Aalto University
School of Engineering

MEC-E1070 Selection of Engineering Materials

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Aalto University
School of Engineering

Important notice:

- *Please use your full name to enter the ZOOM session*
- *Registration on name list on-site*

Lecture structure

First Half (40')

Lecture Review (10')

Course content studied from the textbook

Introduction of flipped classroom & group work (10')

Discussion topics and grouping

Group discussion (20')

Task analysis, mutual feedback, questions collection discussion, self-assessment

Break (5')

Second Half (60')

Group presentation (20')

On the findings from the group discussion

Task assessment criteria and grading (5')

Next task introduction (5')

Prof Sven Bossuyt: Material selection for the standing rigging of a sailboat (30')

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Lecture Review

Learning objectives for this Lecture

Knowledge and Understanding

Understanding of *material families* and their *property* relationships

Skills and Abilities

Ability to create *material property charts* for specific purposes

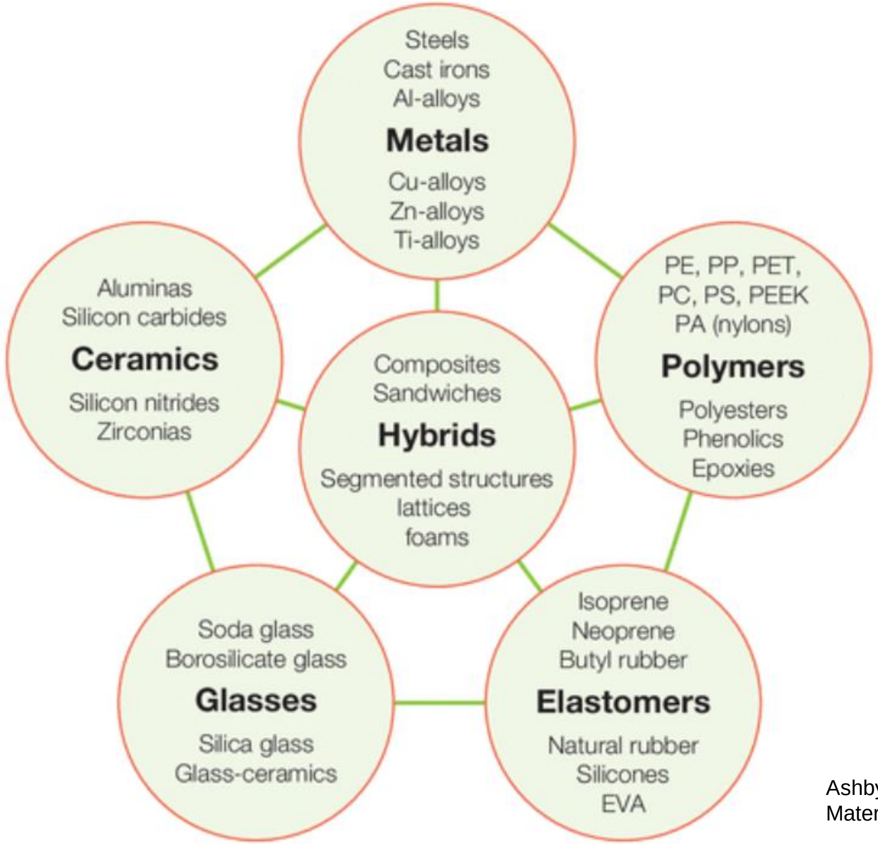
Values and Attitudes

Grasping a broad view of materials information, the big picture

During the session, you will:

- Learn how to do group discussion and presentation
- Learn how to provide peer feedback and assessment
- Be prepared for the first material selection task
- Experience a comprehensive showcase of material selection

