MEC-E1070
Selection of Engineering Materials

Prof. Junhe Lian, Prof. Sven Bossuyt
course assistant Zinan Li

Hybrids materials

Cellular structures

Composites

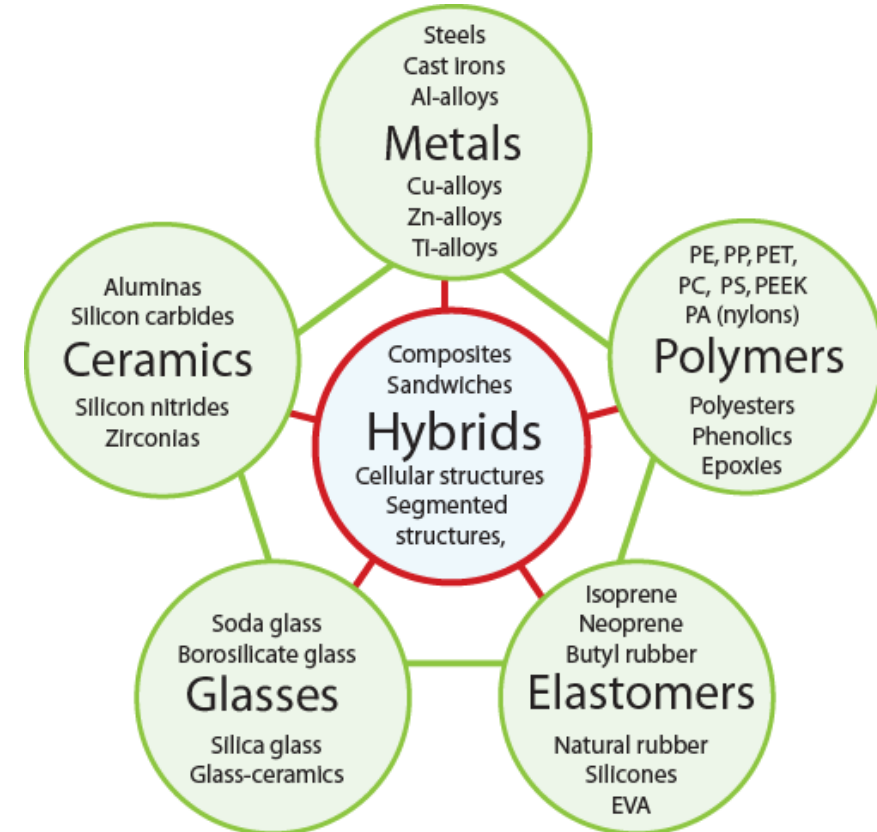**Sandwich structures**

Multi-layers

- **Empty spaces** in material-property graph

- **Hybrids materials** – expanding the filled space

- **Sandwich panels**

- Add your own **Synthesizer model**

Criteria of excellence: material indices

Objective minimise **mass**	Constraints	
	Stiffness	Strength
Tension (tie)	E/ρ	σ_y/ρ
Bending (beam)	$E^{1/2}/\rho$	$\sigma_y^{2/3}/\rho$
Bending (panel)	$E^{1/3}/\rho$	$\sigma_y^{1/2}/\rho$

