Master Programme Computer and Embedded Systems Engineering

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

November 2022

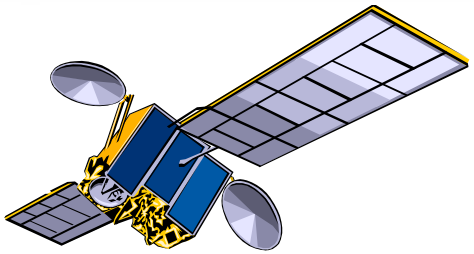
TU Delft

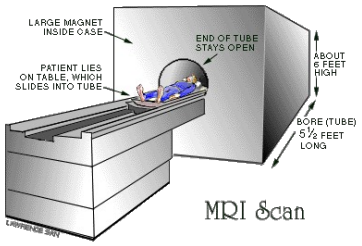
Outline

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

Computer Engineering

Putting software and hardware together to make computers





MRI Scan

Hardware

Computer Arch., Logic design, Heterogeneous architectures, Quantum computing etc.

Software

Compilers, Operating Systems

Design tools & Methodologies

Design tools, Logic synthesis, HW/SW partitioning

Communication Networks

Network Arch., QoS, Mobile Networks, etc.

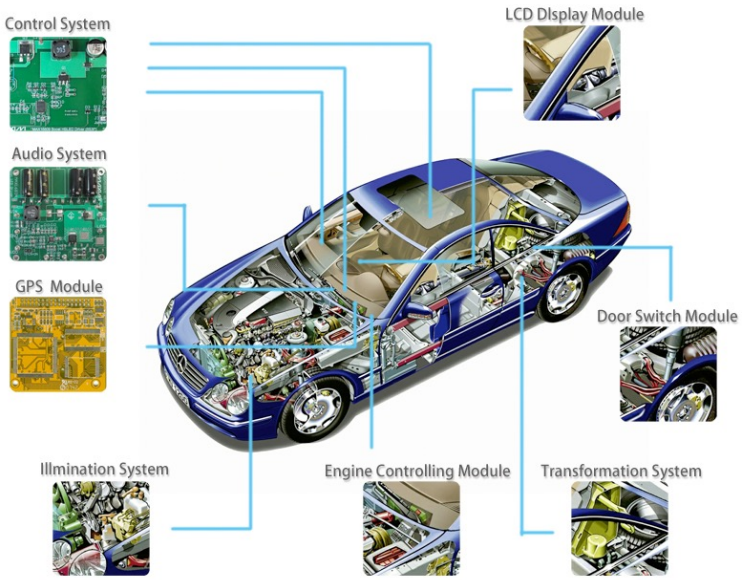
TU Delft

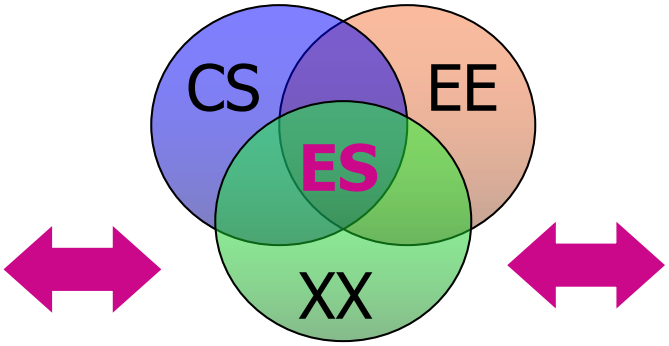
Embedded Systems

Computer 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

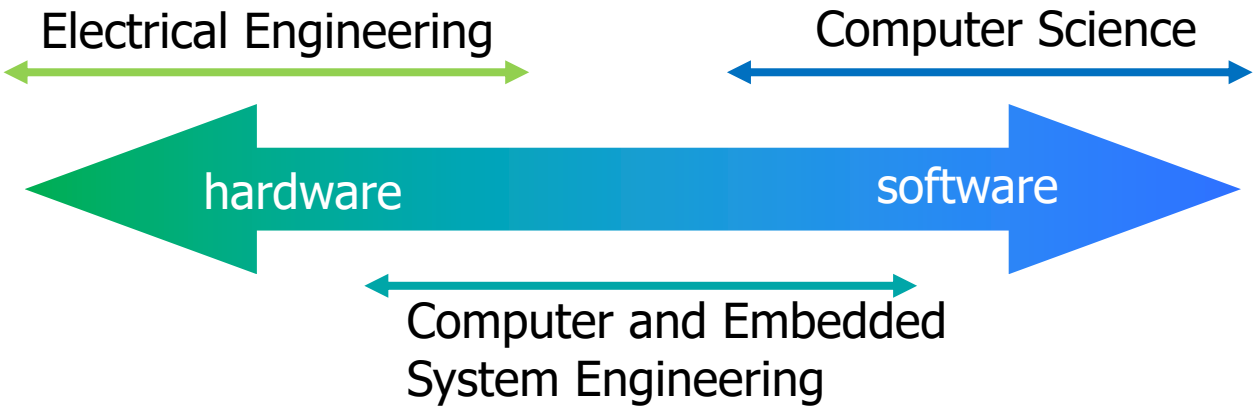




Keywords: dependability, multi-disciplinarity, embedded software, system of systems

TU Delft

MSc. CESE versus other programmes



As an CESE student:

- you will learn about hardware and software, and their integration
- you will learn how to use hardware and software to control other systems
- you can specialize on many different CS, EE and Systems & Control topics

Curriculum

First Year (60 EC)			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Advanced Computing Systems (5 EC)	Software Systems (5 EC)	Specialization (5 EC)	Effective & Responsible Engineering (5EC)
Systems Engineering (5 EC)	Real-time Systems (5 EC)	Embedded Systems Lab (5 EC)	Specialization (5 EC)
Software Fundamentals (5 EC) or Hardware Fundamentals (5 EC)	Specialization (5 EC)	Computer Arithmetic (5 EC)	Processor Design Project (5 EC)

Second Year (60 EC)			
1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Project, internship, or set of elective courses (e.g. quantum, AI, sustainability, entrepreneurship)	Thesis project (45 EC)		

TU Delft

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

Programme

Common core	
System Engineering	5 EC
Effective & Responsible Engineering	5 EC
Software Fundamentals/Hardware Fundamentals (homologation)	5 EC
Advanced Computing Systems	5 EC
Software Systems	5 EC

Integration set 1	
Real-Time Systems	5 EC
Embedded Systems Lab	5 EC

Integration set 2	
Computer Arithmetic	5 EC
Processor Design Project	5 EC

