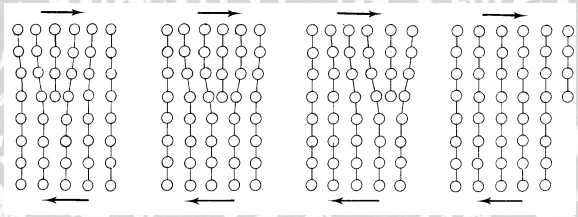
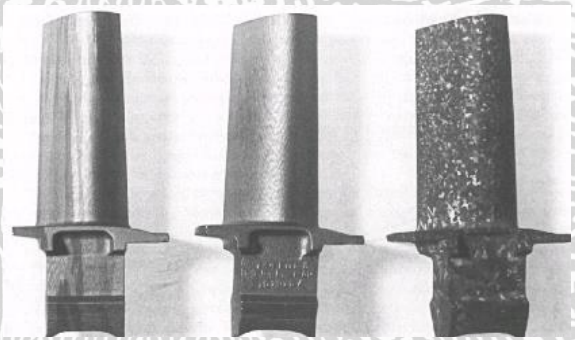
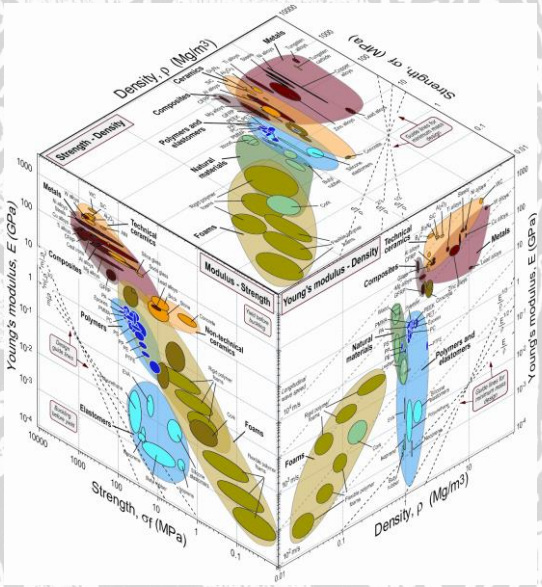
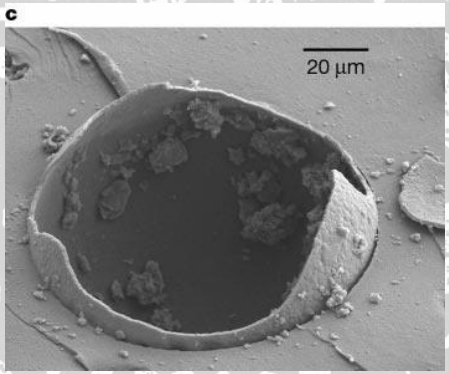
MATERIALS SCIENCE

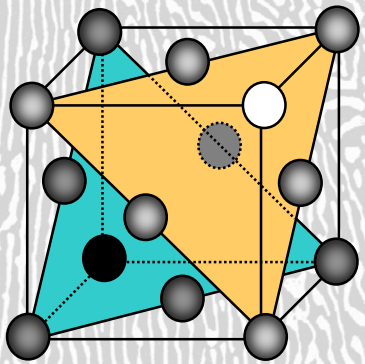
How to create nucleation and growth in student learning of materials science?











Ton Bor

EDUCATION AT UNIVERSITY OF TWENTE

WHY WOULD STUDENTS COME TO TWENTE?

- Small university (10,000 students)
- Personal atmosphere
- Beautiful campus
- Project based education
- Nice city
- High student room availability

UNIVERSITY
OF TWENTE.