Material-property space: Stiffness - Density
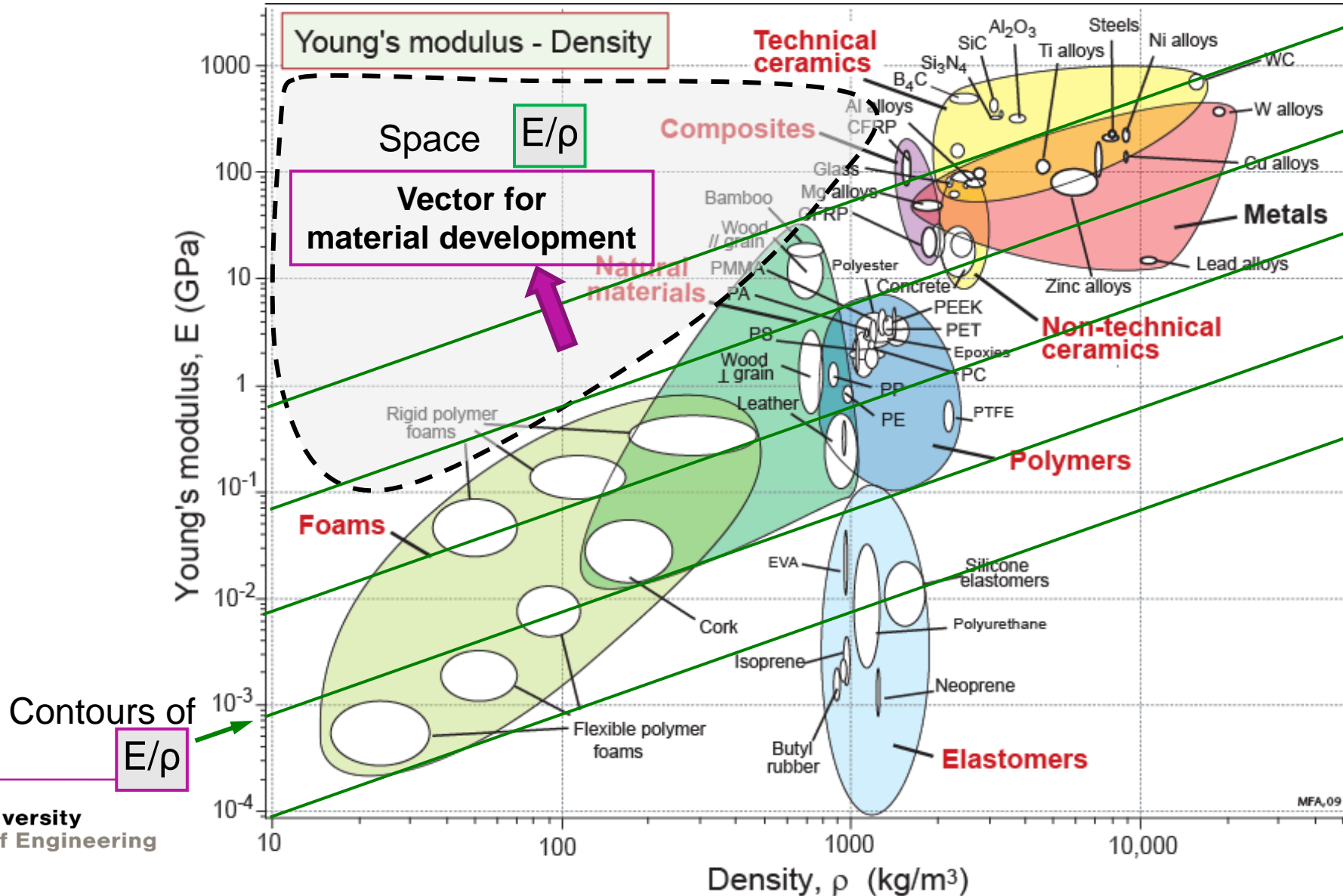
Material-property