

EEE4120F



NOTE: lecture to be recorded*

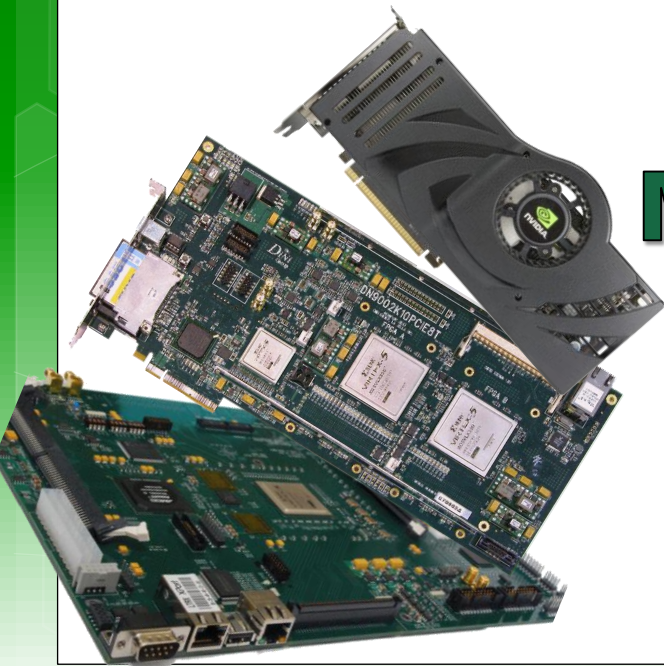
High Performance Embedded Systems

Lecture 1

Meet & Greet

* Participation in and attendance of this recorded lecture is voluntary.

Lecturer:
Dr. Simon Winberg



Lecture recording



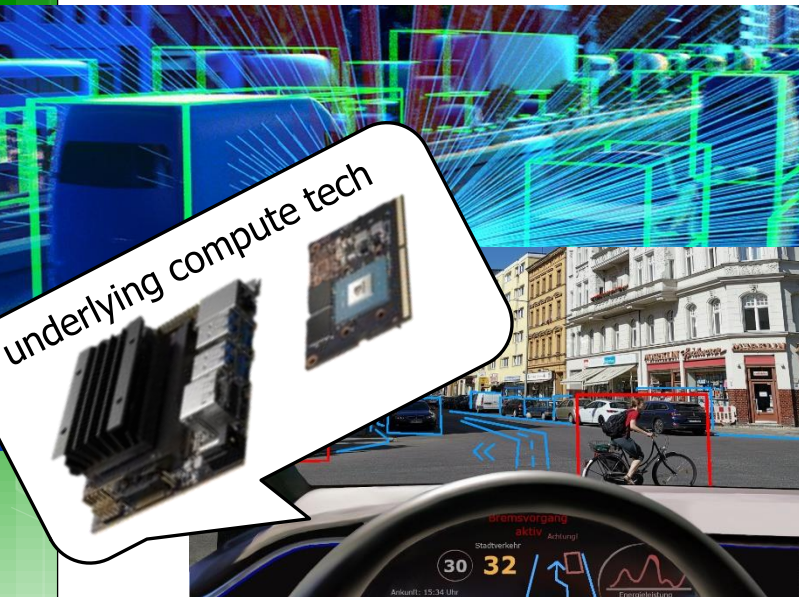
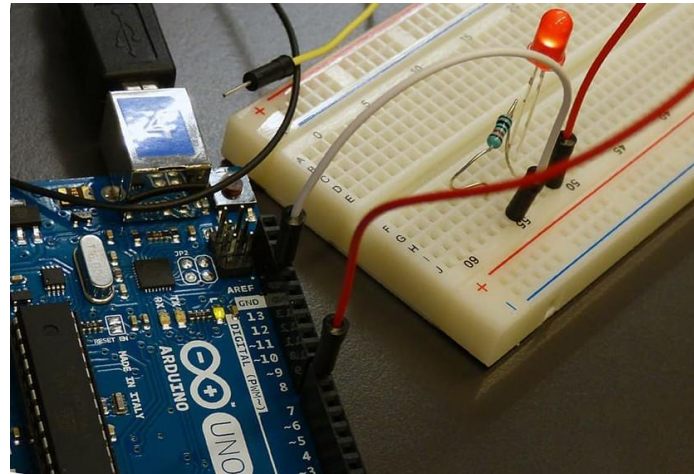
NOTE:

- Please note that these lectures are being recorded and to be made available on Amathuba or MS Teams.