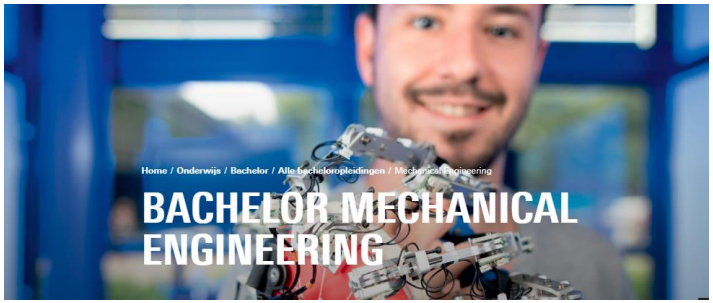
BACHELOR EDUCATION AT UNIVERSITY OF TWENTE

RECENT APPRECIATION OF EDUCATIONAL PROGRAMMES

All UT bachelor programmes at a glance

BACHELOR MECHANICAL ENGINEERING
TWENTE EDUCATIONAL MODEL

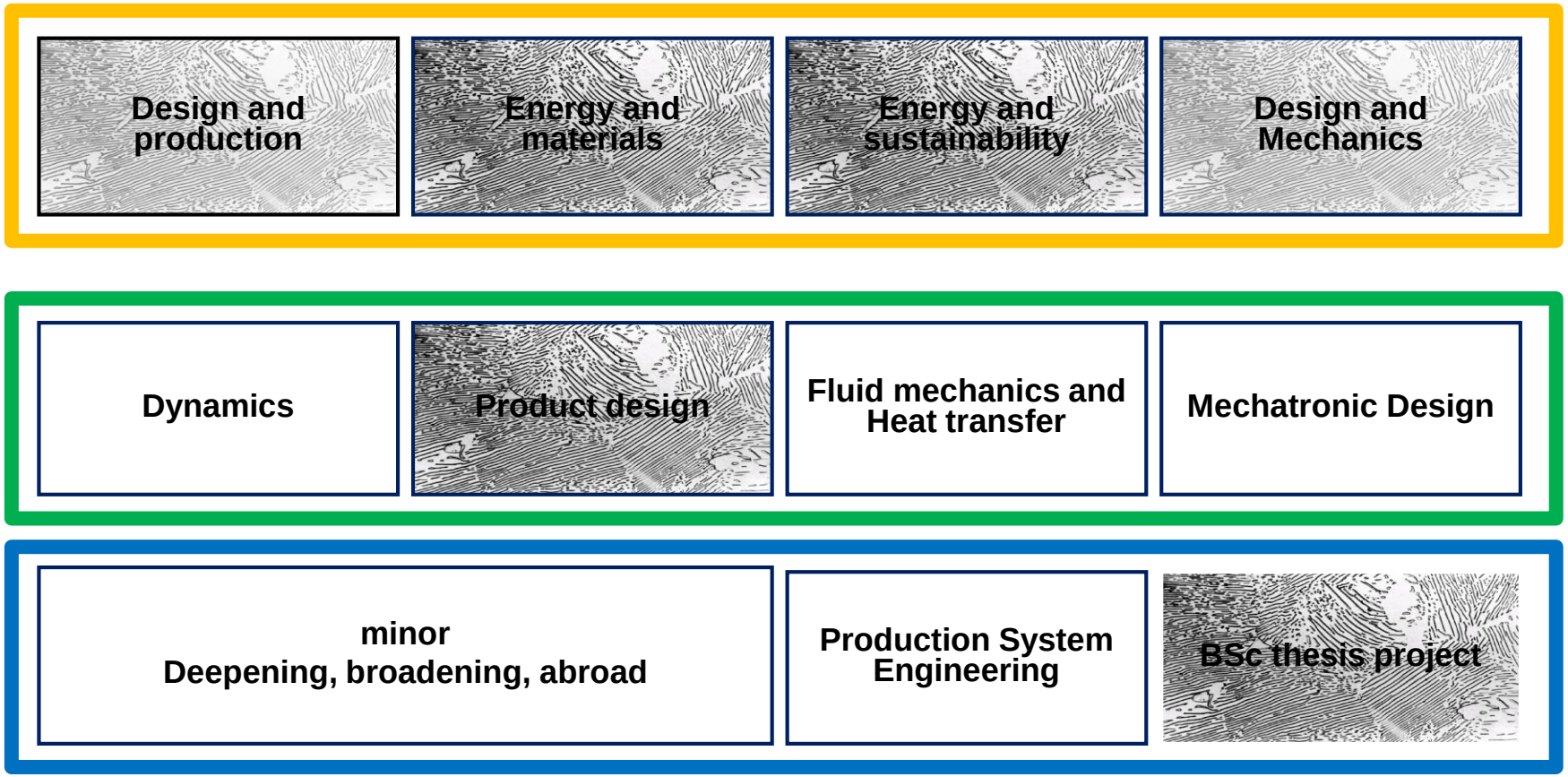
- Project based education (TEM)
- About 240 BSc Mechanical Engineering students
- 30 % international students
- Fully English program