Both integration sets should be taken. However, students doing the specialization Control may replace integration set 2 by Systems & Control spec. courses.

Specialisation Courses

From one specialization profile, at least 15 EC on specialization courses should be chosen:

- Software

  Supercomputing for Big Data, Compiler Construction, Evolutionary Algorithms, Algorithms for Intelligent Decision-Making, Quantitative Performance Evaluation for Computing Systems, Machine Learning 1, Deep Learning, Artificial Intelligence Techniques, Introduction to High Performance Computing, Distributed Systems, Security and Cryptography, Software Architecture, Advanced Algorithms.

- Computer Architecture

  Supercomputing for Big Data, Quantum Computing Architecture and Electronics - Fundamentals and state-of-the-art, Modern Computer Architectures, Reconfigurable Computing Design, System Design with HDLs, Quantitative Performance Evaluation for Computing Systems, Digital IC Design, Digital IC Design II, Hardware Architectures for Artificial Intelligence, Hardware Dependability, Digital VLSI Systems on Chip, High Speed Digital Design for Embedded Systems, Embedded Computer Architectures 2.

Specialisation Courses (cont.)

- Networking

  High-Performance Data Networking, Measuring and Simulating the Internet, Ad-hoc Networks, Wireless IoT and Local Area Networks, Advanced Practical I.o.T. and Seminar, Quantum Communication and Cryptograph, Quantitative Performance Evaluation for Computing Systems, Network Security, Mobile Networks, Telecommunication Network Architectures, Networking, Telecom Business Architectures and Models, Fundamentals of Wireless Communications, Smart Phone Sensing, Performance Analysis, Networked and Distributed Control Systems

- Control

  Quantitative Performance Evaluation for Computing Systems, Intelligent Control Systems, Control System Design, Control theory, Filtering & Identification, Optimization for Systems and Control, Non-linear Systems Theory, Modelling and Control of Hybrid Systems, Control Engineering, Networked and Distributed Control Systems, Dynamic Programming and Stochastic Control, Model Predictive Control, Fault Diagnosis and Fault Tolerance Control, Robust Control, Statistical Signal Processing, Modelling of Dynamical Systems.