Engineering materials basic families



Ashby, Michael F.
Materials Selection in Mechanical Design

Properties: Structured information for ABS*

General properties

Density	1.03e3	-	1.06e3	kg/m^3
Price	* 1.95	-	2.29	USD/kg
Date first used	1937			

Mechanical properties

Young's modulus	2.08	-	2.75	GPa
Yield strength	34.5	-	49.6	MPa
Tensile strength (elastic limit)	37.9	-	51.7	MPa
Elongation	5	-	60	% strain
Hardness - Vickers	10	-	15	HV
Fatigue strength at 10^7 cycles	15.2	-	20.7	MPa
Fracture toughness	1.46	-	4.29	MPa•m$^{1/2}$

Thermal properties

Maximum service temperature	62.9	-	76.9	°C
Thermal conductivity	0.253	-	0.263	W/m.°C
Specific heat capacity	1.69e3	-	1.76e3	J/kg/°C
Thermal expansion coefficient	74	-	123	µstrain/°C

Electrical properties

Electrical conductor or insulator?	Good insulator

Optical properties

Transparency	Opaque		
Refractive index	1.53	-	1.54

Processability

Castability	1	-	2
Moldability	4	-	5
Machinability	3	-	4
Weldability	5		

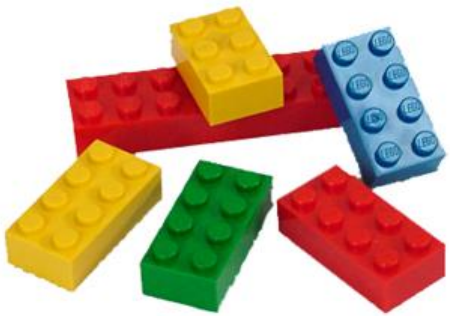
Eco properties

Embodied energy, primary production	* 87.7	-	96.7	MJ/kg
CO_2 footprint, primary production	* 3.27	-	3.61	kg/kg
Recycle				

Links to Processes

*Excerpts from *GRANTA EduPack* Level 2

Properties: Unstructured information for ABS*



The material. ABS (Acrylonitrile-butadiene-styrene) is tough, resilient, and easily molded. It is usually opaque, although some grades can now be transparent, and it can be given vivid colors. ABS-PVC alloys are tougher than standard ABS and, in self-extinguishing grades, are used for the casings of power tools.

Design guidelines. ABS has the highest impact resistance of all plastics. It takes color well. Integral metallics are possible (as in GE Plastics' Magix.) ABS is UV resistant for outdoor application if stabilizers are added. It is hygroscopic (may need to be oven dried before thermoforming) and can be damaged by petroleum-based machining oils.

ABS can be extruded, compression moulded or formed to sheet that is then vacuum thermo-formed. It can be joined by ultrasonic or hot-plate welding, or bonded with polyester, epoxy, isocyanate or nitrile-phenolic adhesives.

