Master Programme Embedded Systems

Arjan van Genderen,
MSc. Coordinator ES
Faculty EEMCS, TU Delft
A.J.vanGenderen@TUDelft.nl

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Outline

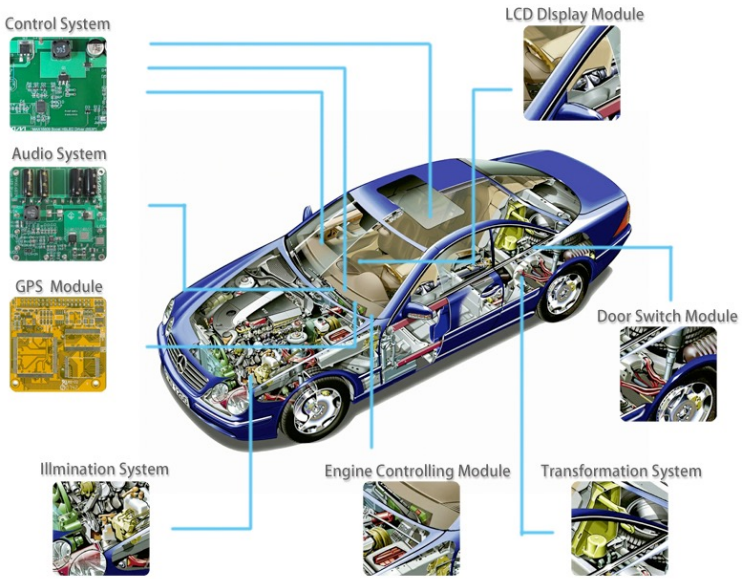
- What is Embedded Systems ?
- ES versus other MSc. programmes
- Curriculum MSc. ES
- ES research groups
- Thesis projects
- Entry requirements
- Some statistics

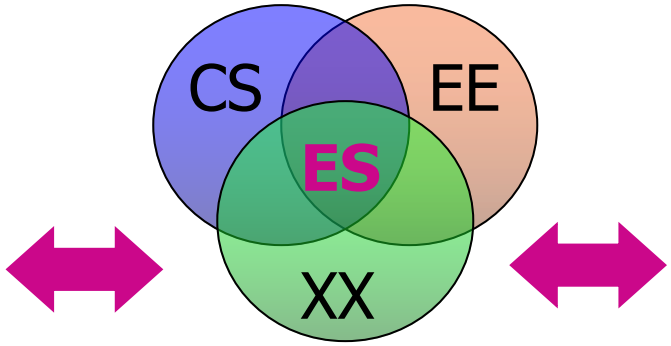
Embedded Systems (ES) =

Hardware/software systems, embedded in other systems to determine their functionality

E.g. systems to control:

- car functionalities
- the automatic pilot of an aircraft
- a robot
- a smartphone
- a pacemaker
- IoT





Keywords: dependability, multidisciplinarity, embedded software, system of systems

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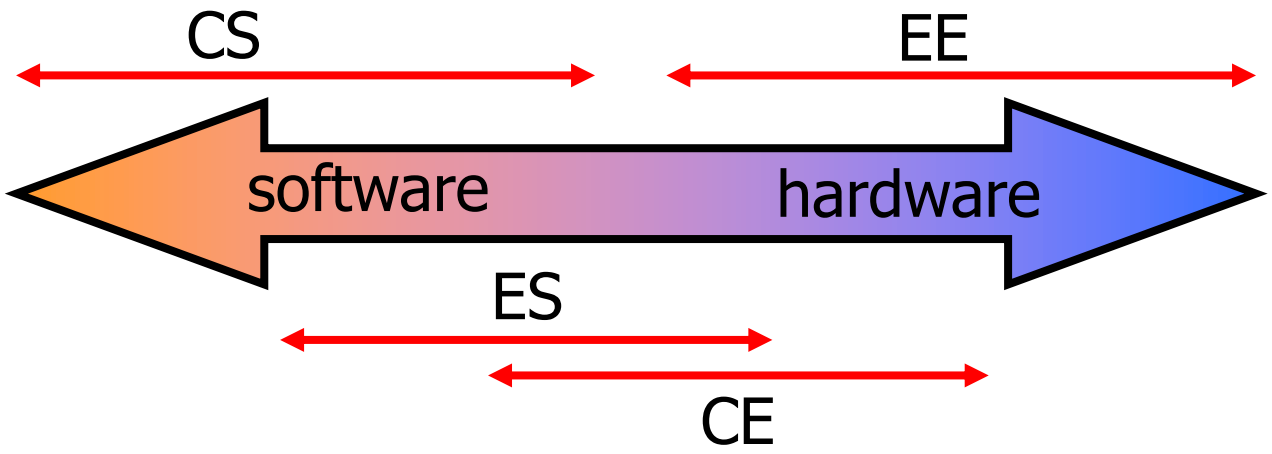
MSc. ES versus other programmes