- In parallel: development of new Mechanical Engineering bachelor program in co-operation with the VU in Amsterdam.
- Start: September 2019
  - About 70 students
  - (Inter)national students
  - Fully English program

BACHELOR MECHANICAL ENGINEERING

TWENTE EDUCATIONAL MODEL (REGULAR PROGRAM)



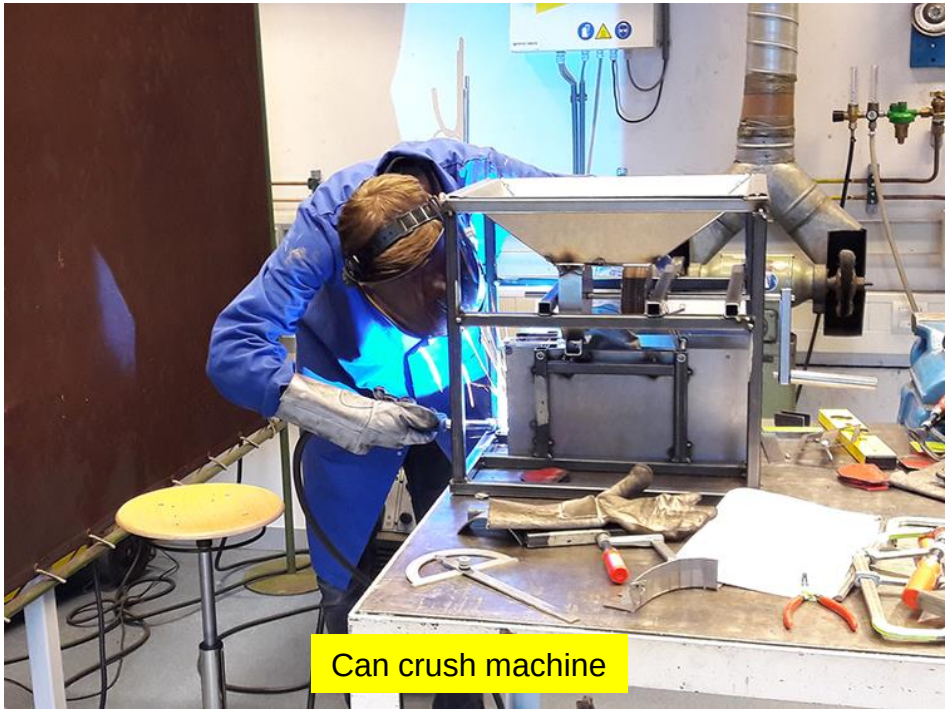
FIRST YEAR

MODULE 1: DESIGN AND PRODUCTION

Project 1: Manufacturing of a non-existent tool

- Intro to Materials Science (metals)
- Manufacturing technologies
- Statics
- Technical drawing skills

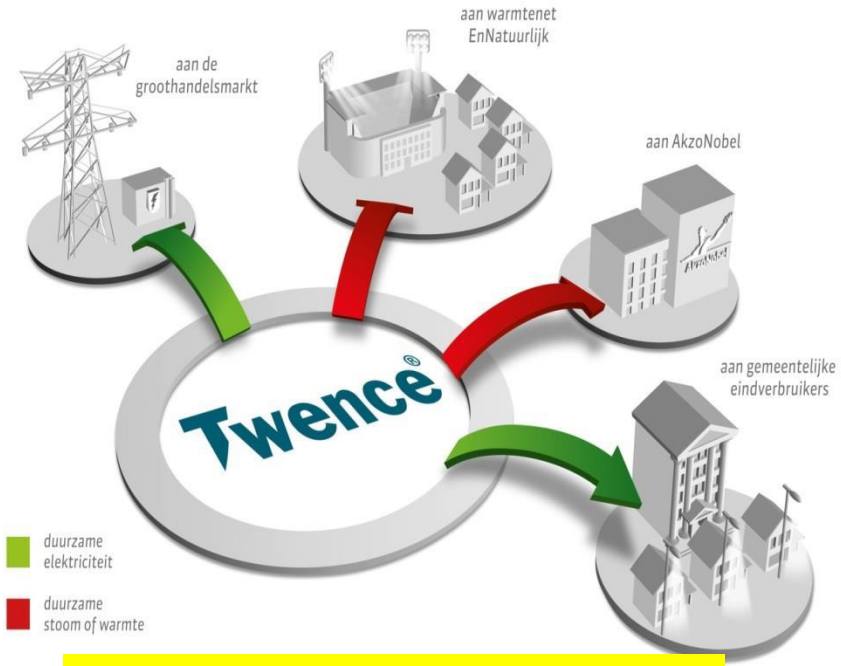
Muscle force measurement device



Can crush machine

Project 2/3: Analysis and design of an energy system

- Materials Science I & II (metals)
- Engineering Thermodynamics
- Sustainability / Life Cycle Analysis