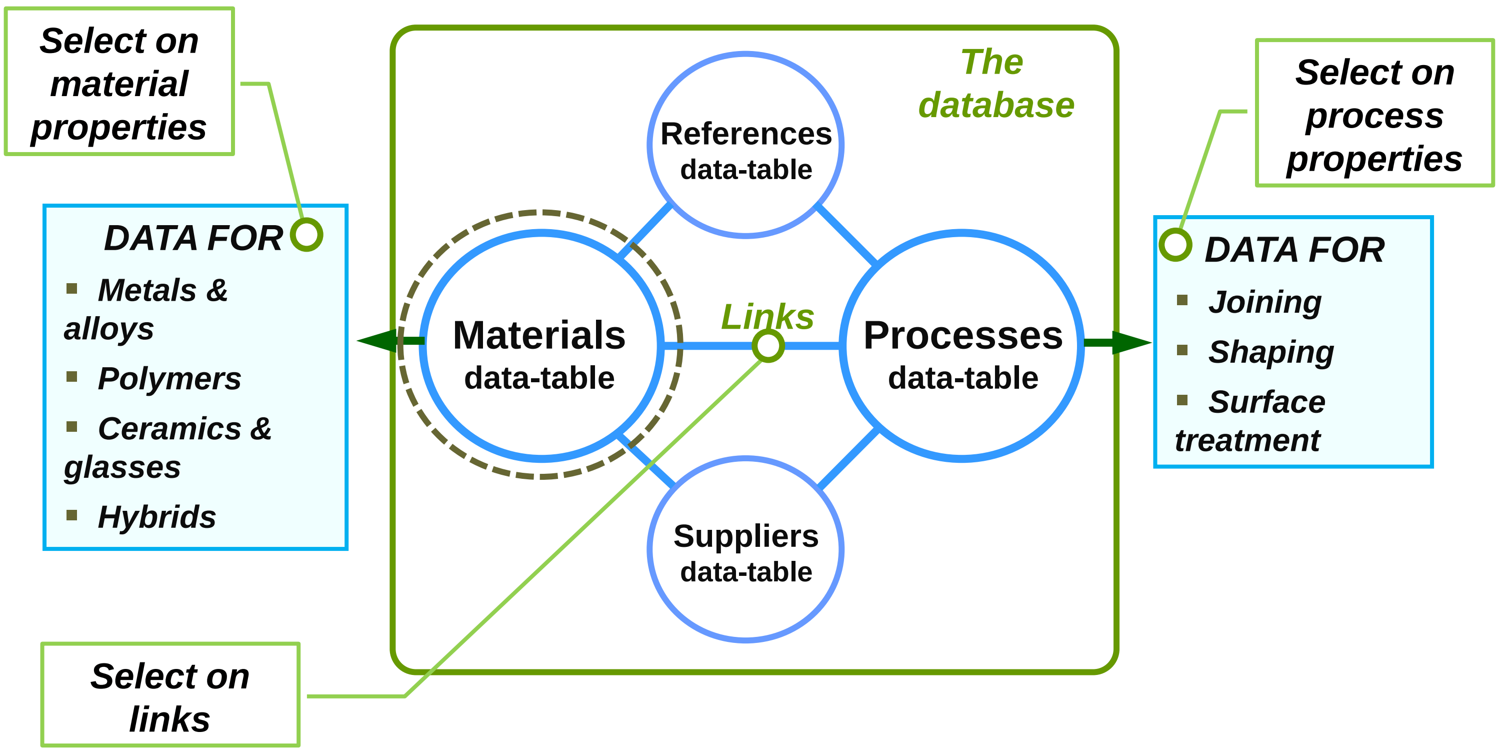
Technical notes. ABS is a terpolymer - one made by copolymerising 3 monomers: acrylonitrile, butadiene and styrene. The acrylonitrile gives thermal and chemical resistance, rubber-like butadiene gives ductility and strength, the styrene gives a glossy surface, ease of machining and a lower cost. In ASA, the butadiene component (which gives poor UV resistance) is replaced by an acrylic ester. Without the addition of butyl, ABS becomes, SAN - a similar material with lower impact resistance or toughness. It is the stiffest of the thermoplastics and has excellent resistance to acids, alkalis, salts and many solvents.

Typical uses. Safety helmets; camper tops; automotive instrument panels and other interior components; pipe fittings; home-security devices and housings for small appliances; communications equipment; business machines; plumbing hardware; automobile grilles; wheel covers; mirror housings; refrigerator liners; luggage shells; tote trays; mower shrouds; boat hulls; large components for recreational vehicles; weather seals; glass beading; refrigerator breaker strips; conduit; pipe for drain-waste-vent (DWV) systems.

