EEE3096S: Embedded Systems II

LECTURE 1:

INTRODUCTION

Presented by:

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ABOUT ME

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Dr Yaaseen Martin

Software Engineering, Space Science, Signal Processing, Machine Learning

BSc(Eng) PhD Cape Town

Research Interests

- Software Engineering
- Space Science
- Signal Processing
- Machine Learning

Postgraduate Supervision

Masters

- Athenkosi Mtonjeni, Statistical models for radar returns of sea clutter amplitude (Co-supervisor)

Current Undergraduate Teaching

- Embedded Systems II: EEE3096S

TEACHING STAFF

Lecturers:

- Dr Yaaseen Martin (course convener; lecturer for 3rd term)
- Mr Stanley Mbewe (lecturer for 4th term)

Teaching Assistant:

- Mr William Bourn

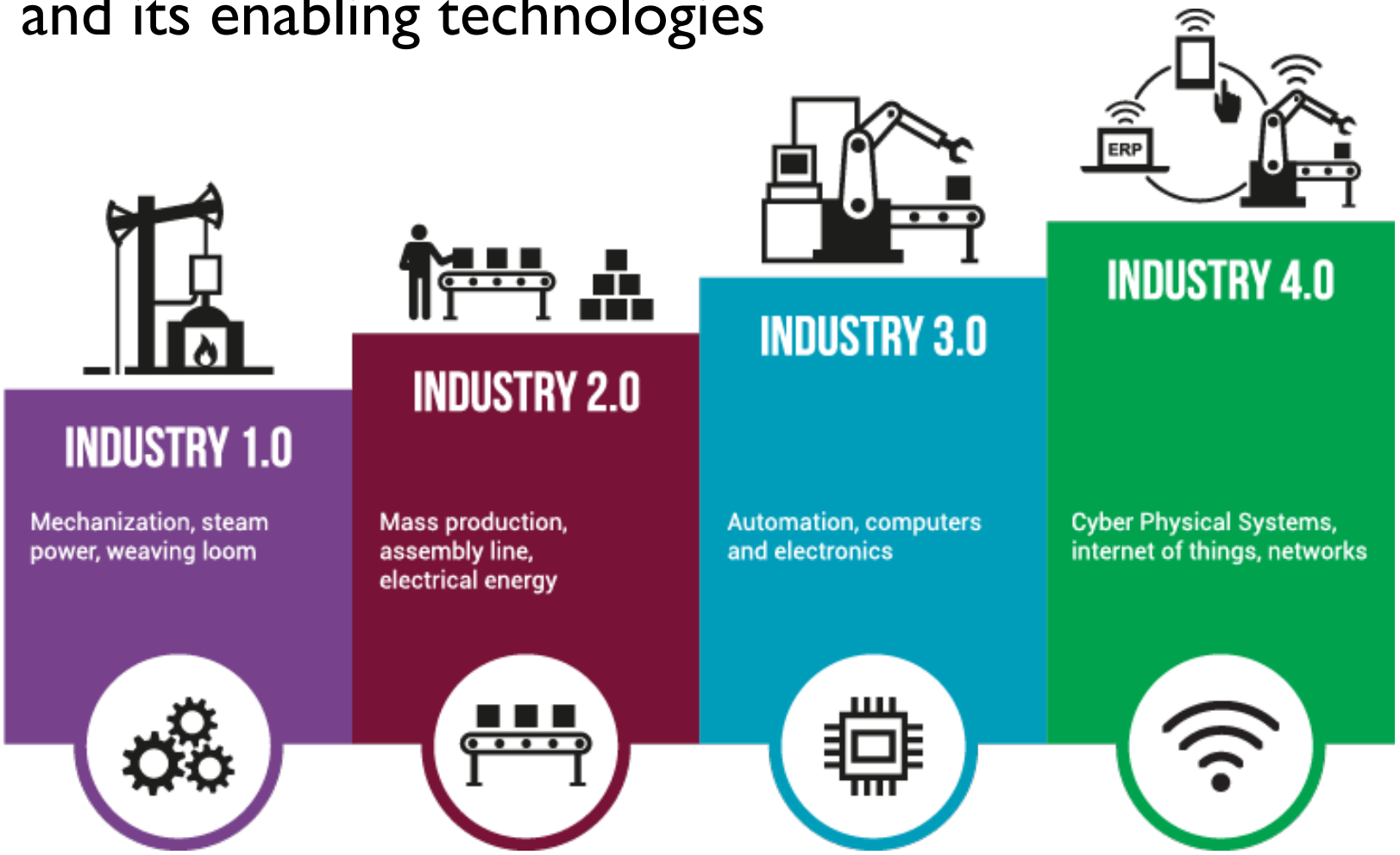
Tutors will be available in the practical sessions