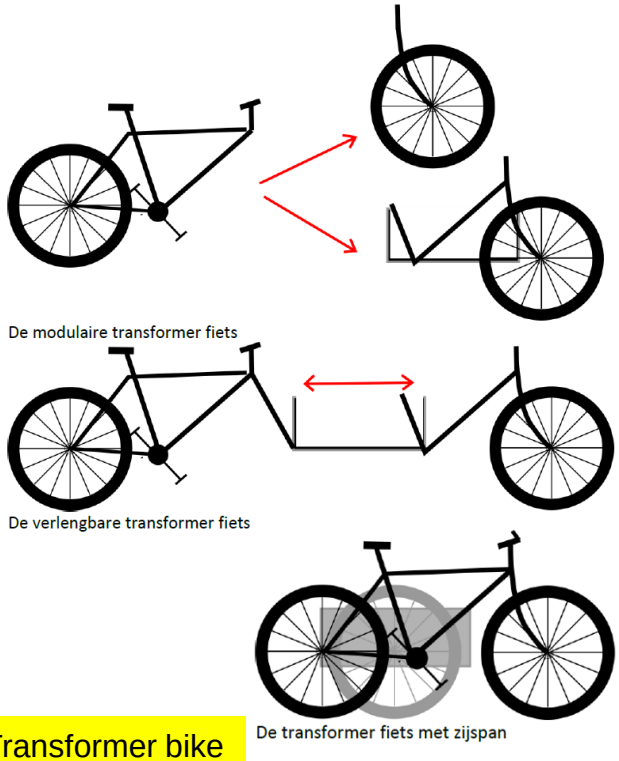
Hengelo based waste incineration Twence

Solar power station

Geothermal power station

Project 4: Design mechanical structure

- Mechanics of Materials
- Machine elements



Transformer bike

Bicycle taxi

Lift systems for removal of old oil rigs

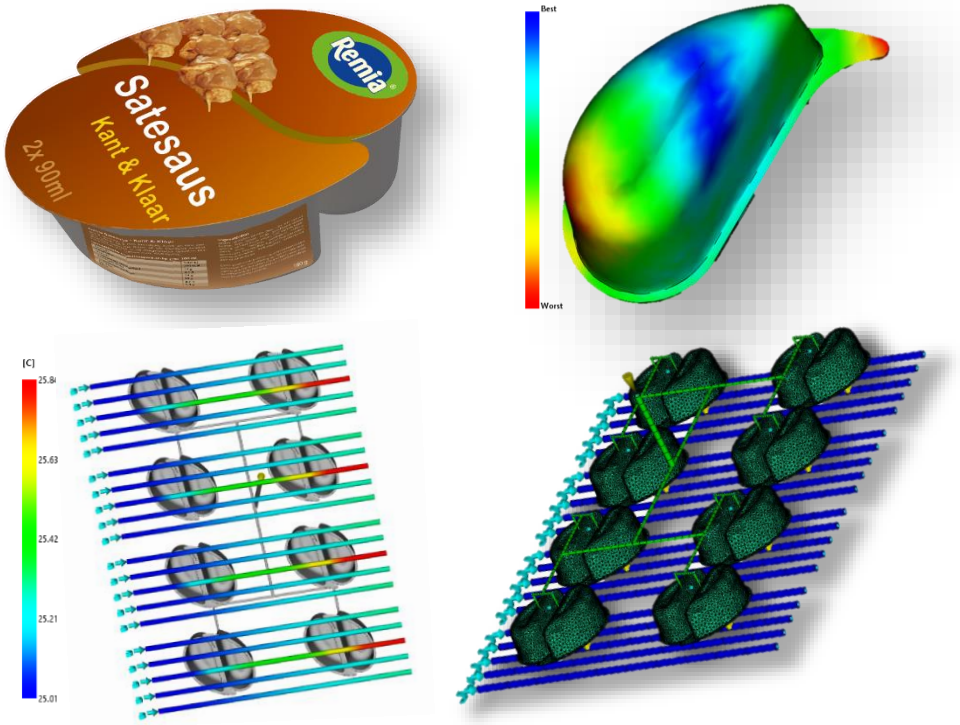
SECOND YEAR

MODULE 6: PRODUCT DESIGN

Project 6: Consumer product (ME, IDE, IEM)