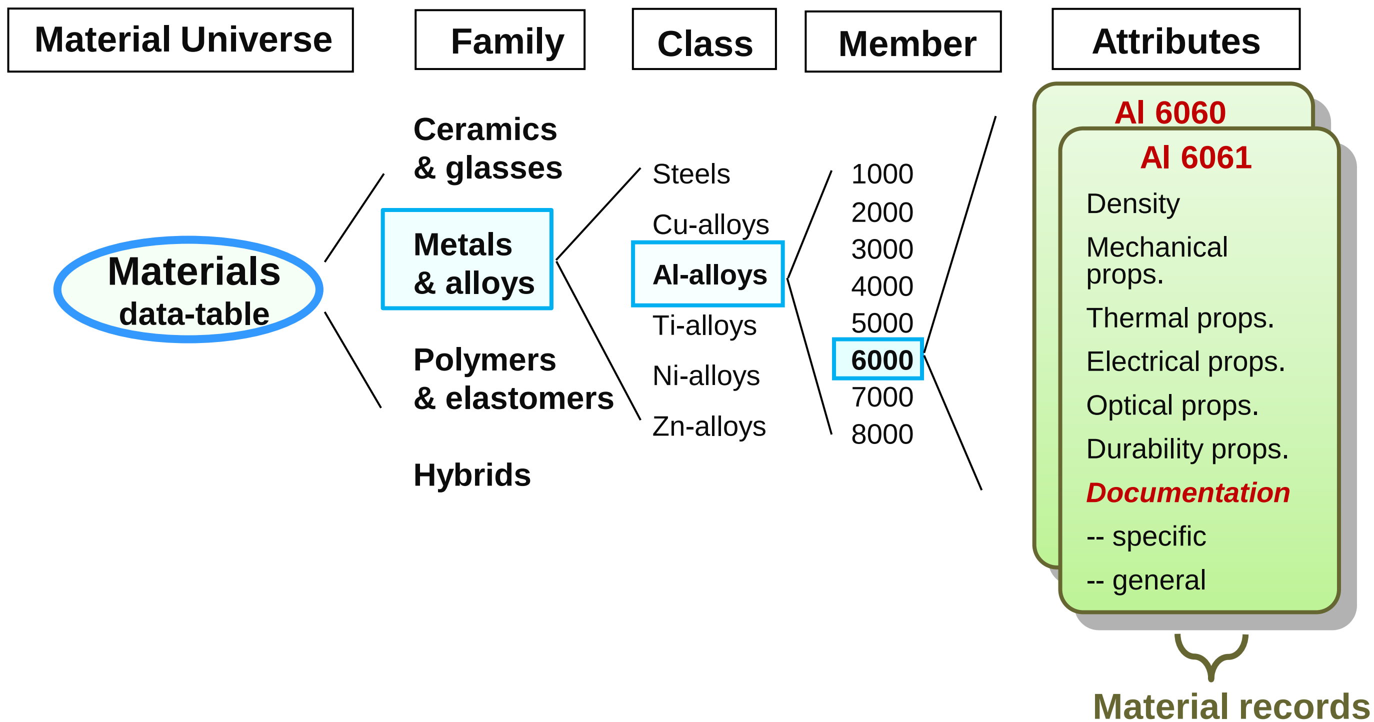
Environmental notes. The acrylonitrile monomer is nasty stuff, almost as poisonous as cyanide. Once polymerized with styrene it becomes harmless. ABS is FDA compliant, can be recycled, and can be incinerated to recover the energy it contains.