LEARNING PROCESS

- A new collection of topics starts every week or two
- Lectures introduce these topics as well as upcoming tutorial and lab activities
- A new lab will start every ~2 weeks
- We may also run a few **short quizzes** to encourage consistent learning and assess your progress in preparing for tests and the exam

LECTURE 1 – INTRO TO ES II

What economists are now calling, 'Industry 4.0' and its enabling technologies



'Industry 4.0' is a term coined at the Hannover Fair in Germany, 2011, to describe how organizations are changing*

Image source: Nitin's Fundas Blog Spot – "Reflections on Leadership, Innovation, Self Development, Spirituality and Transforming India" (http://nseth71.blogspot.com/)
* K. Schwab, "The Fourth Industrial Revolution", Portfolio Penguin. 2017

Industry 4.0

Industry 4.0 =
the name for the current trend of automation and data exchange in manufacturing technologies.

This includes in particular harnessing the power of:

- Cyber-physical systems
- The Internet of things
- Cloud computing
- Cognitive computing

Leading to the concept of
"smart factories“

Many of these plans are a reality, already in place especially at large companies that want to stay ahead of the ‘game’.

Are Industry 4.0 Technologies

GOOD

or

BAD

?

e.g. Industry 1.0 was epitomized by machination, machines people used to work faster. But it demanded a huge number of people who knew how to use these machines. It was a big transition from serve poverty and poor health towards people who essentially had more freedom.

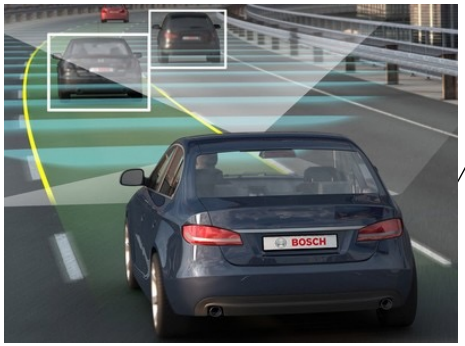
Technologies that are 'successful' may impact the world to a greater or lesser extent. But generally once a technology is invented it can't be undone ('immutability of invention').

So you might as well see if it can benefit you and others ☺

IMPACT ON JOBS?

- Major impacts are:
  - **Innovation** at the forefront like never before
  - **Speed:** things happening faster than ever
  - **Labour substitute:** repetitive and highly prescribable tasks done by machines…

Think: cashiers vs. self-checkout / Tesco scan as you shop



Think: taxi drivers vs. self-driving cars

HOW WILL THESE TRENDS EFFECT JOBS?

Jobs most prone to automation*

Probability	Occupation
0.99	Telemarketers
0.99	Tax preparers
0.98	Insurance Appraisers, Auto Damage
0.98	Umpires, Referees, and Other Sports Officials
0.98	Legal Secretaries
0.97	Hosts and Hostesses, Restaurant, Lounge, and Coffee S
0.97	Real Estate Brokers
0.97	Farm Labor Contractors
0.96	Secretaries and Administrative Assistants, Except Legal, Medical & Executive
0.94	Couriers and Messengers

Least prone to automation

Probability	Occupation
0.0031	Mental Health and Substance Abuse Social Workers
0.0040	Choreographers
0.0042	Physicians and Surgeons
0.0043	Psychologists
0.0055	Human Resources Managers
0.0065	Computer Systems Analysts
0.0077	Anthropologists and Archaeologi
0.0100	Engineers/ Technologists**
0.0130	Sales Managers
0.0150	Chief Executives

Where do (elec./comp.) engineers and computer scientists end up?...

* K. Schwab, "The Fourth Industrial Revolution", Portfolio Penguin. 2017

**The author more indicates marine engineers and architectures in the original table but reading further in the book you can interpret that engineers, particularly those involved in developing and maintaining complex systems are unlikely to become automata, at least not anytime soon.

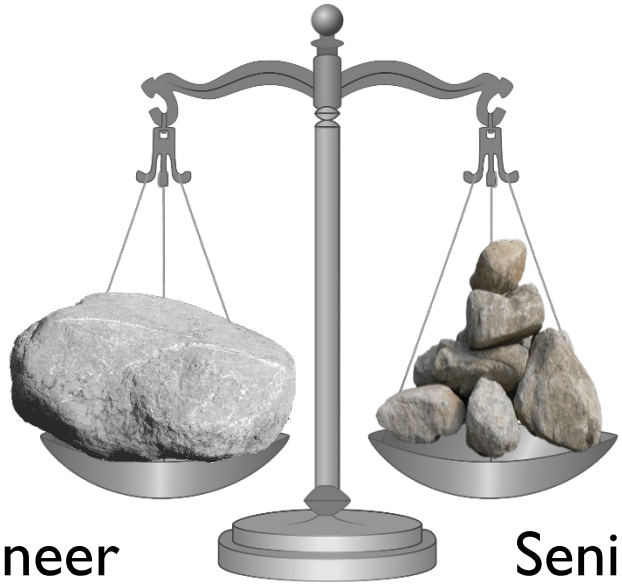
Embedded Systems Jobs & What Employers Want

We have a flavour of training *towards Professional ES Engineers*… touching on what such professionals should know. But the main focus in ES2 is on development, predominantly implementation that is also highly relevant to other fields, such as electrical engineering, telecoms, mechatronics, and C S.