- Processing and properties of polymers
- Tribology
- Elasticity theory
- Specializations:
  - Designing in Plastics
  - Mould Design
  - Simulation of Injection Moulding

Smart workspace (Ahrend)



Satay sauce packaging (Remia)

THIRD YEAR

MODULES 9/10: MINOR

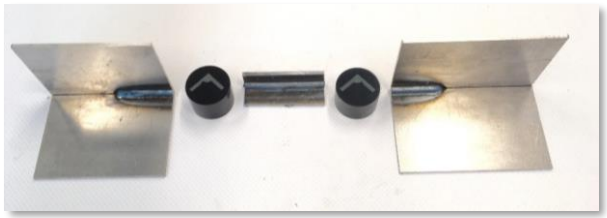
Materials science related minors Mechanical Engineering

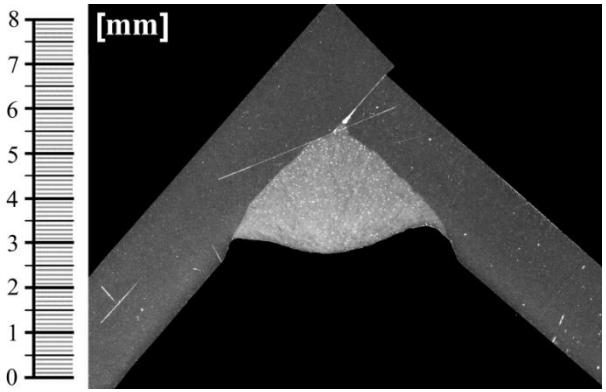
- Materials for the design of the future
- Aircraft Engineering
- Student teams (Solar team, Green team, ….)

THIRD YEAR

MODULES 12: BACHELOR ASSIGNMENT

Research and/or design project carried out in one of the ME research chairs





MATERIALS SCIENCE 1 & 2

MY APPROACH TO TEACHING MATERIALS SCIENCE

Materials Science 1 (3.5 EC) & MS2 (1.5 EC)

- Provide information in appealing order
  - *For a mechanical engineer Materials Science is a way to select materials and understand material behavior up to a certain level and not truly driven by inherent curiosity.*
  - *So, education should be directed towards the need for understanding.*
- Is there an engaging example from daily life that explains the phenomenon?
- Provide various ways of training
  - *practicals: CES Edupack (MS 1), Hands-on (MS 2) + poster*
  - *Homework assignments*
  - *Materials Science Exercise Platform*
  - *Old exams & answers*
- Create a safe and positive environment for fruitful interaction in the lecture room
- Have a bit of patience and humor

MATERIALS SCIENCE 1

LEARNING OBJECTIVES (3.5 EC)

On completion of this course, you will be able to:

1) Describe the structure of materials and explain what consequences the structure has for material properties;
2) Determine relevant mechanical properties from the results of tensile tests and hardnesss measurements;
3) Explain how materials can fail and undergo plastic deformation under various conditions of production and use;
4) Explain the influence of heat treatments on material structure and properties;
5) Perform simple analyses as a basis for the optimum production and use of materials;
6) Select materials for certain applications with the aid of a performance index.

Not truly appealing…, so:

MATERIALS SCIENCE 1

OPTIMIZE PRESENTATION ORDER

The order of presentation that works for me:

Mechanical properties
tensile test, hardness

Failure and plastic deformation
brittle vs ductile fracture, creep, toughness

Material selection
on basis of performance index

Material microstructure
crystal structure, dislocations, strain hardening, xrd

Heat treatments
recovery, recrystallisation, grain growth

Optimization
fatigue, creep life, carburization

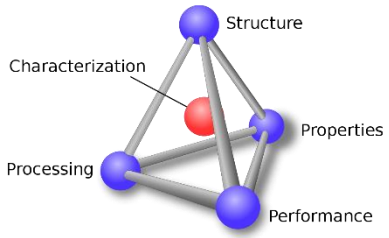
What are the properties of materials?
How do materials fail?

⇩

How to choose materials?