- As an ES student you will learn about software and hardware and you can specialize on many different CS, EE and Systems & Control topics
- Compulsory courses CE and ES are different, pool of electives largely similar
- ES is a 4TU programme (with TU/e and UT)

Curriculum Embedded Systems

<table>
<tr><td colspan="3">First year</td></tr>
<tr><td colspan="2">1st semester</td><td>2nd semester</td></tr>
<tr><td colspan="2">Homologation courses</td><td rowspan="2">Compulsory courses</td></tr>
<tr><td colspan="2">Compulsory courses</td></tr>
<tr><td colspan="2">Specialization courses</td><td>Specialization courses</td></tr>
<tr><td colspan="3">Second year</td></tr>
<tr><td colspan="2">1st semester</td><td>2nd semester</td></tr>
<tr><td>Spec. courses (optionally free electives or internship)</td><td colspan="2">Thesis project (45 EC)</td></tr>
</table>

Duration: 2 years (2 x 60 EC = 120 EC)

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The Embedded Systems Programme

Homologation (≤ 10 EC)

e.g. Circuit Analysis
Digital Systems
Operating Systems
Modeling & Control
Digital Signal Proc.
Software Engineering

Compulsory (25 EC)

System Validation
Modern Computer Architecture
Quantitative Evaluation of Embedded Systems
Real-Time Systems
Embedded Systems Laboratory

Specialization (40 - 50 EC) CS, EE and SC courses.
Also possible are free electives like language or business courses, a project, or an internship (max. 15 EC).

Thesis Project (45 EC)

ES Specialisation Profiles

At least 20 EC on specialization courses from one specialisation profile:

- Software & Networking

  Algorithms for Planning and Scheduling, High Performance Data Networking, Networking, Advanced Network Security, Compiler Construction, , Compiler Construction Project, Evolutionary Algorithms, Networking, Measuring and Simulating the Internet, Fundamentals of Wireless Communications, Wireless IoT and Local Area Networks, Artificial Intelligence Techniques, Machine Learning 1 & 2, etc.

- Computer Architecture

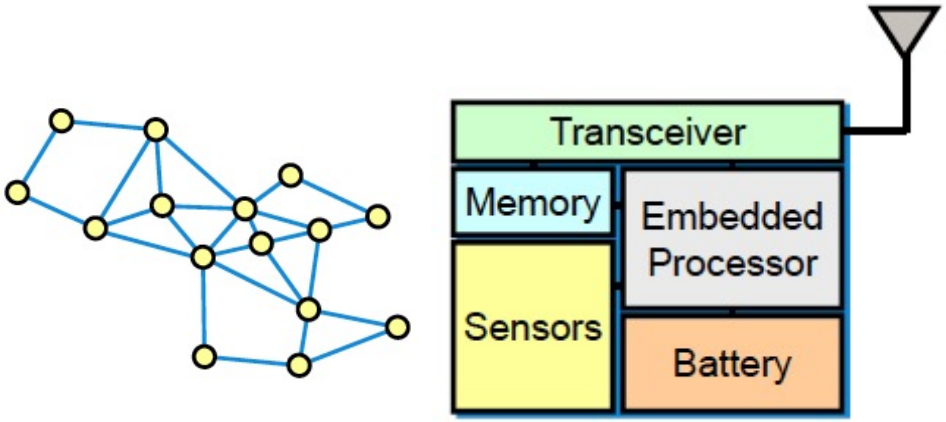
  Advanced Computing Systems, Electronics for Quantum Computing, Methods and Algorithms for System Design, Hardware Dependability, Computer Arithmetic, Processor Design Project, Digital IC Design I & II, VLSI Systems on Chip, Hardware Architectures for Artificial Intelligence, Embedded Computer Architectures 2.