Other electives

The remaining 15 EC can be filled with e.g.

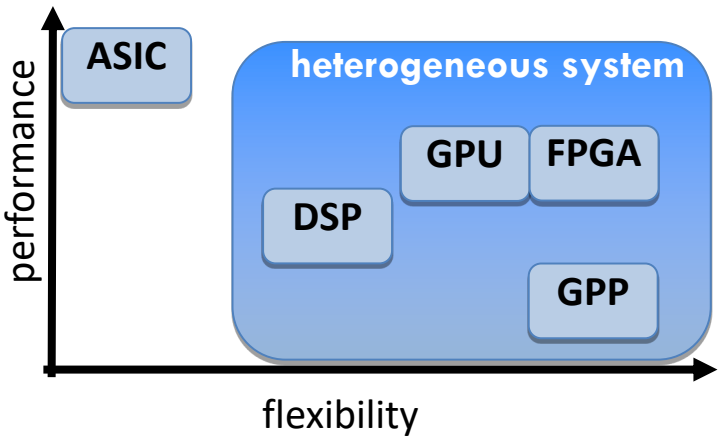
- Internship
- Joint Interdisciplinary Project
- Interdisciplinary Advanced Artificial Intelligence Project
- More specialization courses
- Other CS, EE and System and Control courses
- A few non-technical courses (language, business)