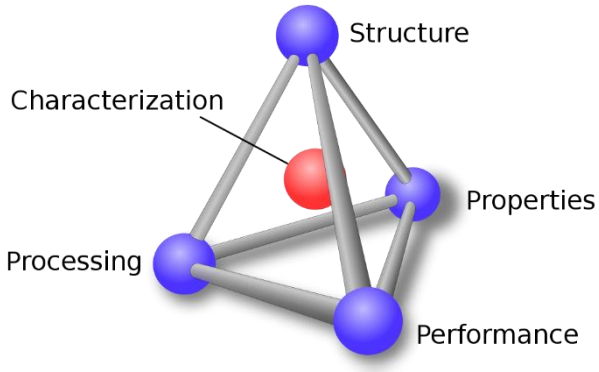
⇩

To answer you need to understand origin of material properties



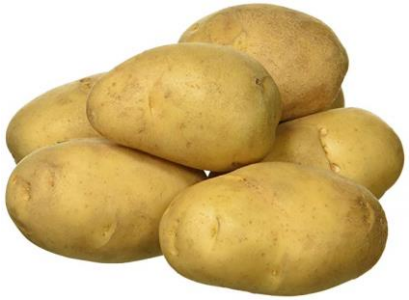
MATERIALS SCIENCE 1

DAILY LIFE?



Relation food processing
and
material heat treatments

Constant composition

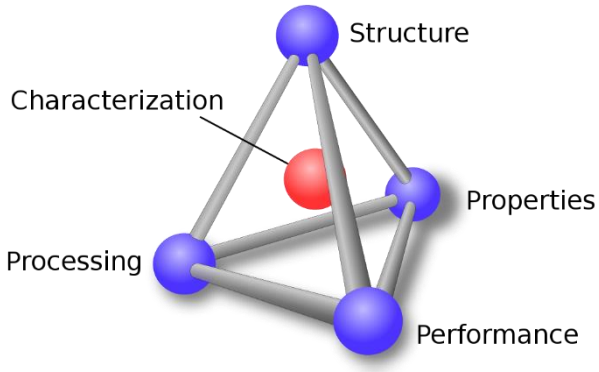


Different heat treatments

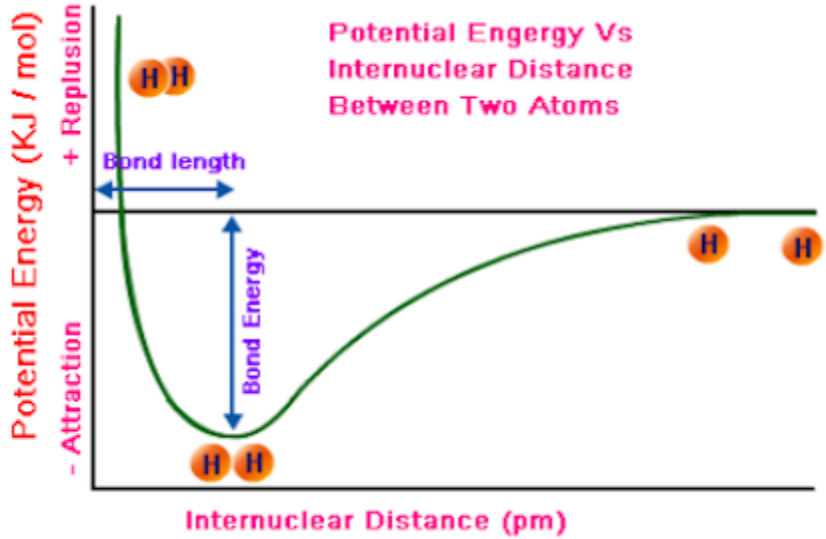
Different properties

MATERIALS SCIENCE 1

DAILY LIFE?