*Excerpts from *GRANTA EduPack* Level 2

Organizing information

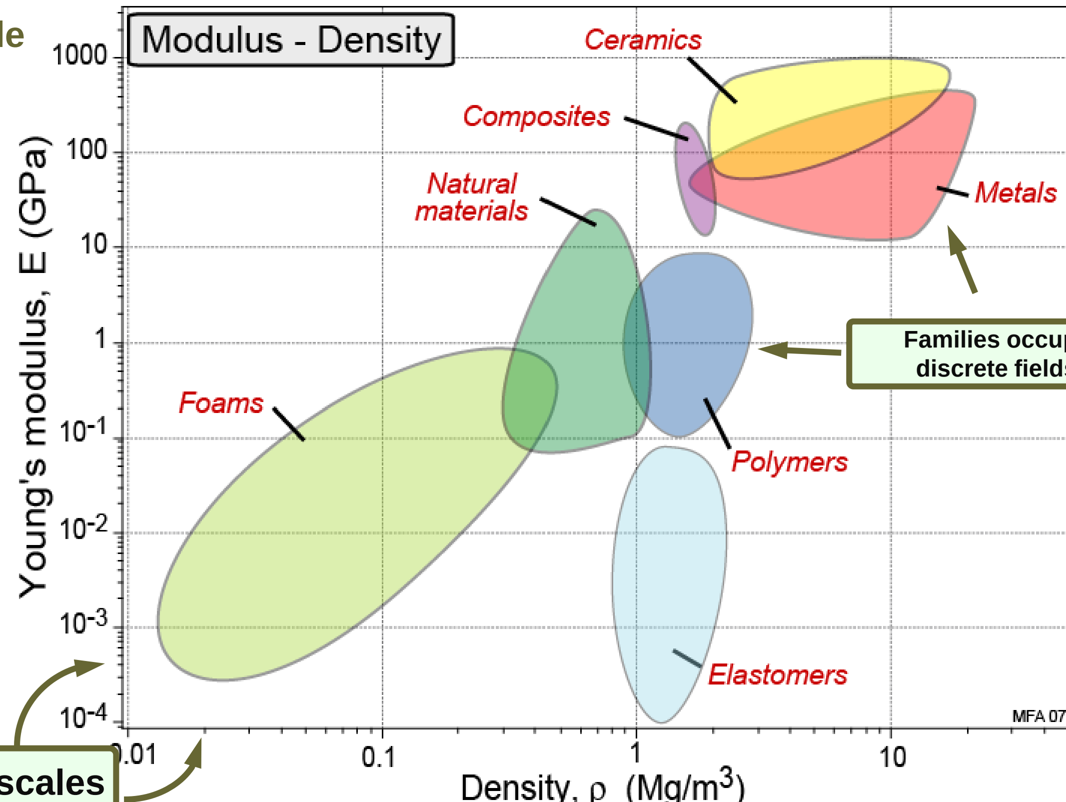


Organizing information: the MATERIALS TREE



Material property charts (Ashby diagram)

