Welcome at the online TU/e Graduate School Event

Master Systems and Control (S&C)

Erjen Lefeber, assistant professor (ME, D&C Group)

Saray Bakker, student MSc S&C

Today’s program:

- Presentation Master’s & pre-Master’s program S&C (30 min)
- Time for questions (15 min)

CONTENT

- **Brainport region**
- Systems and Control: why?
- Systems and Control: what?
- After graduation
- Studying S&C at TU/e
- Systems and Control pre-Master program
- Application / More information

Top-ranking Dutch university

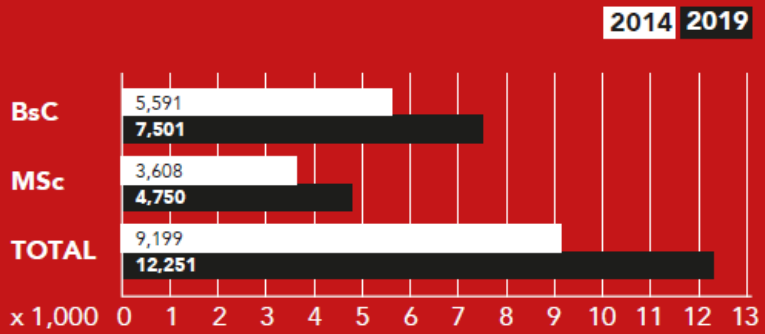
At the heart of the Brainport region

Strong technology heritage in Eindhoven

The Netherlands → Brainport → Eindhoven

Accounts for 23,1% of total Dutch private R&D expenditure*

Student growth



Engineers for the future

More than **93** nationalities

86% Dutch
14% International

73% Male
27% Female

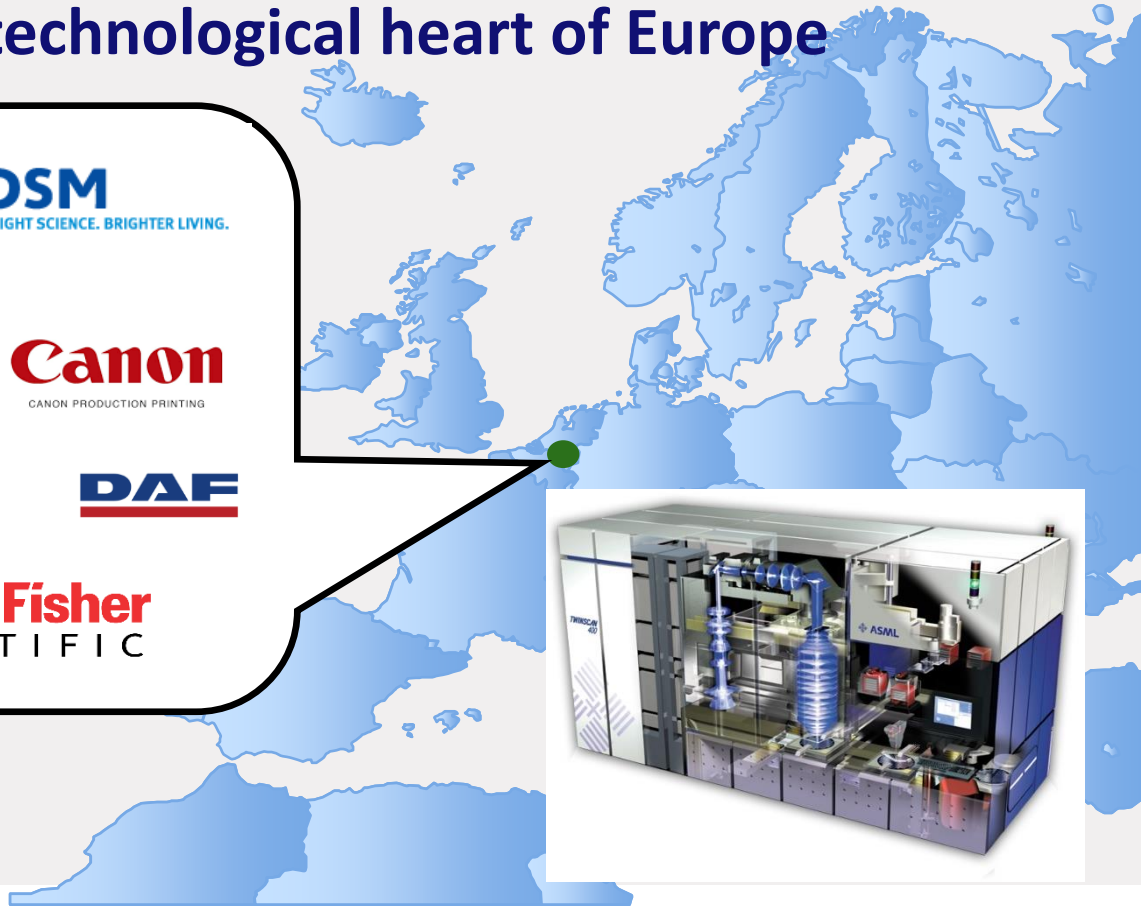
12,251 total number of students

92% of the graduated students finds a job within 6 months. Nationwide this is 89%