ES vs HPES

Embedded Systems (ES)

VS



High-Performance Embedded Systems (HPES)*

*High-Performance Embedded Computing (HPEC) is a term used frequently instead of HPES. HPECS also. You can choose, but for this course sticking to HPES.

Skills needed for ES vs. HPES?!

For focusing on Embedded Systems (as in the classic concept)

sequential programming

skills to gather and use

comms

HW/SW interfacing

(NB: this is just a relative image, not the full set of skills!!)

Circuit design

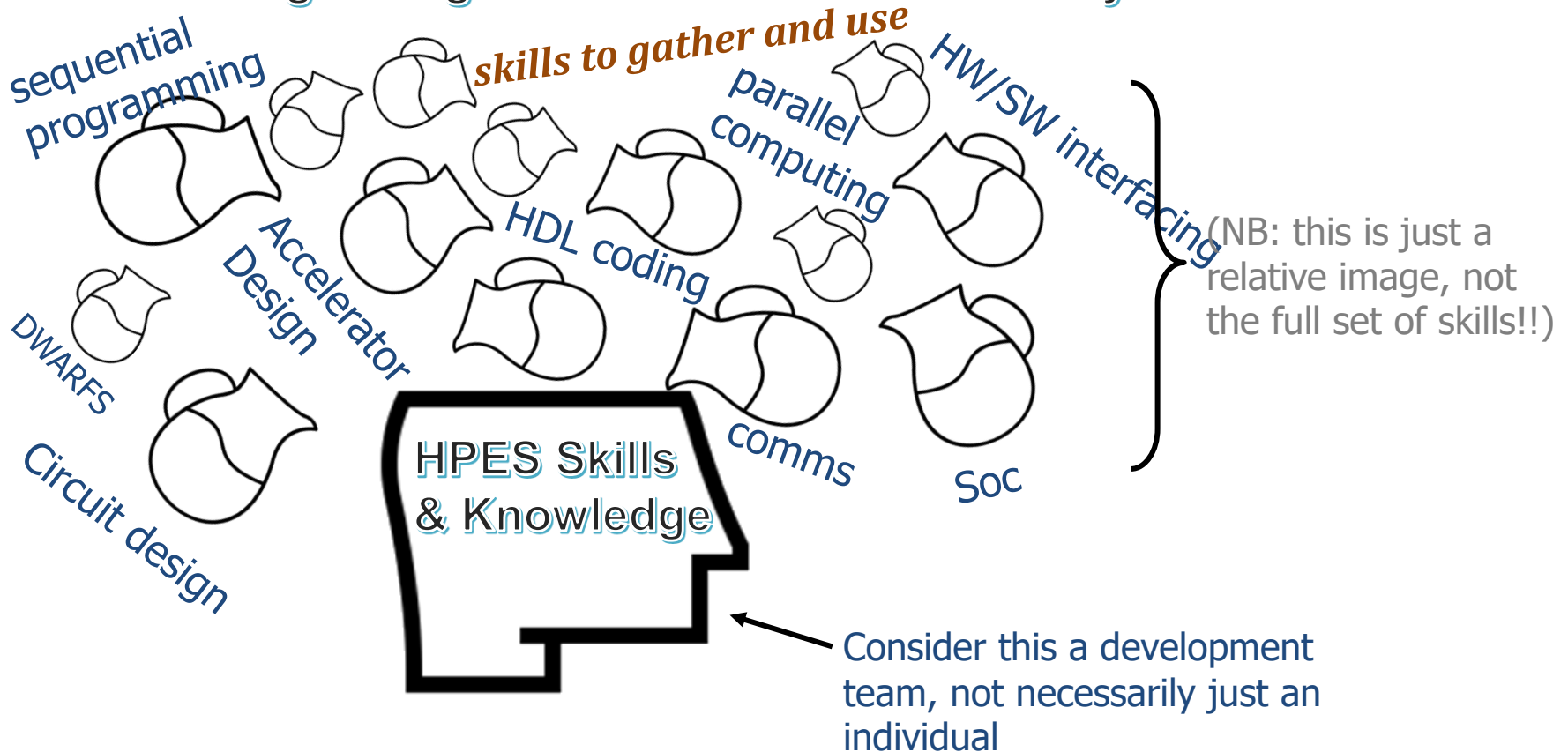
ES Skills & Knowledge

Consider this a development team, not necessarily just an individual

Of course there is more to it than that... but what about HPES development??