Bubble chart

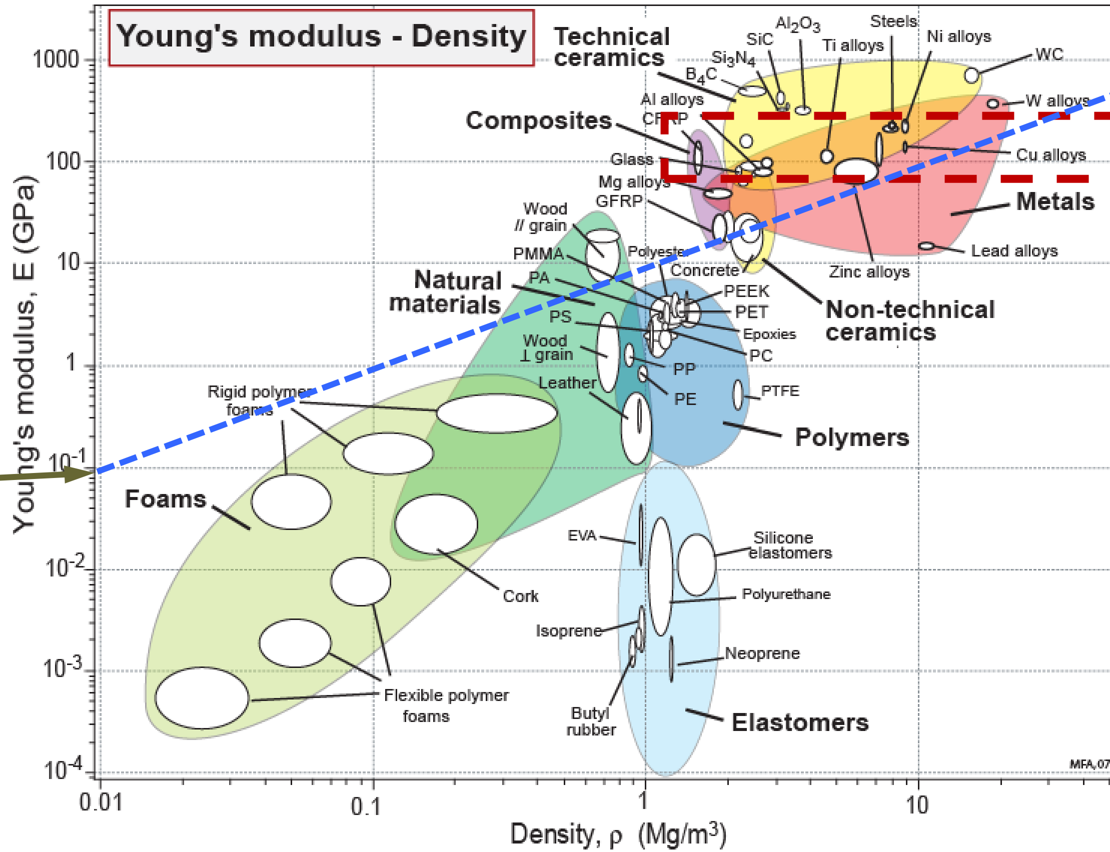


Families occupy discrete fields

Log scales

Application of Ashby diagram in design

Display line:
Materials with constant specific stiffness [E/ρ]



Display Box:
Materials with high Modulus and Density

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Introduction of flipped classroom & group work

Please watch the 1 minute video about the Flipped Classroom teaching method used in our course. Click [What is a flipped class?]() link to open resource.

Flipped Classroom

Limited traditional lecturing

self-study using textbook

Class time is used for discussion and feedback

send questions beforehand, so teachers can prepare

Tasks to be done before each class

guidance and self-assessment for studying from textbook

Review the course content
from the textbook and online lecture

**Group discussion and analysis
of the previous task**

mutual feedback

**Questions
collective discussion**

Self-assessment & peer feedback

Explain next task

Preparation & questions

Group discussion & presentation

- Please turn on the **camera** in group discussion
- **Moderator**: Min. {Birth month (day)}

- **Explain** your answers/analysis for each task;
- Give **feedback/assessment** to the results of your peers;
- Share your **questions/concerns** during the learning experience
- Self-assessment and peer feedback to formulate a **perspective** on the learning outcomes
- Decide **persons/form** present the findings from your group in the flipped classroom

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Task and task assessment criteria and grading

Tasks

5 tasks planned and one week to solve one task

The task is a tool for guidance and self-assessment of independent study with the textbook; each task contains at least two subtasks, and your report of the task is used to discuss and compare in class how each of you did it

- 0 point: you fail to submit the report, or the report fails to address the tasks
- 1 point: you make clear that you read the textbook and tried the subtask
- 2 points: you completed the task in a way that makes clear that you understood the textbook, or asked a good question about where you got stuck
- 3 points: a model answer, with clear & concise explanations, and exemplary language and presentation

At the end of the course, a review task gives you a second chance for the topics covered in weekly tasks

- 1 point: you completed the task in a way that makes clear that you understood the textbook
- 2 points: a model answer, with clear concise explanations, and exemplary language and presentation

Peer feedback (Task assessment)

MyCourses "Workshop" environment

At the submission deadline, it randomly allocates you three other reports to "assess" and compare with your own