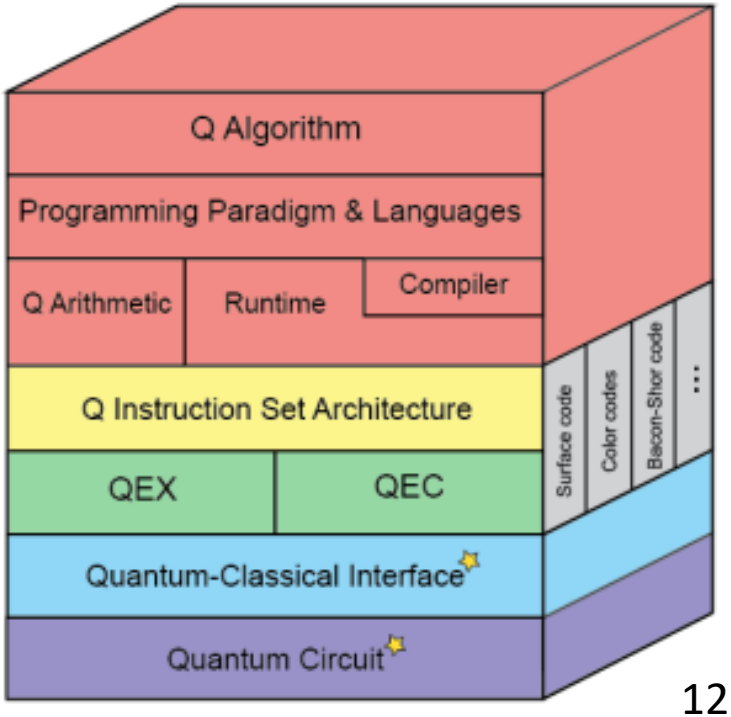
Research groups for thesis projects

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 Research Topics

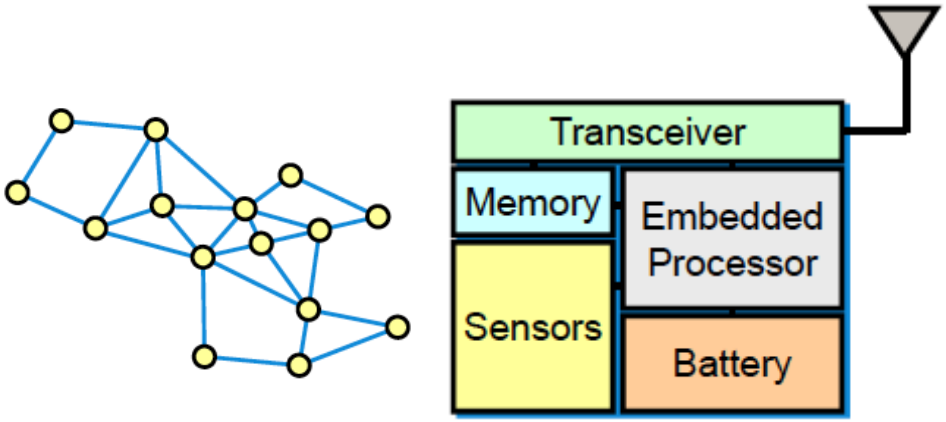
- Heterogeneous multi-core systems
  - Which parts of the application will use which hardware resources ?
  - Run-time reconfiguration
- Hardware security
- In-memory computing
- Quantum computing
  - New logic building blocks and architectures are required to build Quantum computers.



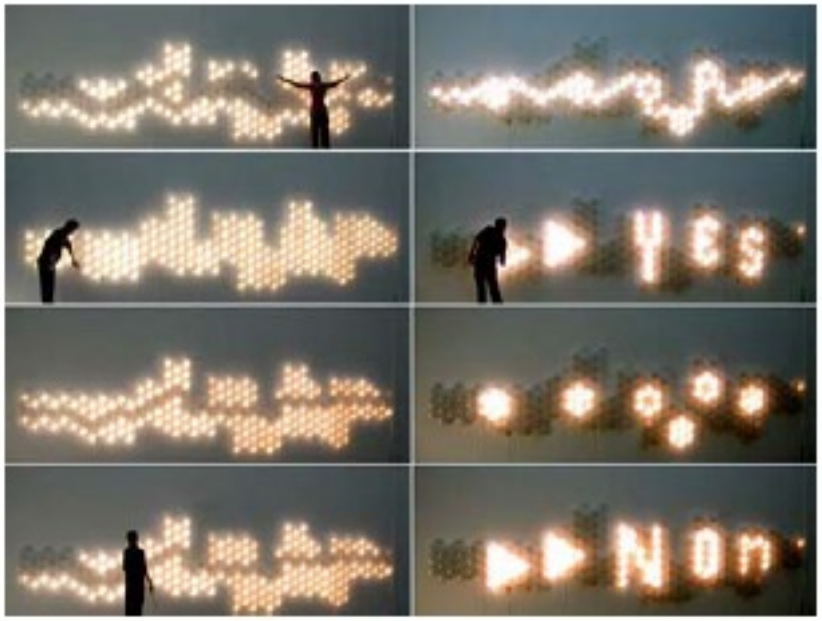


Some Research Topics (cont.)