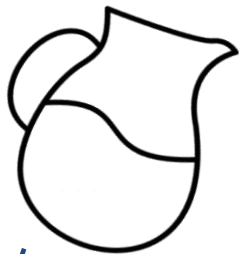
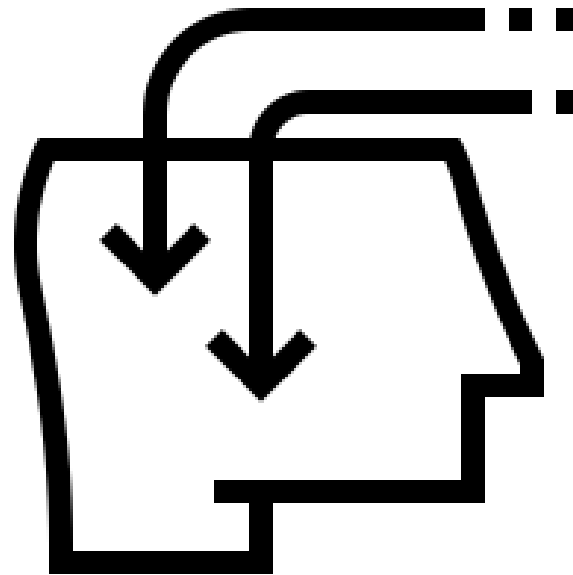
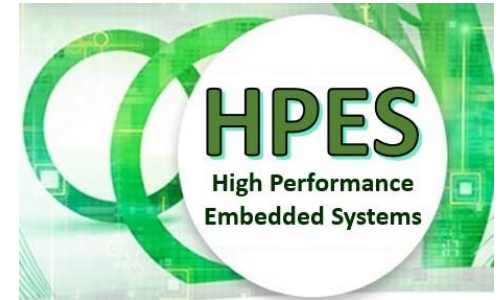
Skills needed for ES vs. HPES?!

For focusing on High-Performance Embedded Systems



Of course there is more to it than that... but you surely get the 'picture'.

The Learning Model



HPES
knowhow

Well, it's not about having some refreshing juice to build understanding...
Learning is (currently) more involved than that, so how will learning be done?

Staff Intro

•LECTURER

A/Prof Simon Winberg

E-mail: simon.winberg@uct.ac.za

Office: Menzies 6.13

•TEACHING ASSISTANT

•Zaakir Ebrahim

E-mail: EBRMUH018@myuct.ac.za

•TUTORS

•Dean Makoni

E-mail: MKNDEA002@myuct.ac.za

•Umutesa Munyurangabo

E-mail: MNYUMU002@myuct.ac.za

Learning Model

The course handout outlines the approach that will be used... **in summary:**

but too many words, could illustrate the general notion ...

- Blended, Online, Class Attendance Optional
- Combination of ...
 - **Differentiated Instruction**: using a variety of resources from which to learn
 - **Expeditionary learning**: where students can try different approaches to learn a topic
- Essentially a combination of activities, resources, assignment, assessments.
- The Implementation ...



You, with a good secure vantage point of strange new 'digital worlds' ...

**The Mission:
To Explore Strange New (for some) digital designs**

e.g. Design elements that might play nice together, or not.

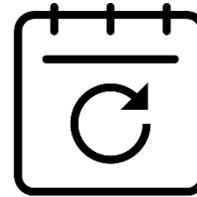
**At least, to start with
Then there's issue of
assignments and group
Project, GA, test... etc.**



Learning Model

Prac methods and times??? To discuss!

The Weekly Routine



Learning is often more effective if a regular routine is followed. We will try for that!