3,298 total degrees awarded
1.441 BSc / 1.455 MSc
120 PDEng / 282 PhD

59,341 total number Alumni
83% Male, 17% Female

Brainport: the beating technological heart of Europe



TU/e

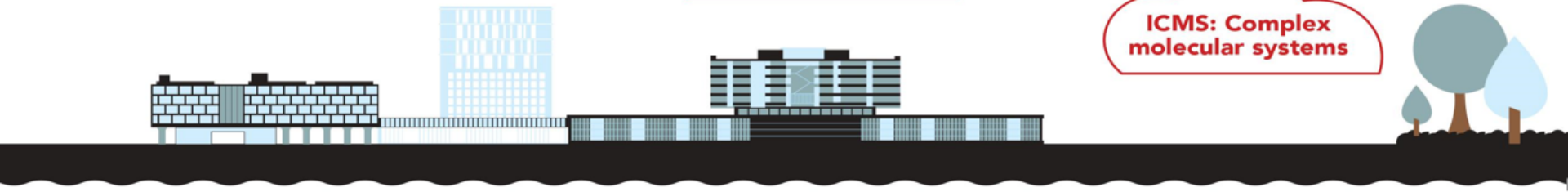
The TU/e campus covers an area of 75 hectares

EIRES: Energy transition

3 Interdisciplinary research institutes

EAISI: Artificial intelligence

ICMS: Complex molecular systems



Ecosystem and characteristics

- **47** new patent applications
- **7** patents filed by third parties
- **29** provisionals converted
- **35** transferred via a transfer or license
- **2747*** Scientific publications
- **54** New start-ups and spin-offs
- **15** Large research labs
- **50** Smaller research facilities

International working environment

3,301.3 Total staff (fte)

2,122 Research staff (fte)

- 64.3% Dutch
- 35.7% International
- 61.5% Male
- 38.5% Female

- 154 Full professors
- 138 Part time professors
- 144 Associate professors
- 300 Assistant professors
- 1,572 PhD fellows

Rankings:

- CWTS Leiden Ranking 2020: **TU/e no. 4 in industry cooperation**
- Times Higher Education: 2021 **no. 187 of 1000**
- QS-Ranking 2021: **no. 120 of 1003**

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- **Systems and Control: why?**
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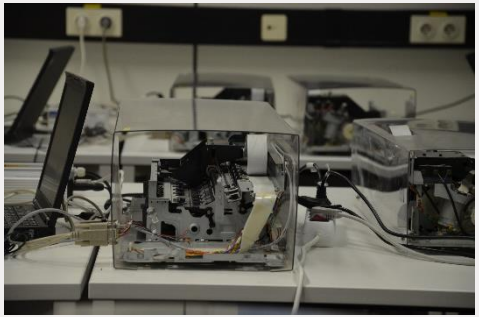
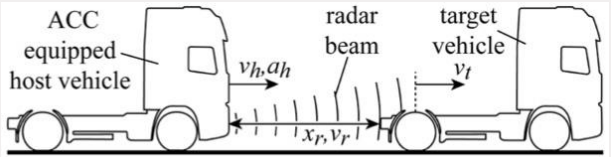
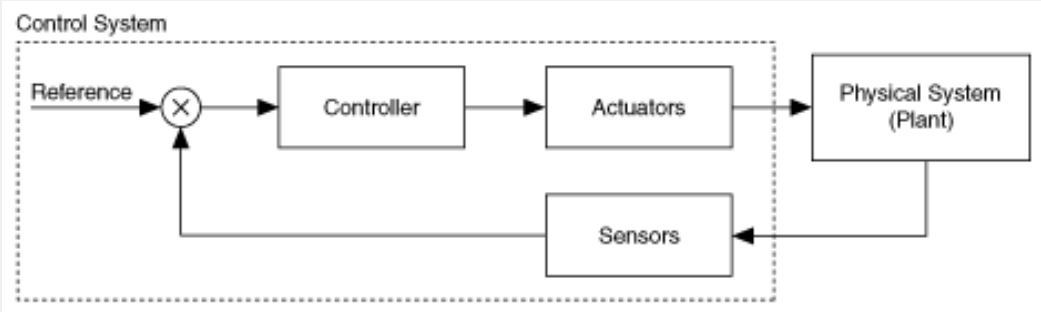
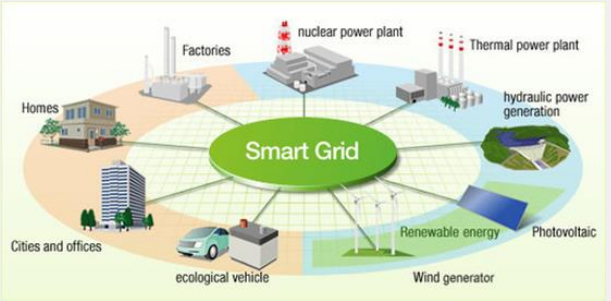
Systems and Control