space: Strength - Density
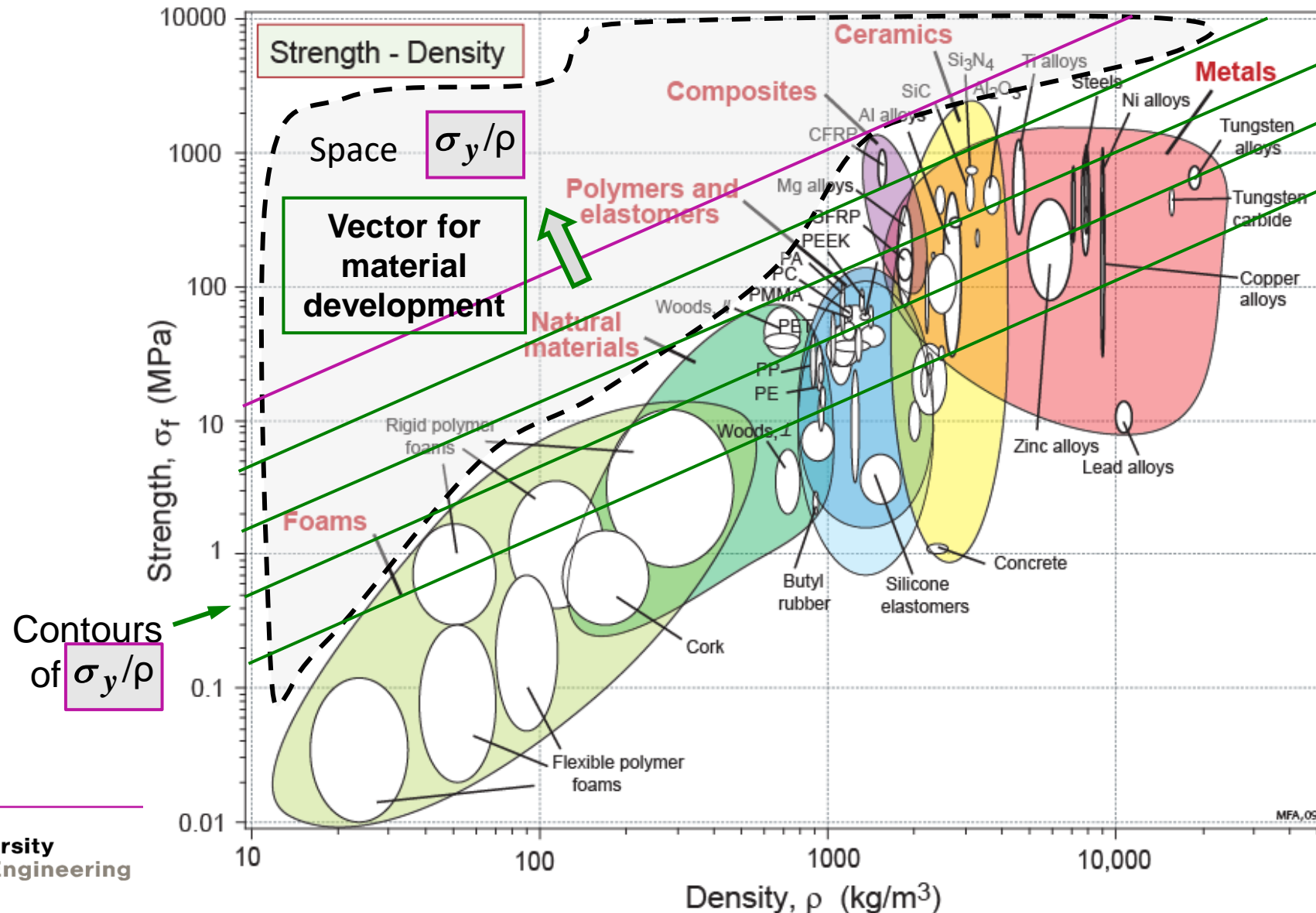
Sandwich panel property models