- **Tuesday Homeroom (16h00-18h00)**
 - Lecture, possible quiz, sometimes a seminar, group activity
 - Next consignment of learning, review readings, learning tasks
- **Thursday Homeroom / Red lab (16h00-18h00)**
 - Homeroom group work, practical work, tutorials, tool methods
 - Tutors available to assist, sometimes quiz/tes
 - Discord monitored (Red lab only available 15h00-17h00)
- **Thursday RedLab (partly used?)**
 - Term1: Red lab available 2pm-4pm (but Linux not available)
 - Term2: Red lab available 9am-11am (but Linux not available)
- **Wednesday (no bookings)**
 - Not used (can add e.g. tutorial room booking)

Method for Queries

- The tutors, TA and lecture will use **Discord** for both prac queries and other course related queries and online discussions. This helps to efficiently handle direct queries from students.
- Also a MS Teams for general messages
- This is to **avoid masses of emails** being posted to the lecturer and/or TA, which can mean queries being lost among seas of other emails causing slow responses.
- For questions or comments you don't want share with class: email lecturer or TA directly, ensure clear subject line, e.g.
EEE4120F query: <brief subject>

Discord Link



- Open up from:
- <https://discord.gg/HgKX2Ab6>

Note: This link will self-destruct in a few days,
so join in the Discord server soon

- Take note of the introductory
announcements and directions

Short Quizzes? And rules.

- **Yes**, that's the approach we're going to attempt. It has worked well in the past to encourage students to engage with the learning material and activities on a regular basis leading to better performance, and hopefully having an added advantage of reducing your stress levels.
- There **won't be quizzes every week**, you will be told a week before of a scheduled quiz so that you usure to be prepared.
- Solutions to quizzes usually discussed in lecture session after the quiz, memo shared online
- Quiz options and rules ...

Quizzes Options and rules

- You can **request to skip all quizzes** and have your quiz mark weight moved to the exam
- You need to do this prior to DP finalization
- You **can miss one quiz per term** without needing an excuse (e.g. doctor's certificate). Missing more than one quiz/term \rightarrow 0 for that quiz, or you can discard all quiz marks and have added exam weight.
- There **won't be quizzes every week**, you will be told a week before of a scheduled quiz so that you can to be prepared.
- Solutions to quizzes are usually discussed in lecture session after the quiz, memo shared online

Tests? Besides quizzes?

- **Yes**, but not necessarily how you may have expected it.
- Two shorter class tests & one longer:

Test	Date and Venue
GA2 Comprehension Test	See course handout
GA2 Validation Essay	

There are venue-based tests. And isn't just about theories and possibly remembering stuff from lectures/readings. It's going to involve proposing solutions, design strategies, critiquing solutions, various things where we will test your understanding and skills in the subjects of this course. Comprehension Test depends on Prac1 and Prac3.

Practical Work

- Certainly, pracs are big part of this course
- Prac1 is individual work
- The Pracs can be worked on whenever you like, **but keep to due dates!** (disclaimer note: tutors can only assist with pracs that related to scheduled prac sessions, if you decide start early on pracs you cannot expect tutor to provide support until the scheduled release date for the prac concerned).
- One course project:
 - YODA Project

EEE4120F Marks Breakdown

- **MARKS:**
- See next slide...
- **DP:**
- Pass GA2 assignment and tests
- Minimum 40% overall class average to write the final exam



Marks Breakdown (16 credits)

- **Practicals: 15%**

- 4 practicals:
 - Golden Measure in MATLAB/OCTAVE;
 - MATLAB Parallel Computing Toolkit;
 - OpenCL project-based learning;
 - OpenMPI collaborating nodes
 - HDL prac leading to project activities

- **GA assessment & tests : 5%**

- Comprehension test based on pracs 1,3, technical essay; this is a DP requirement for EEE4120F.

- **Tests : 15%**

- 5% quizzes (can move to exam), 10% class test ('exam prep test'). Venue-based test. No make-up tests. Tests you miss (including class test) has it's weight moved to exam.

- **Project : 15%**

- Blog; Status update; Draft Report; Final report; Demo

- **Final exam : 50%**

- Venue-based exam

Practical Support using Discord

- Discord <https://discord.com/> you have likely use before (e.g. in EEE3096S), and we will be using it in this course also as an online platform for working collaboratively on pracs/projects and for tutors being able to provide you support.
- The details of connecting up to the Discord server for this course will be announced.
- For working online collaboratively on projects with teammates you can decide what tool you prefer, that is flexible. But connecting with lecture/TA/tutors for discussing project artefacts and the like we encourage use of Discord.
- Prac1 done individually
- Other Pracs planned to be done as a team of two
 - (we do not encourage teams of more than two, but if for some reason you cannot find a teammate and an existing team is allowing you to join them, then please get permission by emailing lecture or TA)

Pracs Day(s)?