- Plant
- Sensor
- Actuator
- Controller









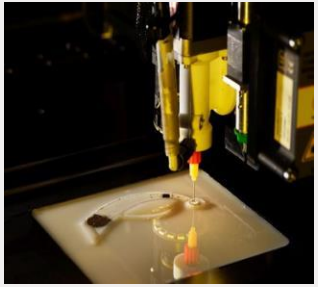
Systems and Control

- Technological contributions in many fields
- Hidden but crucial technology
- Generic theory for many applications
- Applications in high tech industry, communication, health, 3D printing, etc...
- Key ingredient of AI for engineering systems

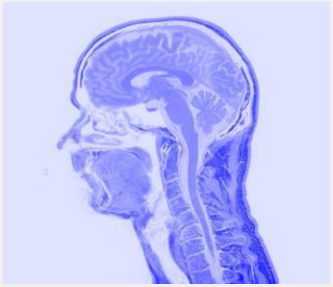
Automotive applications

Energy distribution

Communication



Additive manufacturing



Health and care

Aviation systems

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Systems and Control: an interdisciplinary study

TU/e
Mechanical
Engineering

TU/e
Electrical
Engineering

Partner universities:

TU Delft Delft University of Technology

TU/e Technische Universiteit Eindhoven University of Technology

UNIVERSITY OF TWENTE.

WAGENINGEN UR For quality of life

4TU.

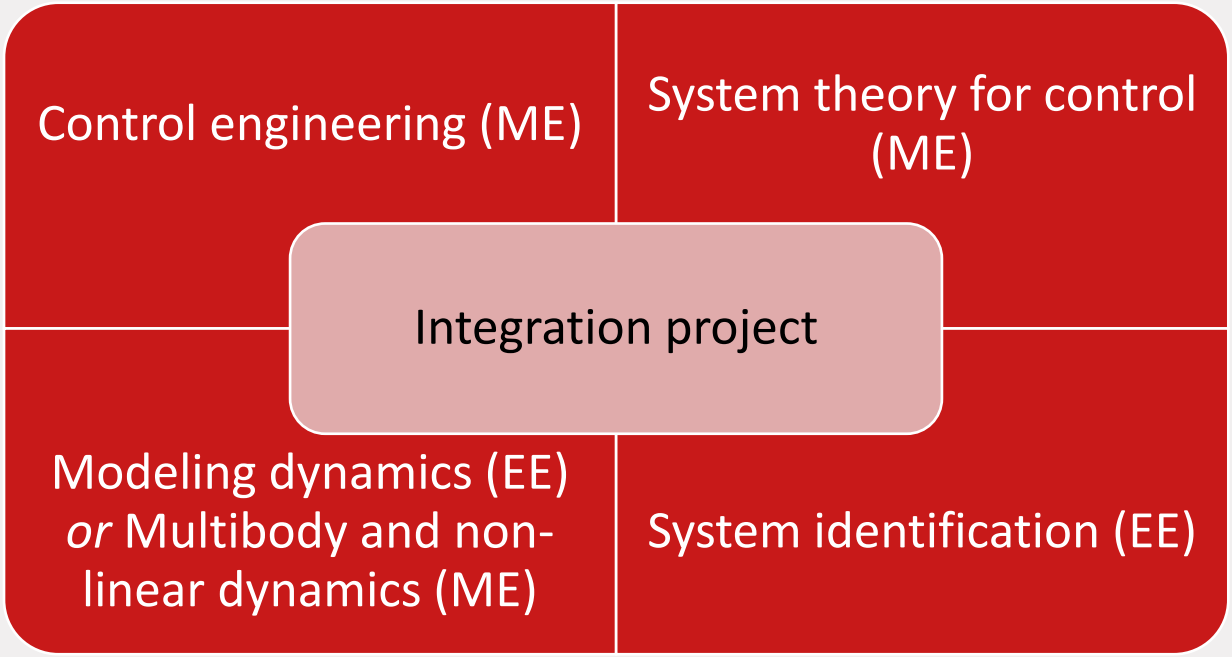
TU/e

Program overview

1st year	• **Core program (25 EC)** • Specialization courses (20 EC) • Free electives (incl. homologation, 15 EC)	
2nd year	Internship (15 EC)	Graduation project (45 EC)

**double degree with AI&ES is not allowed*

Education - core program S&C



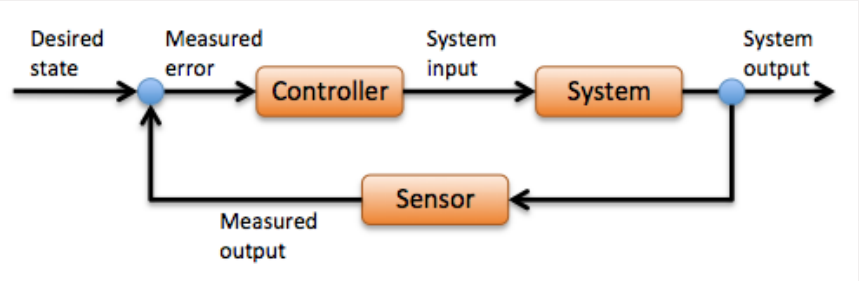
First year schedule

Quarter 1	Quarter 2	Quarter 3	Quarter 4
• Control Engineering • System theory for control • Homologation, or choice, or Modeling Dynamics*	• Multi-body and Non-linear Dynamics* • Choice • Choice	• System Identification • choice • choice	• Integration Project • choice • choice