Faces: material A

Core: material B

Elastic response

Bending

Core shear

Collapse response

Face yield

Face buckling

Core failure
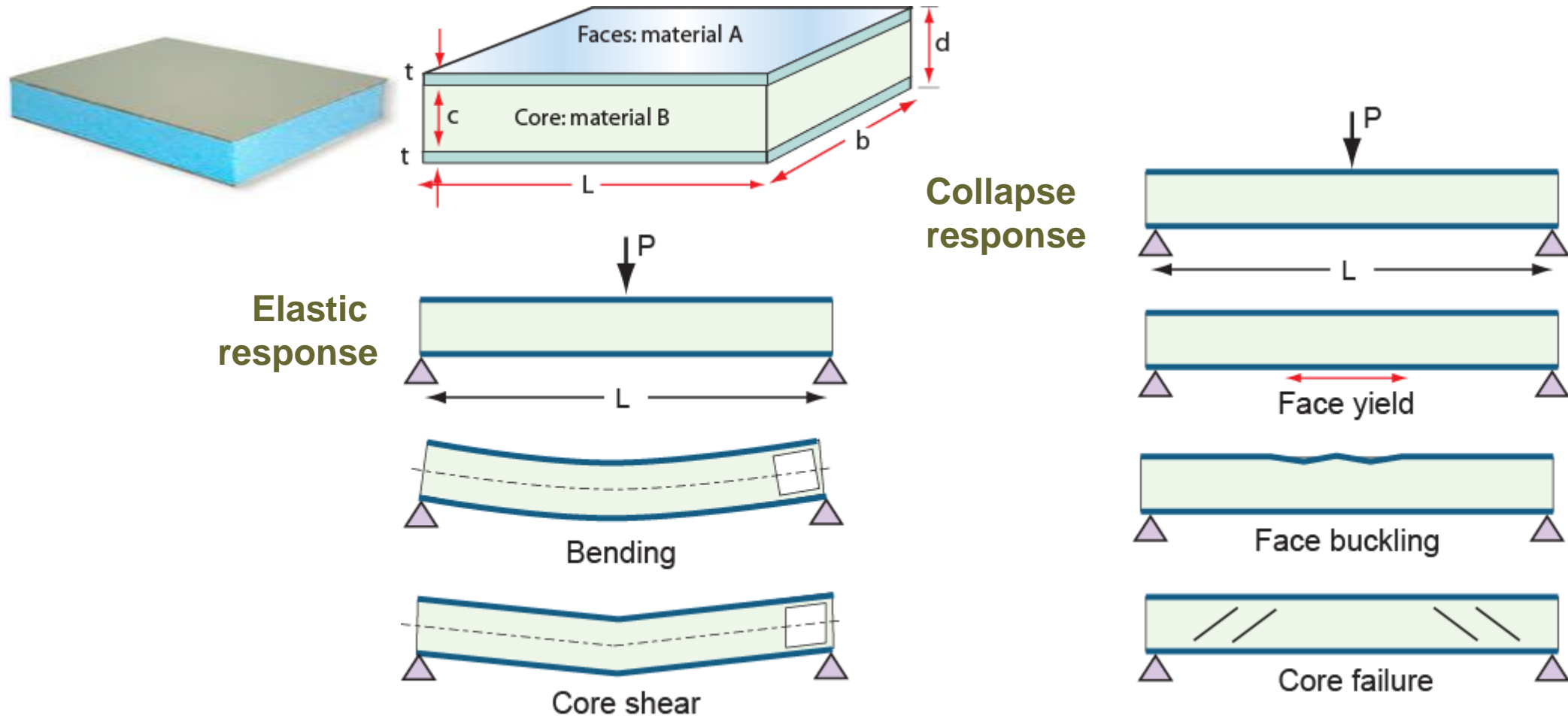
Structure of a Hybrid Synthesizer

User interface

Choose:
- *Configuration*
- *Components*
- *Volume fractions*

Models for configuration props.
- *Moduli*
- *Strength*
- *Thermal props*
- *Electrical props*

Data for component props.
- *Moduli*
- *Strength*
- *Thermal props*
- *Electrical props*