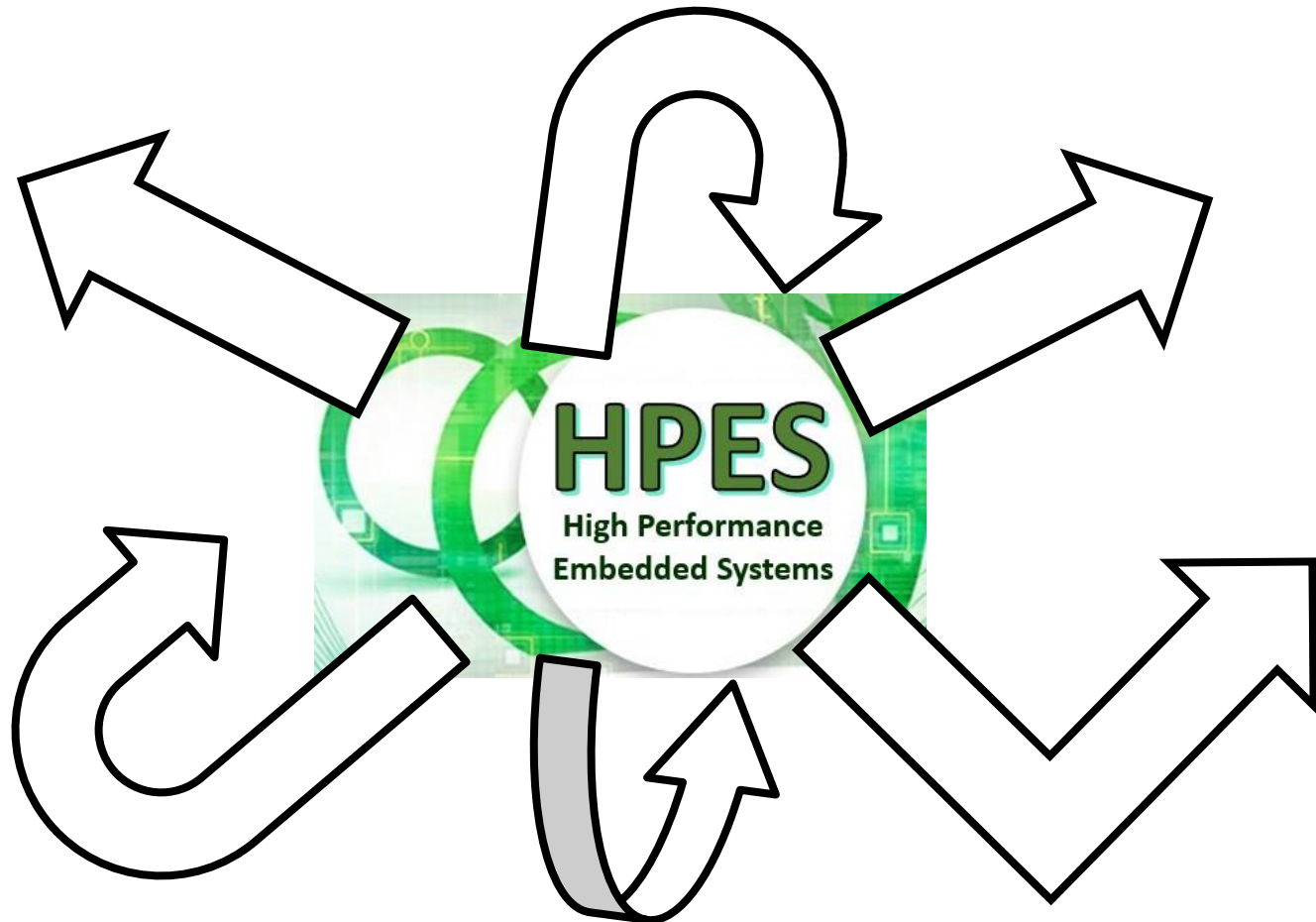
- You can choose **when & where to work** on pracs and assignments
- **Thursday 4pm-6pm** assigned as homeroom where venue available to work on pracs
- **Redlab** available **Thursdays 3pm-5pm**
- Help us decide when best to have tutor monitoring Discord to provide you prac guidance and assistance outside regular lab/homeroom times.