- Control Systems

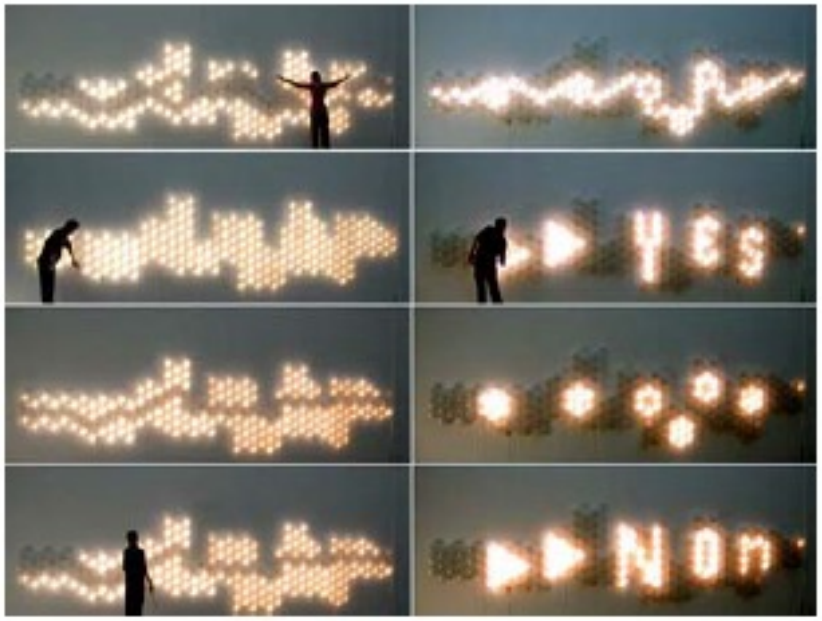
  Control Systems Design, Control Theory, Filtering & Identification, Model Predictive Control, Knowledge Based Control Systems, Optimization in Systems and Control, Nonlinear Systems Theory, Modeling and Control of Hybrid Systems, Digital Control, Networked and Distributed Control Systems, etc.

Some ES Research Topics

- Wireless sensor networks
  - self-configuration
  - node localization
  - low-bitrate communication
  - ad-hoc routing
  - in-network data processing
  - time synchronization



- Cyber physical systems
  - medical monitoring
  - mobile-phone sensing
  - robotics