Calculate hybrid properties and scan

Data sheet for proposed hybrid
- *Moduli*
- *Strength*
- *Thermal props*
- *Electrical props*
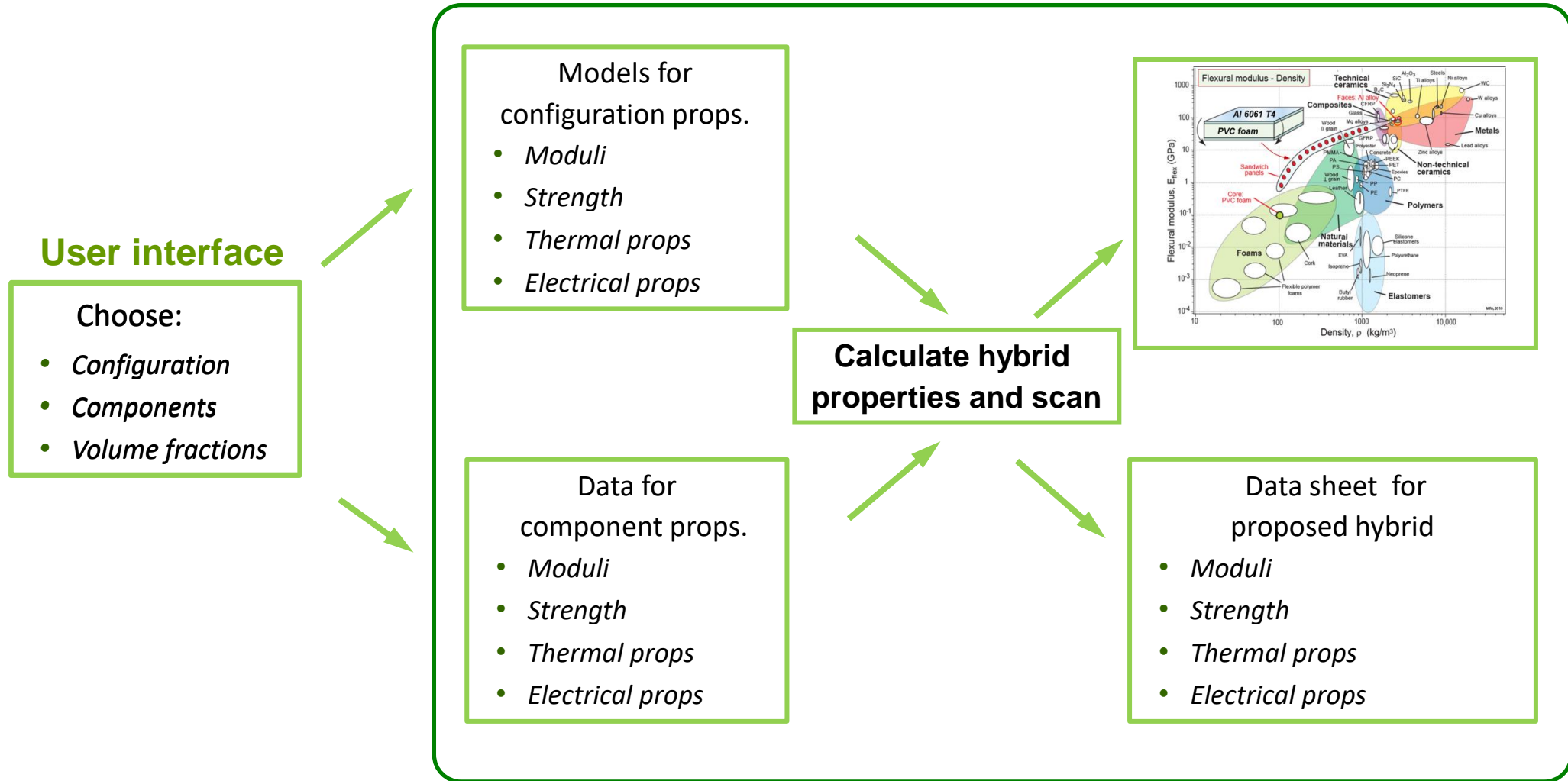