Prac 1

- You can start this any time
- Use your own PC (especially this week)
- Redlab can be used for Prac1
- Individual work (mainly)

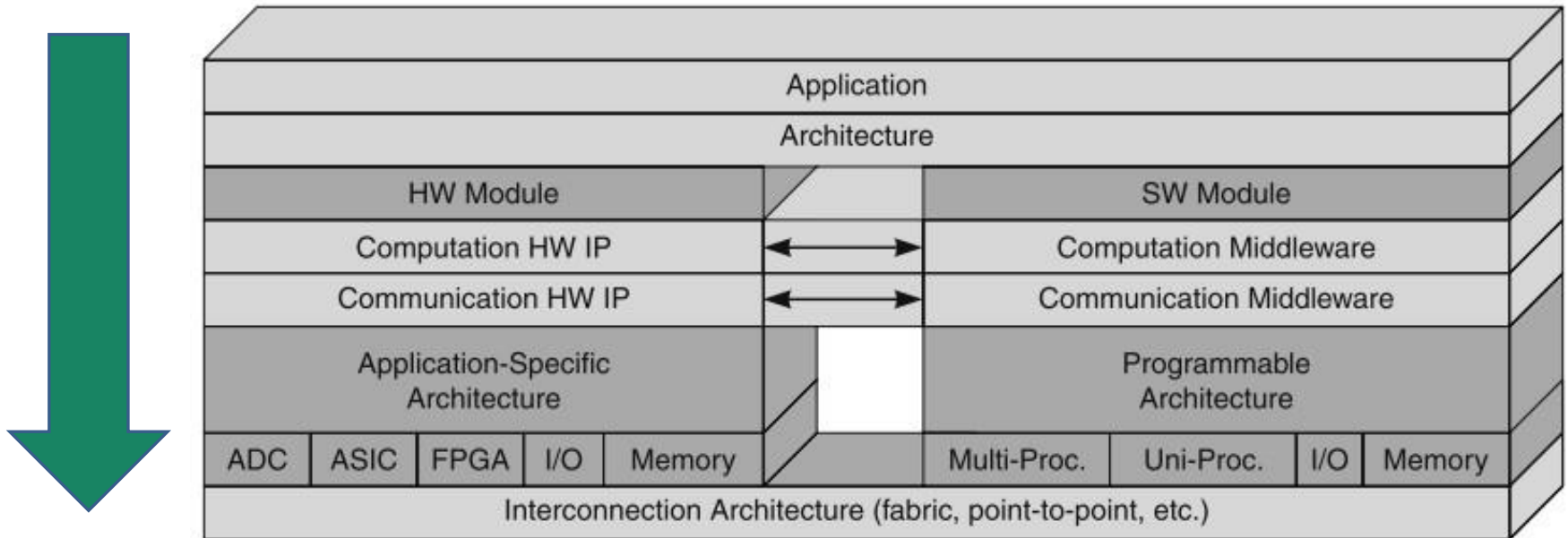
Will get back to Prac1 momentarily! ...

The *wh*'s of this course: what, why, when, where?



HPES : High Performance Embedded Computing Systems

We're going to follow the content of HPES systems in a somewhat top-down fashion, moving from application through to implementing application accelerators and other nitty gritty of these type of systems



Canonical framework illustrating key subsystems and components of a high performance embedded computing (HPEC) system.

Class handout

Available on Amathuba



EEE4120F High Performance Embedded Systems

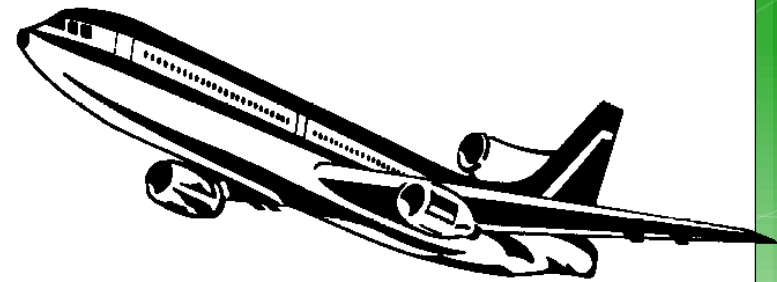
Objectives & ...