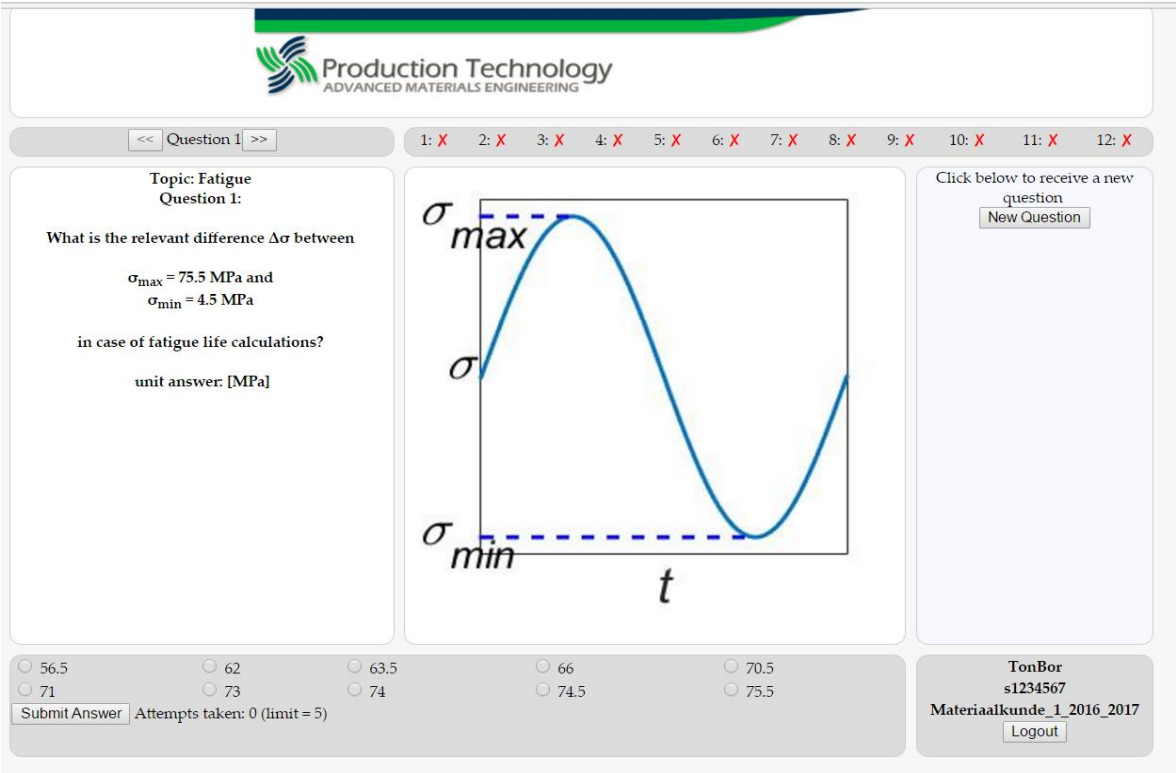
Atomic interaction
vs
human interaction



=

MATERIALS SCIENCE 1

MATERIALS SCIENCE EXERCISE PLATFORM



- 12 compulsory questions
- Individual input data
- Multiple choice
- Maximum of 5 attempts per question

Advantage: individual training of students

Disadvantage: "freeware" Matlab programs available solving the questions without proper understanding. However…

MATERIALS SCIENCE 2

LEARNING OBJECTIVES (1.5 EC)

On completion of this course, you will be able to:

1) Predict the microstructure of simple iron alloys and other alloys with reference to phase diagrams and time-temperature-transformation diagrams;

2) Explain the course of phase transitions such as solidification, precipitation and martensite formation;

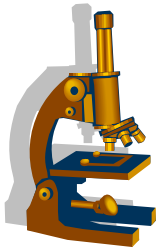
3) Explain how and why the microstructure of iron, steel and other alloys needs to be modified to ensure reliable material behaviour at very high and low temperatures;

4) Recognize the main corrosion mechanisms and suggest possible ways of preventing corrosion.

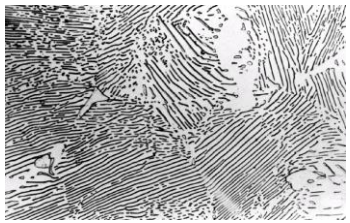
MATERIALS SCIENCE 2

PRACTICALS: 3 PARTS / STUDENT

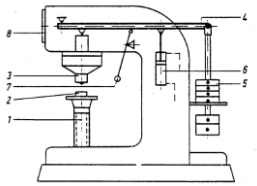
Part I



Microscopy 1

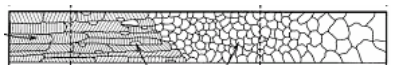


Microscopy 2



Hardness

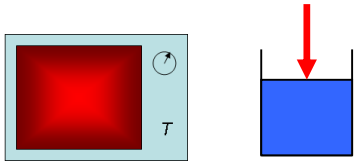
Part II



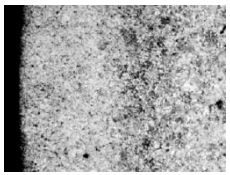
Tensile test

Rolling

Part III



Hardening



Carburizing

MASTER MECHANICAL ENGINEERING

SPECIALIZATIONS (FROM SEPTEMBER 2020)