The Synthesizer tool and its models
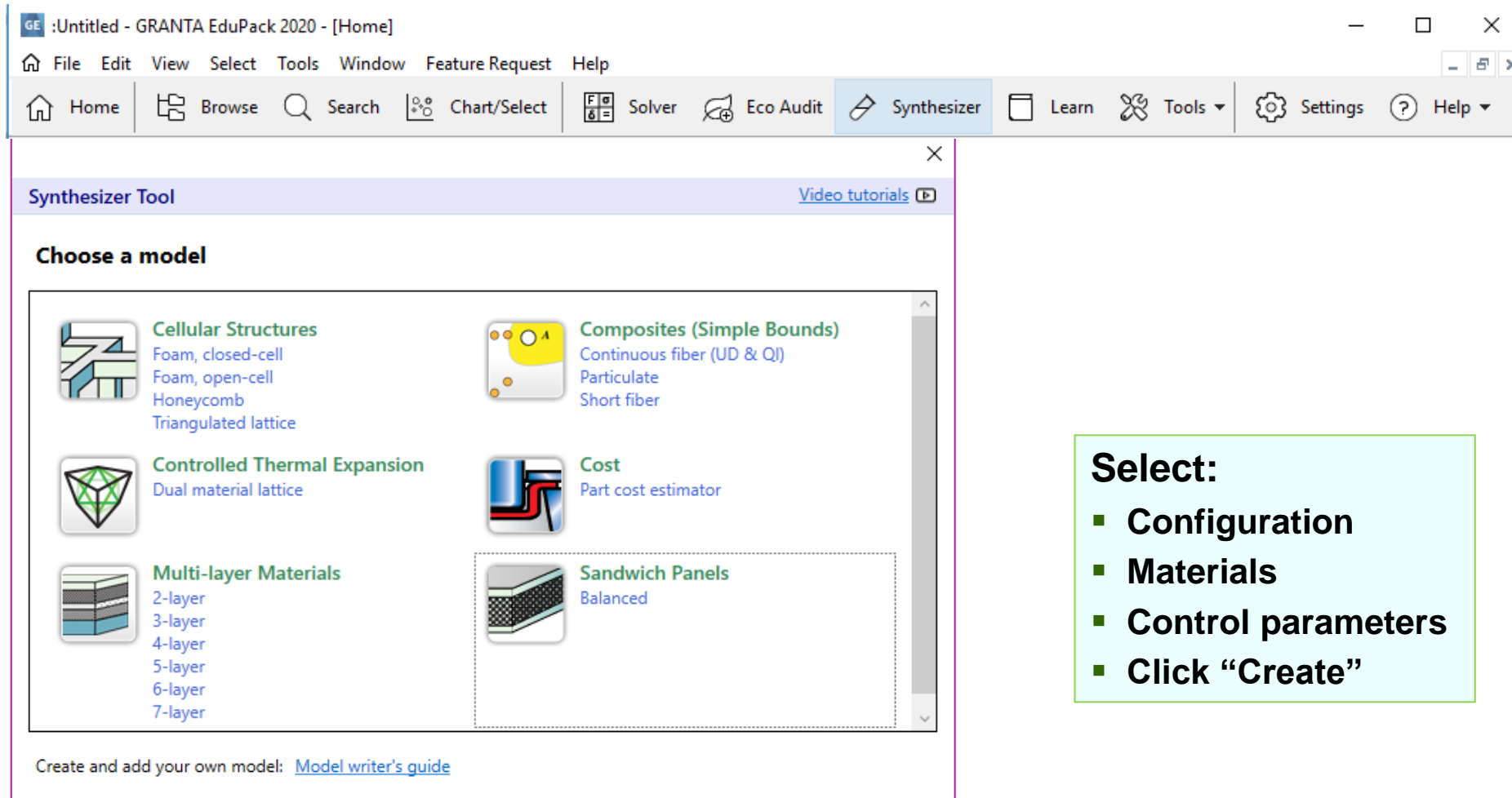
Select:
- **Configuration**
- **Materials**
- **Control parameters**
- **Click "Create"**