Relevance of EEE4120F to You



The Objectives

- Equip you with expertise and knowledge of the **state-of-the-art**.
- Apply and build on knowledge from previous courses, taking it to a **new level**.
- Work on **exciting** and interesting projects that will help to...



Prepare you for a high-flying high-tech career!!

Relevance to you...



- You'll be expected to graduate with good knowledge of the fundamental + some experience with the latest techniques and technology.
- But more than that...
intent as a "capping course", that draws on prior knowledge; provide an "upwards push" towards taking things further on your own in your future career or studies.



Reading Material

- A selection of academic papers, links and other resources will be provided to support your learning.
- See Readings in Amathuba for these articles



When do pracs start?

- Planning to start Prac1 today!
- Like in a moment!
- All got a laptop? If not, then 'XP' style it*.
- But first:
 - TEAManology terms, syllabus, pracs, GA2, proj.

*Extreme Programming (XP) is a form of Agile software development, which often includes working in pairs, e.g. pair programming, where one developer may be at the keyboard, applying changes / coding, and the other may be more observing and commenting (may differ approaches for 'paired work').

Further info at:

https://en.wikipedia.org/wiki/Extreme_programming



HPES TEAManology

3 Types of Teams:



- Study Buddies Team (SBT)
 - An optional thing, but suggested strategy
 - Small team of peers to help each other learn
- Prac Assignment Group (PAG) *
 - Independently or as a team of 2
- YOda Group (YOG)
 - 4 members. Form prior to starting YODA project

* *Disclaimer:* You or your teammate may need to give impromptu explanations or demonstrations of what you have done to demonstrate that you both know what you are doing (if the one member seems clueless then you might both get marks deducted). The lecturer may also do random spot checks to request students to do brief prac oral tests.

Lab Practicals

#	Title
TERM 1 PRACS	
1	MATLAB/OCTAVE: <i>basic operations, graphing, implement function.</i>
2	MATLAB Parallel Computing Toolkit {may change to OpenMPI}
3	OpenCL: SIMD on GPUs
	<i>(Optional) pThreads dynamic: dynamic partitioning and speed comparison to static partitioning</i>
TERM 2	
4	Simulation-based IP Core Integration Using iVerilog or Vivado
	YODA Project
...	Remainder of the prac sessions will swing to working on Your Own Digital Accelerator (YODA) project. (Prac4 due early in Term 2)

Links to recommended C / C++ tutorials if you haven't used C much before: <http://www.cplusplus.com/doc/tutorial/>



GA2 Task and Assessment

A tiny (5%) but crucial part of your mark

Something the SBT team can help with

- The purpose is to

- Evaluate you on achieving GA2 ← NB

GA2= Application of scientific and engineering knowledge

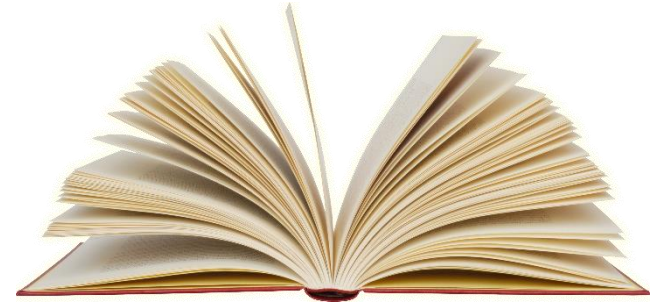
- It is for DP! (only DP for engineering students)

- The approach:

1. Given a reading related to a natural phenomenon.
2. Demonstrate comprehension of this
3. Given a desired engineering product / problem related to this phenomenon
4. Explain how you would (applying your engineering skills) to develop a solution
 - The combination of a written test (for #2) and a lab practical (for #4) is used to evaluate this.
 - Use skills learned in lectures & pracs