*Students have to choose one of these 2 courses

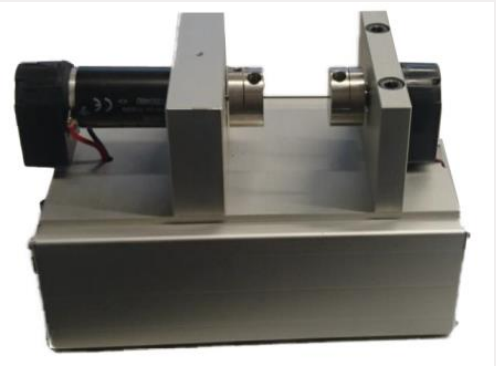
Choice = free elective or specialization

Education



Core courses (25 EC), compulsory:

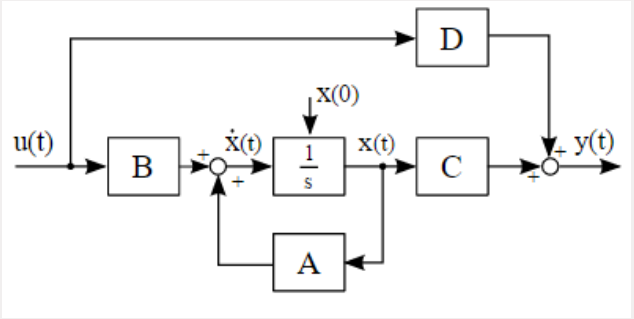
- **Control engineering**
- System theory for control
- Modeling dynamics *or* Multibody and non-linear dynamics
- System identification
- Integration project



Specialization courses (20 EC):

Choose in consultation with your mentor

Education



Core courses (25 EC), compulsory:

- Control engineering
- **System theory for control**
- Modeling dynamics *or* Multibody and non-linear dynamics
- System identification
- Integration project

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-2 & 0\\ 0 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix} u$$

$$y = \begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Specialization courses (20 EC):

Choose in consultation with your mentor

Education

Core courses (25 EC), compulsory:

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- System identification
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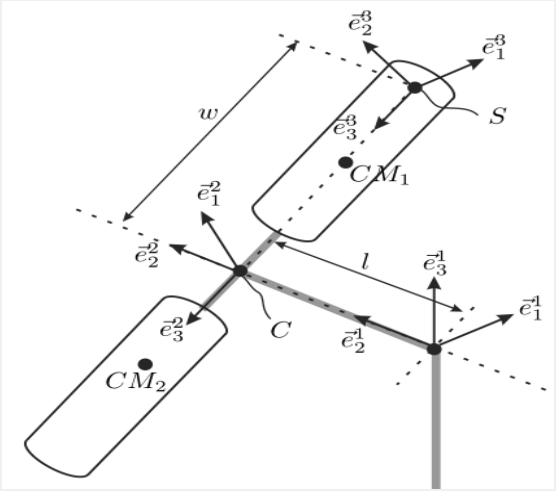

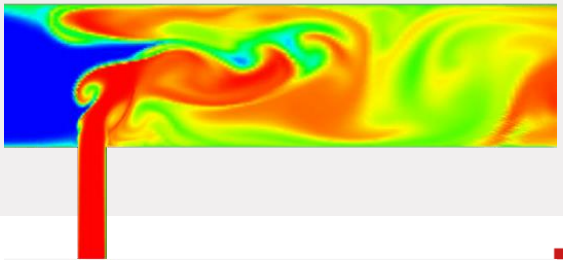

Education

Core courses (25 EC), compulsory:

- Control engineering
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- **System identification**
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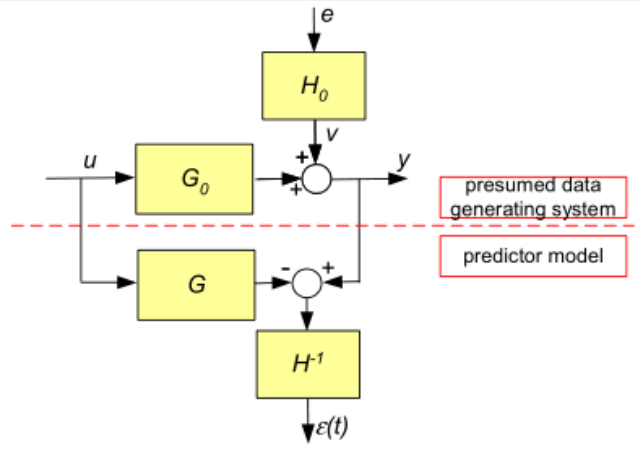
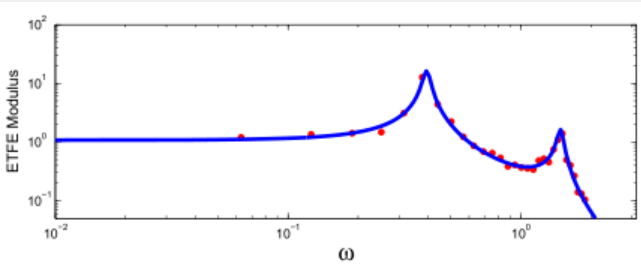
Specialization courses (20 EC):