- 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



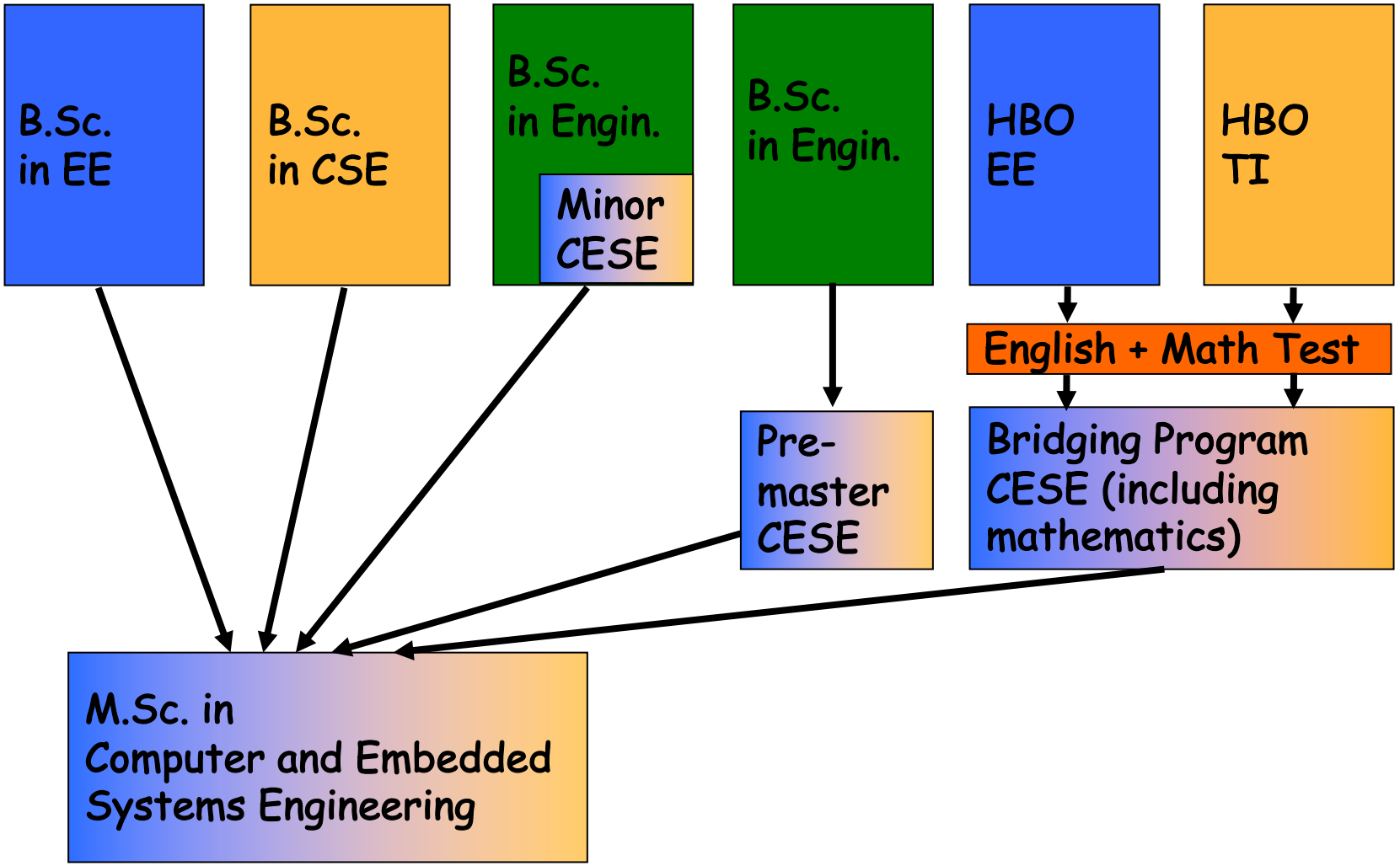
Some Thesis Projects

- Design for Testability for Secure ICs
- Interconnect Test for 3D Stacked Memories
- Porting Linux to the ρ-VEX reconfigurable VLIW softcore
- GPU-Based Simulation of Brain Neuron Models
- Libswift-PPSPP Information Centric Router: SHA1 Accelerator
- Fault-Tolerant On-Board Computer Software for the Delfi-n3Xt Nanosatellite
- Acceleration of Cancer Diagnosis Algorithms on Super Computing FPGA Platforms
- Acceleration of Big Data Algorithms for Behavioral Experiments
- A Quantum Emulation Platform

Some Thesis Projects (cont.)

- 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. CE + ES/CESE			
	total	NL	Int EU	Non EU
2013/2014	55	33	7	15
2014/2015	80	53	10	17
2015/2016	78	22	12	44
2016/2017	77	31	13	32
2017/2018	95	41	16	38
2018/2019	95	37	28	30
2019/2020	77	51	5	21
2020/2021	90	46	6	28
2021/2022	88	49	10	29
2022/2023	110	55	19	36

Who is employing our students?

- Philips
- NXP
- ASML
- ARM
- Alten
- Fox-IT
- Vanderlande
- Rijkswaterstaat
- ABB
- TU Delft
- Technolution
- Erasmus MC
- Intel
- Qualcomm
- NVIDIA
- Synopsys
- WhatsApp
- TomTom
- CERN
- Thales
- Robot Care Systems
- Lely Industries
- Ned. Octrooibureau
- ISIS Space
- Deloitte
- MyOmega Systems
- Imagination Techn.
- Bosch
- BMW
- ....

Thank you!

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

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