- Certainly, **professional ES engineers are expected to know**, and have experience, with being able to do the **lower-level development tasks**, such as:
  - Coding, selecting components, knowing about PCB design, comms, hardware/software interfacing, installing and using embedded O/S
- But also **expected to know the high-level aspects**, which obviously imply lower-level tasks but which other members of the team may do, e.g.:
  - Requirements analysis, specification, high-level design for both software and hardware aspects, certification needs, ethics, inspecting procedures, skills needed for a projects, consultants, (team) leadership, engaging clients, documentation, and more.

Embedded Systems Jobs & What Employers Want

Often fewer, more focused and clearly defined tasks to do (under supervision of senior engineer).



Often more, but less well-defined tasks that are done (often in close collaboration / review of specialists, e.g. certification officer or discipline expert).

Newbie Engineer

Senior Engineer

Different companies or organizations may have quite different approaches to what their engineers do, where they are involved, how they progress at the company (hence a disclaimer that this view is not universal).
Often, though, newbie (or junior) engineers are recruited to fill a particular need. E.g. needing someone to do coding, or help with PCB design. Often responsibilities shift over time, as management becomes more aware of an individual's expertise and interests; and identifies particularly dependable people.
I use a balancing scaling to illustrate this: that initially one might have fewer but bigger jobs. With more seniority there are likely more things to keep tabs on, and (hopefully) colleagues helping to get them done. The scale emphasizing how employers should (ideally) be aware of their employees needing a work-life balance, limits to what one person can do.

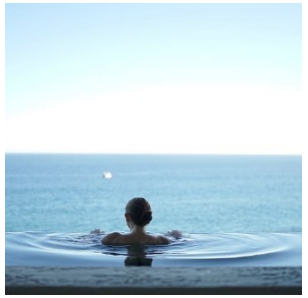
Rocks Image source: https://pngimage.net/piedras-png-1

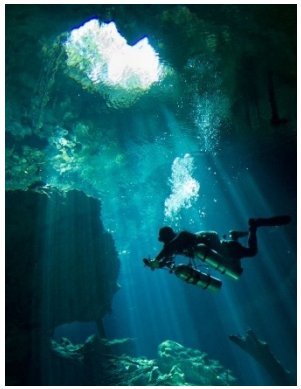
Embedded Systems Jobs & What Employers Want

Curriculum reasoning

Students should have options to do some of their learning as

- *'surface learning'* : to see more breadth of the discipline, to know about areas they may want to learn more about, or of areas where there are experts, this may influence their decisions later in their academic studies or in their workplace… and some aspects as
- *'deep learning'* : to greater understanding into particular or specialized aspects of the discipline.





Keeping in mind that an expert, e.g. great at developing device drivers (which would involve deep learning), would still know about the other areas, like there being specialists in signal processing, in communications, etc., that they may influence.


YOU
EMBEDDED SYSTEMS
THE BORING STUFF WE'VE COVERED SO FAR
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DEFINING AN EMBEDDED SYSTEM

"Dortmund (2011) Definition": [Peter Marwedel]
Embedded systems are information processing systems embedded into a larger product.

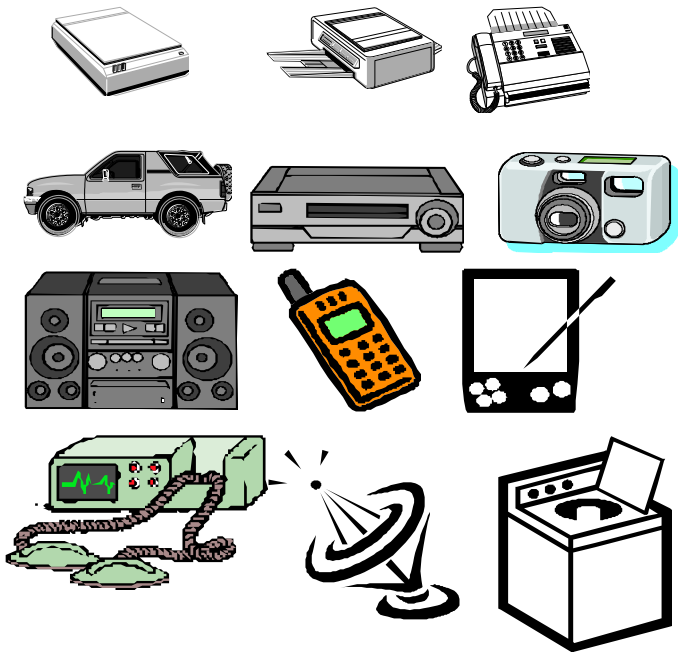
"Berkeley (2004) Definition": [Edward A. Lee]
Embedded software is software integrated with physical processes. The technical problem is managing time and concurrency in the computational systems.