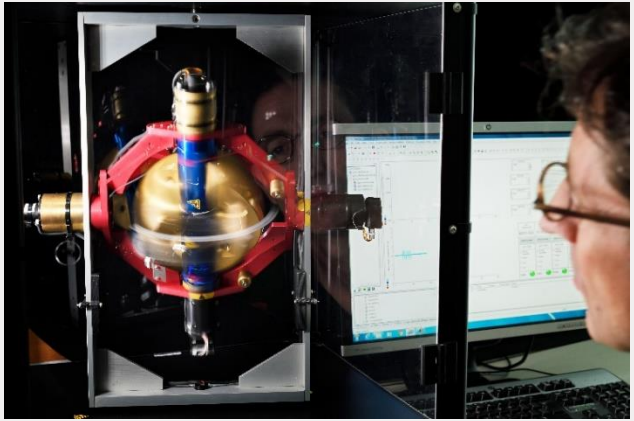
Choose in consultation with your mentor





Integration project

- Apply all knowledge from the other core courses
- Define the goal yourself on a given set-up such as a 3-DOF gyroscope or a drone
- Work in a multidisciplinary project team (+/- 4 members)
- Develop your professional skills



Foto's: Bart van Overbeeke

Specialization in the program

1st year	• Core program (25 EC) • **Specialization courses (20 EC)** • Free electives (incl. homologation, 15 EC)	
2nd year	**Internship (15 EC)**	**Graduation project (45 EC)**

- Curriculum = coherent, in line with specialization, guidance from mentor
- Internship and graduation project: independent work, explore new research questions, within university or in cooperation with industry

Sections S&C

- **Control Systems Technology /**
  prof. Steinbuch
  prof. Heemels

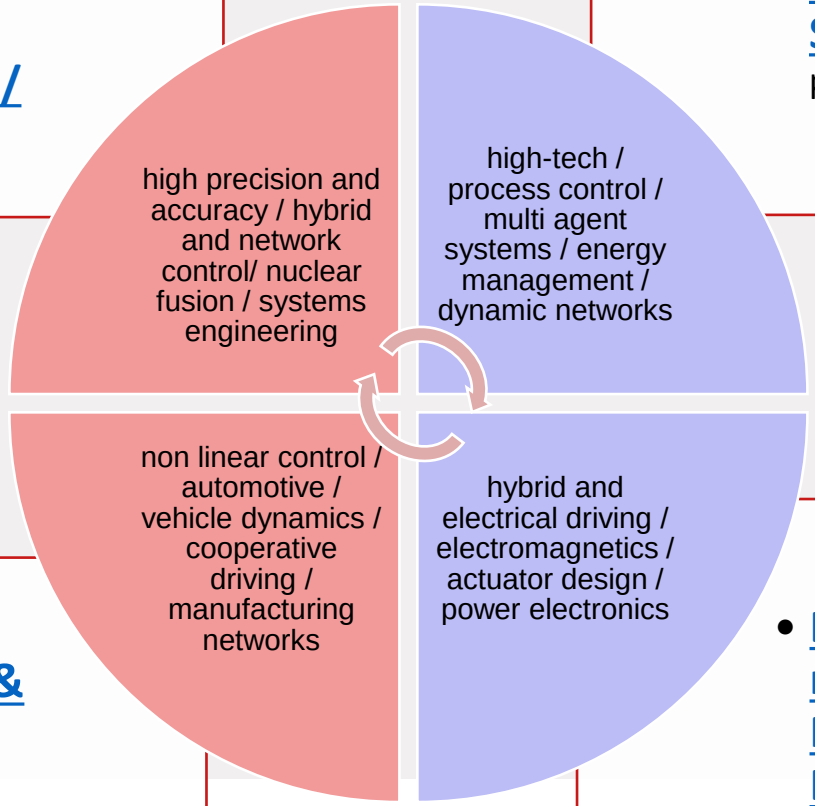

MECHANICAL ENGINEERING DEPARTMENT

- **Control Systems /**
  prof. Van den Hof

ELECTRICAL ENGINEERING DEPARTMENT

- **Dynamics & Control /**
  prof. Van de Wouw

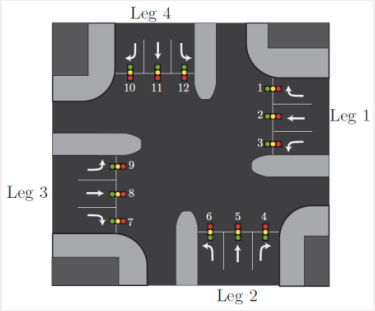
- **Electro - mechanics and Power Electronics /**
  prof. Lomonova