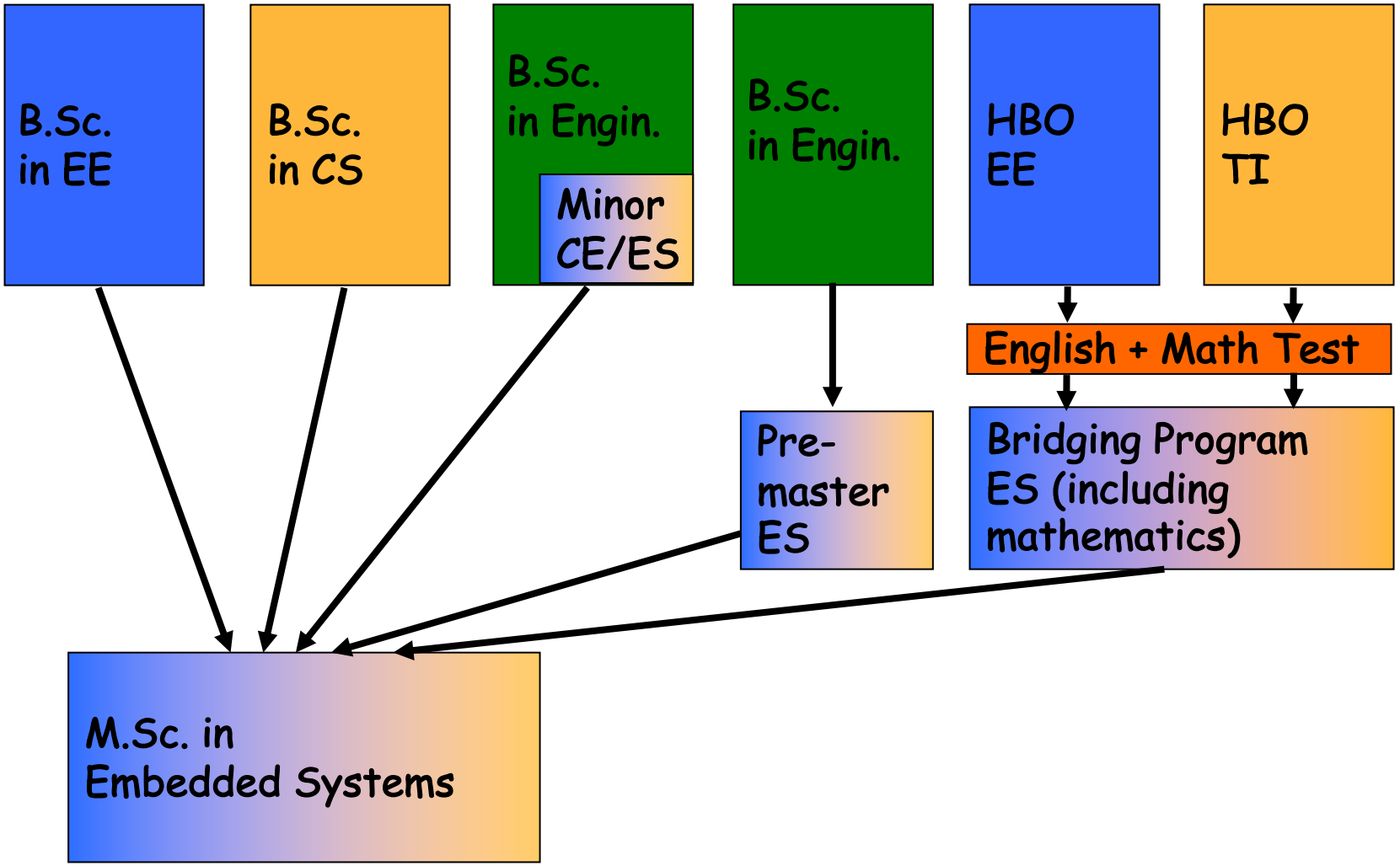
Research groups for thesis projects

Group	Department
Algorithms	ST
Circuits and Systems	ME
Computer Engineering	Q&CE
Cyber Security	IS
Distributed Systems	ST
Electronic Instrumentation	ME
Embedded and Networked Systems	ST
Interactive Intelligence	IS
Multimedia Computing	IS
Network Architectures and Services	Q&CE
Quantum Circuits Architecture & Technology	Q&CE
Software Engineering	ST
Cognitive Robotics	(Faculty 3ME)
Delft Centre for Systems and Control	(Faculty 3ME)

Some ES Thesis Projects

- Fault diagnosis of advanced wafer scanners (ASML)
- Hardware Components for Real-Time Stereo Matching: Acceleration of 3D HD TV with FPGAs (IMEC)
- A Cow-Feeding Robot (Lely)
- Profiling of Algorithms for a Biomedical-Implant Architecture
- Control of Suction Distributions on Boundary Layer Suction Systems for Automotive Wind Tunnels (Actiflow B.V.)
- Memory and Power Efficient Architecture for Embedded Microcontrollers
- How to optimize a RFID UHF System for Mass Sports Timing
- Handshake Recognition Applied to Wireless Data Exchange in Smartbands (Shake-On YES!Delft)
- Localization with Wireless Power

Entry Requirements



New students per year

	MSc. ES			
	total	NL	Int EU	Non EU
2013/2014	37	19	6	12
2014/2015	54	36	4	14
2015/2016	58	14	8	36
2016/2017	55	19	11	25
2017/2018	66	23	12	31
2018/2019	73	27	21	25
2019/2020	50	25	4	21

Who is employing our students?

- Philips
- NXP
- ASML
- ARM
- Alten
- Fox-IT
- Vanderlande
- Rijkswaterstaat
- TomTom
- TU Delft
- ….

- ABB
- Thales
- Robot Care Systems B.V.
- Lely Industries NV
- ISIS Space
- Deloitte
- NVIDIA
- MyOmega Systems GmbH
- Bosch GmbH
- BMW
- ….

Thank you!

See also https://www.tudelft.nl/en/education/programmes/masters/embedded-systems/msc-embedded-systems/

and https://www.tudelft.nl/eemcs/the-faculty/departments/quantum-computer-engineering/computer-engineering/staff/arjan-van-genderen/