You give points to your peers' reports, as well as an explanation

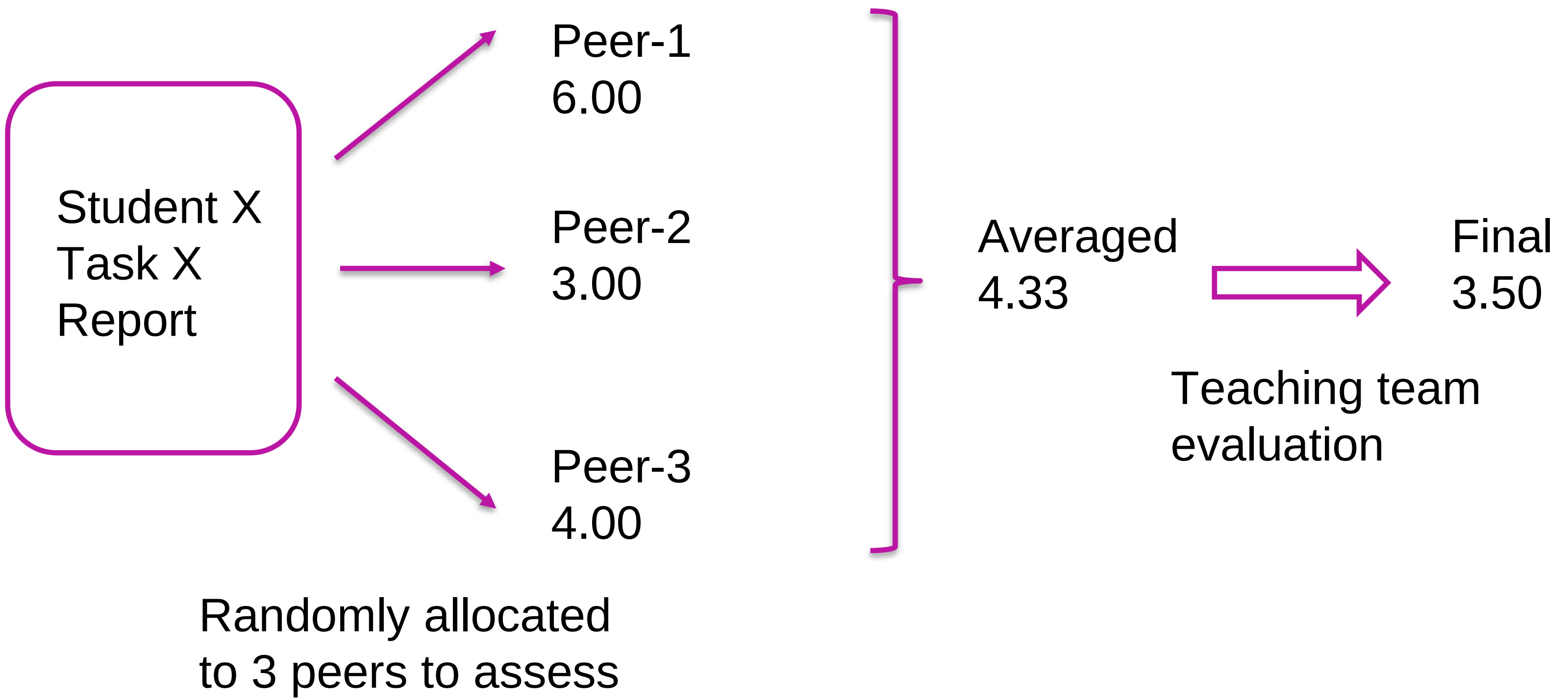
After the assessment deadline and evaluation by us, it shows you the assessments of your task report by your peers

Peer feedback is to be finalized soon after the session

The assessment by your peers may be overridden by the teaching group

You also receive participation points for submitting your work (or questions) on time & providing feedback during flipped classroom

Submission, assessment and evaluation



Submission, assessment and evaluation

Student X
Task X
Report

Peer-1
6.00 (~1.0)

Peer-2
3.00 (~2.0)

Peer-3
4.00 (~2.0)

Averaged
4.33

Final
3.50

Teaching team
evaluation

Randomly allocated
to 3 peers to assess

Introduction to Task 1

Read chapters 3, 4, and 5 (the 4th edition) of the course textbook.

The goal of the task is to understand:

- *how materials selection can be done at **different levels** of detail, going into more detail iteratively as the design progresses*
- *how to derive a **material performance index** from the formulation of a performance objective,*
- *how to use a material performance index in material selection, and*
- *how to graphically represent this with **material selection lines** on a **material property map***

Questions?

- Please avoid emails and use the forum on MyCourses!
- Detailed **Task 1** description will be open on **Friday afternoon**
- Report submission DL is **10:00 Next Friday**
- Finish the assessment of **Task 0** by the DL **18:00 on Next Monday**