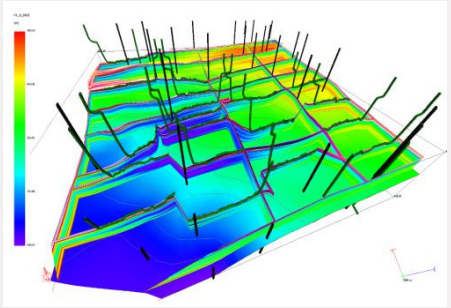
- TU/e world class in control:

  IEEE/IFAC Fellows, National and European Grants (ERC, VICI)
- Contacts and contracts with many industrial partners
- Staff members are authors and editors in top journals
- and have a world-wide network
- Spin-off companies
- Guiding and coaching research of close to 100 PhD students
- Follow-up PhD and graduate work in national Dutch Institute of Systems and Control (DISC)

Project examples



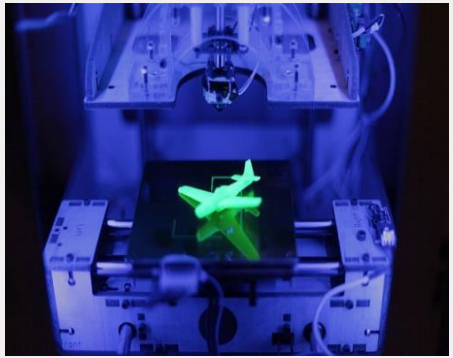
Cooperative vehicles and traffic control