Aalto University
School of Engineering

Demo - Sandwich panels

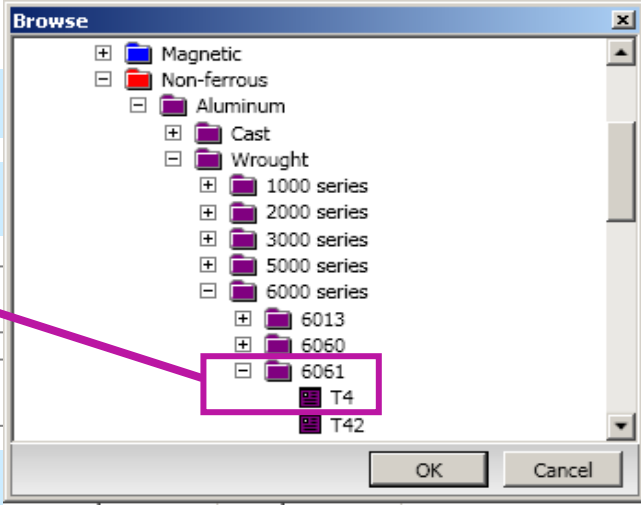**Sandwich panel**

Source material

Face sheet   **Aluminum 6061 T4**

Core   **PVC cross-linked rigid foam (KR 0.09)**

Model variables
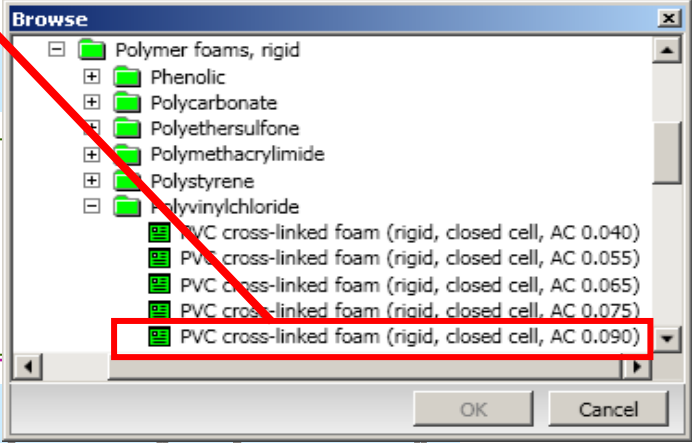
Face-sheet thickness   0.1 - 3   mm   *Number of values*   3