"Brisbane, Australia (2009) Definition": [John Catsoulis]
An ES is a task-specific computer, which is built into a larger system for the purpose of controlling and monitoring the larger system.

Cyber-Physical (cy-phy) Systems (CPS) are integrations of computation with physical processes [Edward Lee, 2006].

SOME EMBEDDED SYSTEMS

Anti-lock brakes
Automatic teller machines
Automatic toll systems
Automatic transmission
Avionic systems
Battery chargers
Camcorders
Cell phones
Cell-phone base stations
Cordless phones
Cruise control
Digital cameras
Disk drives
Electronic card readers
Electronic instruments
Factory control
Fax machines
Home security systems
Life-support systems
Medical testing systems
Microwave ovens
Modems
MPEG decoders
Network cards
Network switches
Pagers
Photocopiers
Point-of-sale systems
Portable video games
Printers
Satellite phones
Scanners
Speech recognizers
Stereo systems
Televisions
Temperature controllers
Theft tracking systems
VCR's, DVD players
Video game consoles
Washers and dryers



DECIDING IF IT'S AN EMBEDDED SYSTEM

- The borders between *embedded and non-embedded computer system* are getting blurred…
  - Cellphones and PDAs … embedded for not?
  - Set-top box for steaming internet TV?
- Traditional deciding factors are:
  - Task specific
  - Non-standard platform architecture
  - Limited resources

As more computing power moves into embedded systems, borders are getting more fuzzy.

CONTENT THIS COURSE INVOLVES

- The course handout elaborates on this.
- In summary each week covers the following topis:

1. Embedded C and debugging
2. ARM, Assembly, Optimization and Benchmarking
3. Embedded Communications
4. Sampling & ADCs, Signal Generation and DACs
5. Verilog
6. Computer Architecture

TUTORIALS AND PRACTICALS

- Note that there are both **Tutorials** and **Practicals** in this course (required for **DP**)
- Each practical is preceded by a tutorial
- The tutorials count for fewer marks but help to get you ready for the subsequent practical

Practical	Tutorials
Emulation and Benchmarking	Linux Virtualisation and Debugging
Timers and SPI	Embedded Communications
ADCs and PWM	Also ADCs and PWM
DACs and (more) PWM	Also DACs and (more) PWM

Prac Process & Assistance

We're planning to have **prac pairs**, so find a partner to assist you in the lab. Tutors will be available to provide guidance and mark your demos (where applicable).

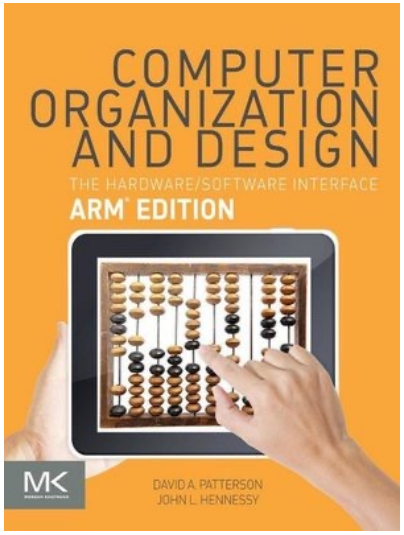
Use the Amathuba Discussions tab to save everyone time in answering questions and rebroadcasting answers. This way you could search the sites to get answers to problems much quicker instead of composing a new query.

WORKING ON PRACTICALS

- **Think**
  - Develop a plan of action before you start doing things!
- **Try**
  - Before saying that you don't know how, try!
- **Don't fry**
  - Don't be careless and fry the equipment (or yourself!)

No frying (or braaing) in the lab!

COURSE TEXTBOOK



Prescribed textbook: "Computer Organization and Design ARM Edition: The Hardware Software Interface" (The Morgan Kaufmann Series in Computer Architecture and Design) 1st Edition. Authors: David A. Patterson and John L. Hennessy.
https://www.amazon.com/Computer-Organization-Design-ARM-Architecture/dp/0128017333