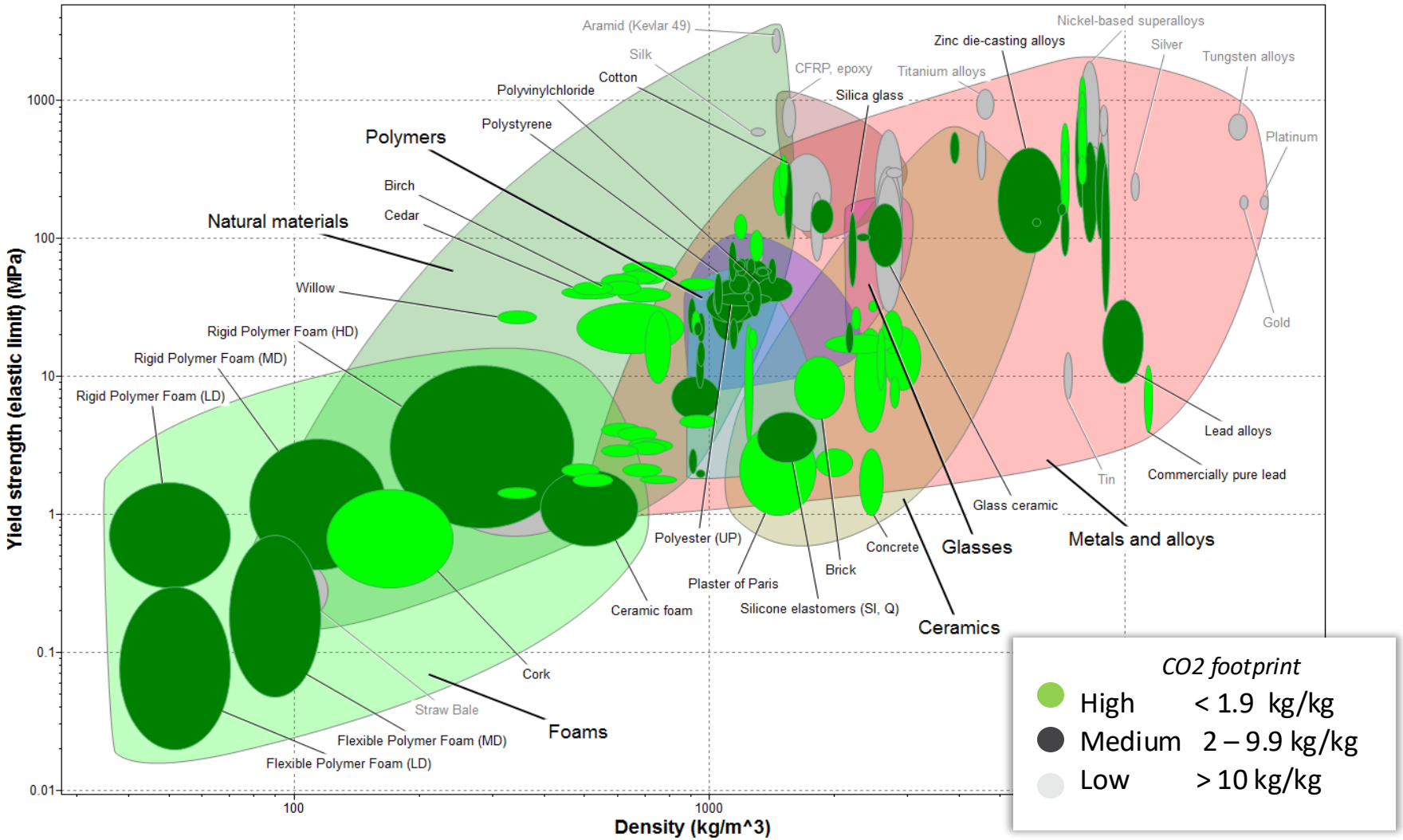


Plot GRAPHS

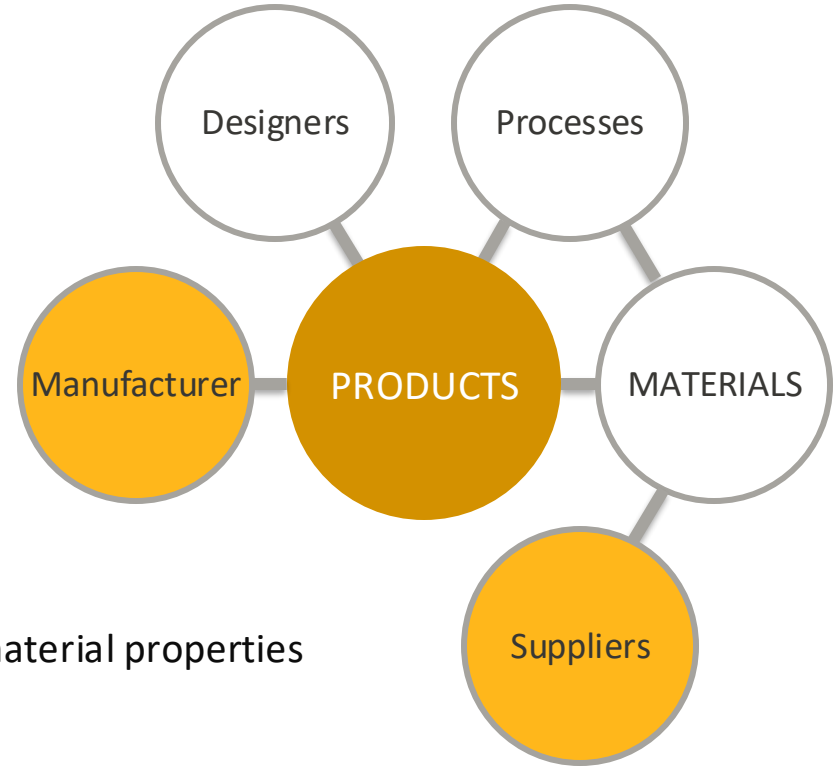
Aesthetic properties - Example Warm / Cool



Example eco materials

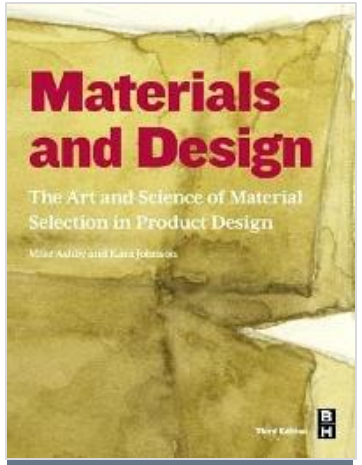


Summary

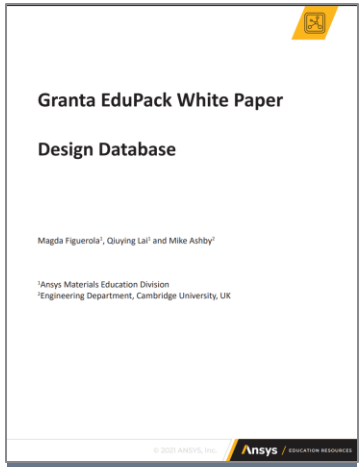


- The Design resources open a window on the role of material properties and manufacturing processes in product design.
- Highlights the interaction between products, materials and processes and their role in creating style, product character, performance etc.
- Suggests how a deeper understanding of products can enable innovation and inspire greater design.

Further resources

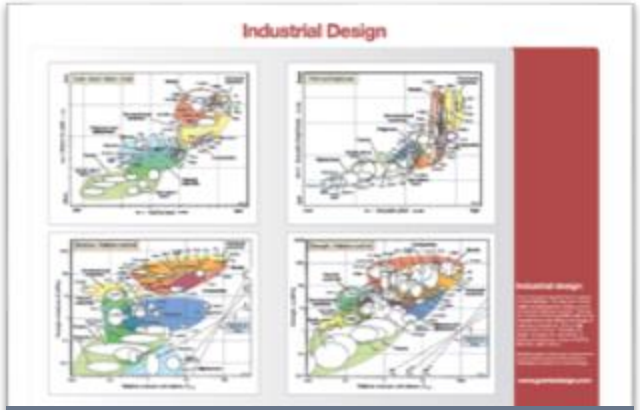


Textbook



White Paper

Exercises



Poster

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