Master Mechanical Engineering

- ***High Tech Materials & Systems***
- ***Design and Manufacturing***
- ***Aeronautics***
- ***Maintenance***

- Energy and Flow
- Robotics
- Personalized Health Technology

Master Mechanical Engineering and Chemical Engineering

- ***Materials Science and Engineering (provisional title, still in development)***

MASTER MECHANICAL ENGINEERING

HIGH TECH MATERIALS & SYSTEMS

- Frontiers in High-Tech Systems and Materials
- Continuum Mechanics
- **Solids & Surfaces**
- Fluid Mechanics 2
- Structural Dynamics
- Control for (Bio-)Mechanical Engineering
- **Plastic & Elastomer Engineering**
- **Design, Production & Materials**
- Design Principles for Precision Mechanisms 2
- Advanced Topics in Finite Element Method
- Fundamentals of Numerical Methods
- **Experimental Methods**

Choose 6 out of 12

How to create nucleation and growth in student learning of materials science?

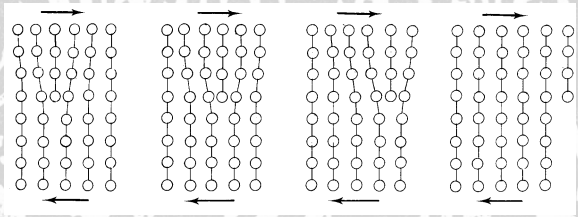
- Small scale university with intensive project-based education
- Materials science is well integrated in bachelor and master curriculum
- Students understand relevance of Materials science.

→ **Sufficient "nuclei" present for "growth"**

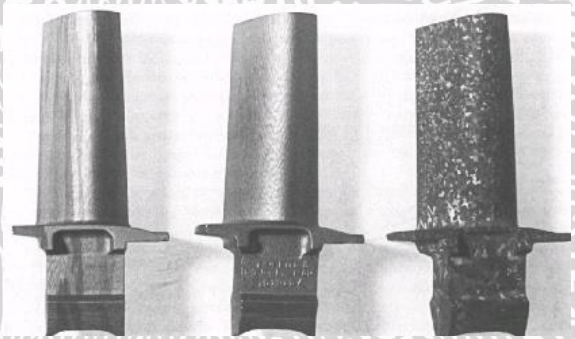
- However: most concepts introduced in first year bachelor are hardly used in later stages
- Master phase provides rehearsal bachelor knowledge
- Potential room for broader/deeper coverage of Materials science field

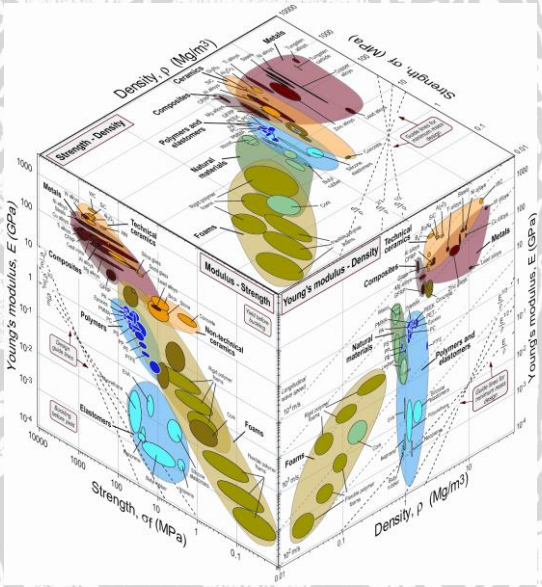
→ **"Growth" needs a bit of driving force!**

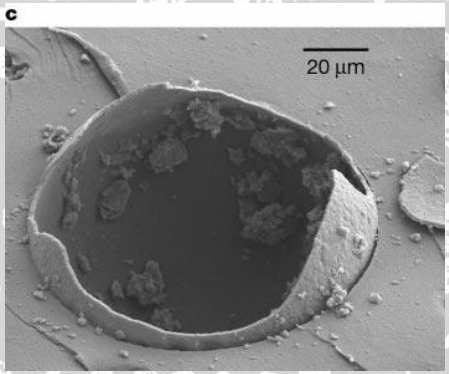
MATERIALS SCIENCE



Thanks!







Questions?