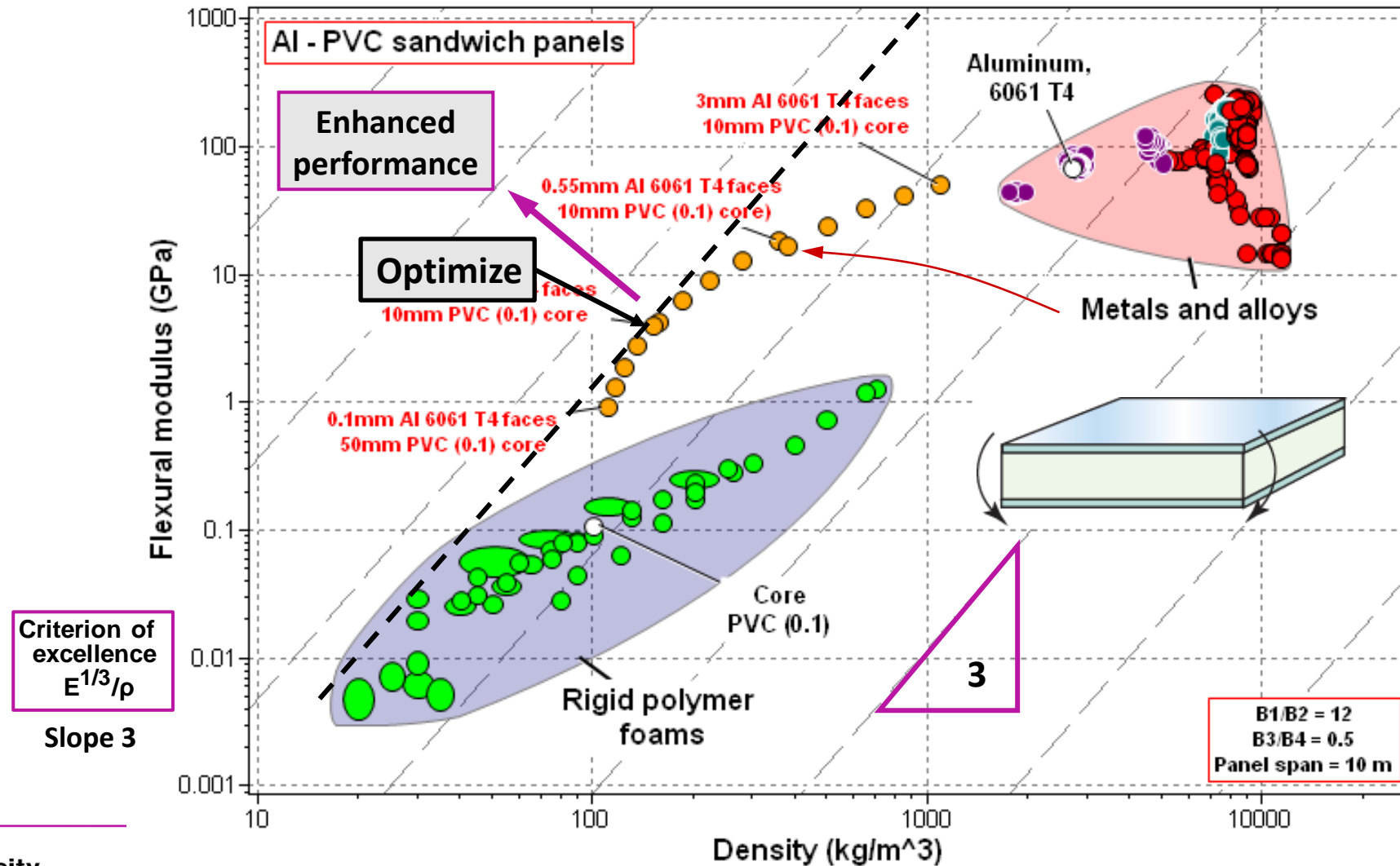*Core thickness -*   10 - 50   mm   *Number of values*   5

Model parameters

Support and load conditions

Span   3   m

Etc.

Model   Previous

Browse
- ⊞ Magnetic
- ⊟ Non-ferrous
  - ⊟ Aluminum
    - ⊞ Cast
    - ⊟ Wrought
      - ⊞ 1000 series
      - ⊞ 2000 series
      - ⊞ 3000 series
      - ⊞ 5000 series
      - ⊟ 6000 series
        - ⊞ 6013
        - ⊞ 6060
        - ⊟ 6061
          - T4
          - T42

OK   Cancel

Browse
- ⊟ Polymer foams, rigid
  - ⊞ Phenolic
  - ⊞ Polycarbonate
  - ⊞ Polyethersulfone
  - ⊞ Polymethacrylimide
  - ⊞ Polystyrene
  - ⊟ Polyvinylchloride
    - PVC cross-linked foam (rigid, closed cell, AC 0.040)
    - PVC cross-linked foam (rigid, closed cell, AC 0.055)
    - PVC cross-linked foam (rigid, closed cell, AC 0.065)
    - PVC cross-linked foam (rigid, closed cell, AC 0.075)
    - PVC cross-linked foam (rigid, closed cell, AC 0.090)

OK   Cancel

Stiff sandwich panels

Summary

The synthesizer stimulates

- Imaginative exploration of novel material combinations

- Interest in materials modelling

- Direct comparison of hybrids with the standard materials of engineering

- Exploration of structured-structures

- Enables you to enter your own materials-based models