Reservoir modeling and control

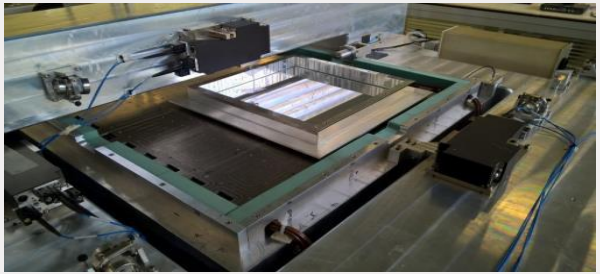
Energy distribution

Process control



3D printing: modeling and control

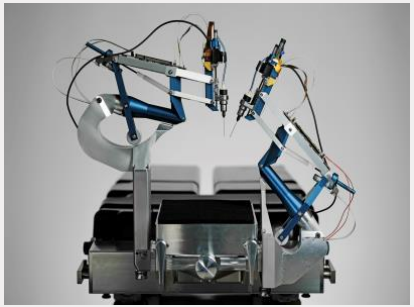
Project examples



Magnetically levitated planar motor

Active car suspension

Wafer scanner



Care and cure robotics

Mechatronic designs, cooperative robotics

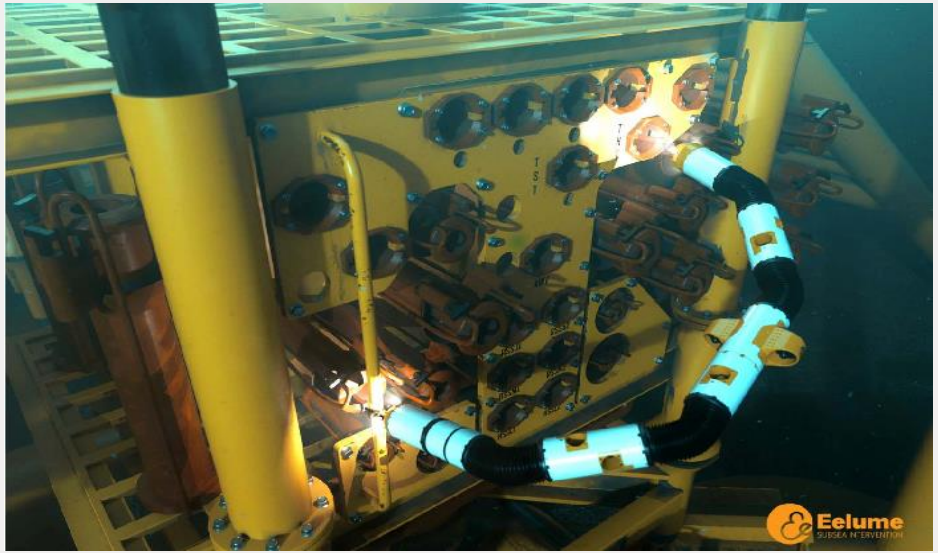
High tech for agriculture

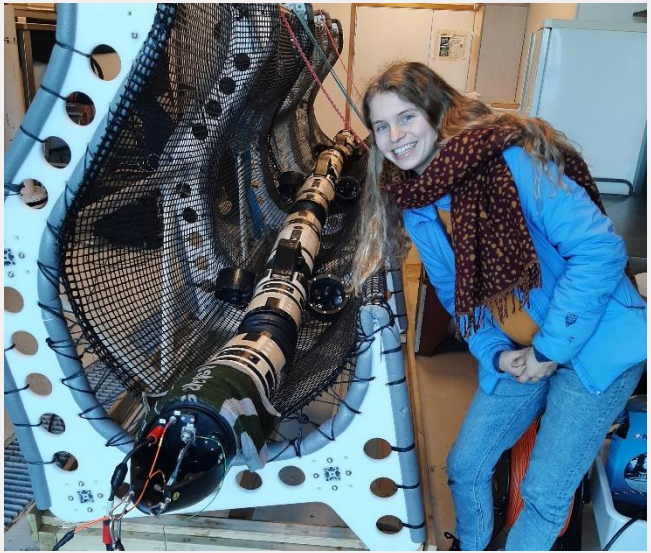
Examples of graduation projects

- “Nonlinear modeling for dynamic analysis of directional drilling processes.”
- “Robust control of an adaptive optics system under non-stationary turbulence conditions.”
- “Constrained Control of An interventional X-ray machine using Sampling-based Nonlinear Model Predictive Control”
- “Controlling structural deformation of a wafer stage: a disturbance-observer based approach.”
- …..

Internship project in Trondheim

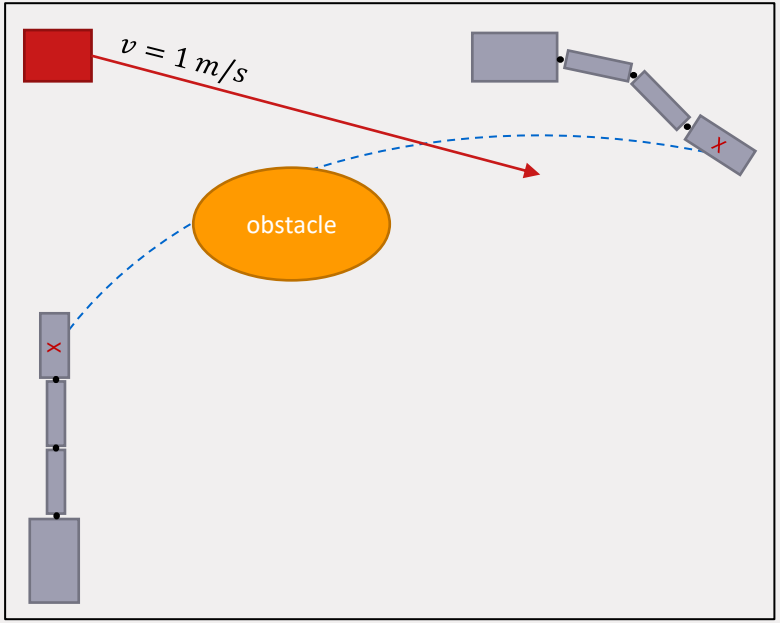
Interaction control for submarine snake robots





Graduation project @Philips

Model predictive control (MPC) with obstacle avoidance for medical robots



Coaching

- Mentor program: Full, associate or assistant professor
- Student mentor
- Academic advisor

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After graduation

Research:

- PhD (graduate school DISC)
- PDEng (Automotive Systems Design, or…)

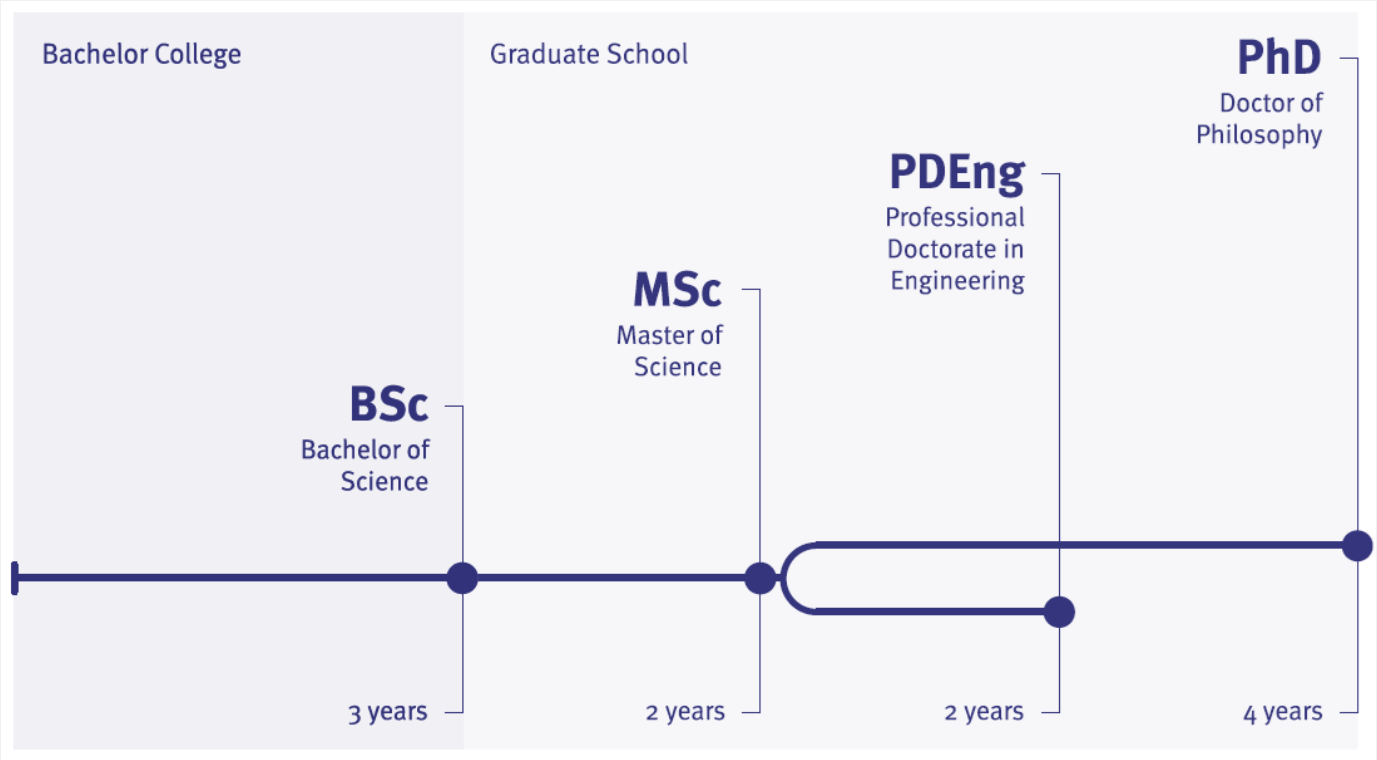
Industry:

- High-tech industry
- Aviation
- Process industry
- Health
- Automotive industry

Consultancy / Start-up / Spin-off company

Foto: Bart van Overbeeke

TU/e Graduate School – shape your own future!



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Studying S&C at TU/e

- Not easy!
- Small scale (approx. 50 students in year 1)
- Highly motivated peers
- Excellent job opportunities
- Good student evaluations

National Student Survey 2021 (1-5 scale):

Content	4.1
Lecturers	4.1
Academic guidance	4.0
General	4.0

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- **Systems and Control pre-Master program**

Pre-Master Systems and Control

- Duration: 1 years (30 EC)
- Time of entry: September
- Language: English

Why?

- Eliminate deficiencies

What?

- Program of 30 EC, to be achieved within one year
- Focus on mathematics (10 EC)

S&C pre-Master program 2021-2022

Compulsory courses			30 EC
quarter 1	2DL60	Linear Algebra	2.5
	2WBB0	Calculus variant 2	5
	5ESC0	DSP fundamentals (signals II)	5
quarter 2	2DL40	Advanced Calculus I	2.5
	4DB00	Dynamics and control of mechanical systems	5
quarter 3	4CC10	Mechatronic Design	5
quarter 4	5EMA0	Mathematics II	5

Mandatory trainings
- RSI (healthy use of laptop)
- Safety & environment

Recommended
- Matlab training

Difference WO & HBO (in general)

University of technology:

- **Developing** new technology and design methods to solve technological problems
- Education focusses on concepts and their implications
- Guaranteeing performance of controlled and engineered systems
- **Internship is a research project**

University of applied science:

- **Applying** existing technology and design methods to solve technological problems
- Education focusses on practical application
- Internship in industry

How to prepare during your bachelor's program?

- A pre-master's program is more work than one might think. You must be willing to work hard.
- It is not advised to do the pre-master in combination with a part-time job in industry.
- Subscription for a pre-master via Studielink before May 1st.
- required minimum level of mathematics: pre-university (VWO) mathematics B or TU/e mathematics B test completed before September 1st
- required minimum level of English proficiency: pre-university (VWO) level English or English language proficiency test completed before September 1st

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Admission with a BSc degree in:

- Aerospace Engineering
- Applied Mathematics
- Applied Physics
- Electrical Engineering (including Automotive)
- Mechanical Engineering

Prior education needs to be of sufficient academic level and quality to be able to complete this Master's degree program

Admission via pre-master's program with

→ Direct admission:

- Automotive
- Electrical and Electronic Engineering
- Mechanical Engineering
- Technische wiskunde
- Aviation / Aeronautical Engineering
- Engineering Physics
- Mechatronics

- Tailor-made pre-master's programs for other (university + HBO) diplomas via admission committee Admission.Mech@tue.nl

APPLICATION MASTER PROGRAMS

For Dutch students:

- More information about admission: www.tue.nl/admission
- Application via http://www.studielink.nl/
- Questions: studeren@tue.nl

For international students:

- Check the requirements for admission via www.tue.nl/admission
- Apply at the online application form (**available from 1 Oct – 1 May)**
- Application fee of €100 for each application (non refundable)
- Application procedure takes +/- 8 weeks
- You will be informed by email about the outcome of your application
- Questions: io@tue.nl

More information

Information:

- TU/e-website: https://www.tue.nl/en/education/studying-at-tue
- Master S&C: https://www.tue.nl/en/education/graduate-school (info on Master's program, curriculum, interviews with students and alumni)

Questions:

- Content program: me.studyinformation@tue.nl