Readings

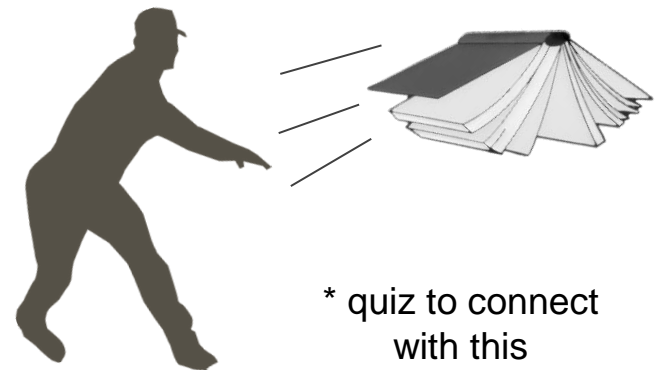


- Readings related to lecture topics will be suggested, students can also use the Chat to suggest additional resources to help learning etc (any of these sort of posting will be reviewed and commented on by the lecture/TA)

Heads-up on Reading Task 1...

- Reading 1 (do before lecture next week*)
 - See Resources/Readings on Amathuba site
 - R01: L01 Berkeley 2006 - Landscale of Parallel Computing Research
 - Asanovic *et al.* "The Landscape of Parallel Computing Research: A View from Berkeley"
 - R01b: L01b Berkeley 2009 - A View ... by Asanovic et al (AD)
 - Newer, more concise and better illustrated take on these issues
- Suggestion:

There are many useful concepts explained here, but I'd suggest reading R01 quickly (various details can be skipped) and read R01b more closely



* quiz to connect with this

Course Project

EEE4120F

Project in this course...

fairly **BIG** project – implementing a digital accelerator on FPGA/GPU

I'm open for new project ideas!

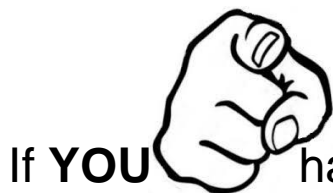
Current list of topics: <http://ocw.ee.uct.ac.za/courses/EEE4120F/YODA.html>

Thoughts on

Final year projects?

Eeeek!!

Various 4th year projects on offer, can share link if interest:



If **YOU** have an idea of a project you want to suggest (within my area of expertise) I'd consider supervising it and adding it to my list of BSc projects offered. *

* Would need to prepare a description and discuss it with me pref. early March.

idea



You can finish the slideshow here...

But please remember to
do Quiz 0 (handout and will share on Amathuba)

... or you can continue to see some (in some cases) inspiring points about HPES and its job-market in SA and elsewhere.



Emergency Stop Button

Some thoughts & Inspirations...

HPES Job Market



FREE Creative Commons License

UKULELE

Music: <https://www.bensound.com>

Click to get to it...

Some inspiration &
food for thought...



What are You Considering...

Your own startup

vs.

Work for someone

vs.

Postgraduate work



Decide later?

Consider the pros & cons

- Postgraduate work
 - Like researching & experimenting; initially pay not as good though.
 - Might want to dev. own product, get support from adviser & community, lab space
 - May lead to better job options later
- Work for someone
 - Gain experience, very beneficial; but likelihood of doing further study tends to diminish over time
- Working for yourself?
 - Nice idea and big possibilities 😊..
 - but more risky ☹️



Thinking about your own business

- **Toying with an idea of starting your own business?** Then ask yourself:
 - Why do you want to go into business?
 - List your reasons; pros & cons..
- What is the right business for you?
 - Your ambitions; your work ethic;
Your emotions; Your connections
- What niche/new product will you provide?



High-tech products super highway



You?

Your own business (harsh) realities

- What **resources** are needed? (equipment, software, people, space)
- How long before it's **self-sustaining**?
- How much **cash** does it need?
- How will it make a **profit**? (business model)
- Where can I get the finances / should I get a business loan? *
- All the while maintaining your own living expenses?

* As a graduate (esp. young graduate like most of you will be soon) with a good idea or IP and promising business plan, then there's actually many options (at least for SA citizens), where you don't need to commit your own or family's hard earned cash, e.g. using an incubator or somehow having the government / venture capitalist give you a chance (but in exchange for a cut of the future earnings and/or demonstrating that you business will be creating jobs).

Some harsh realities

Where is there work for
computer engineers?

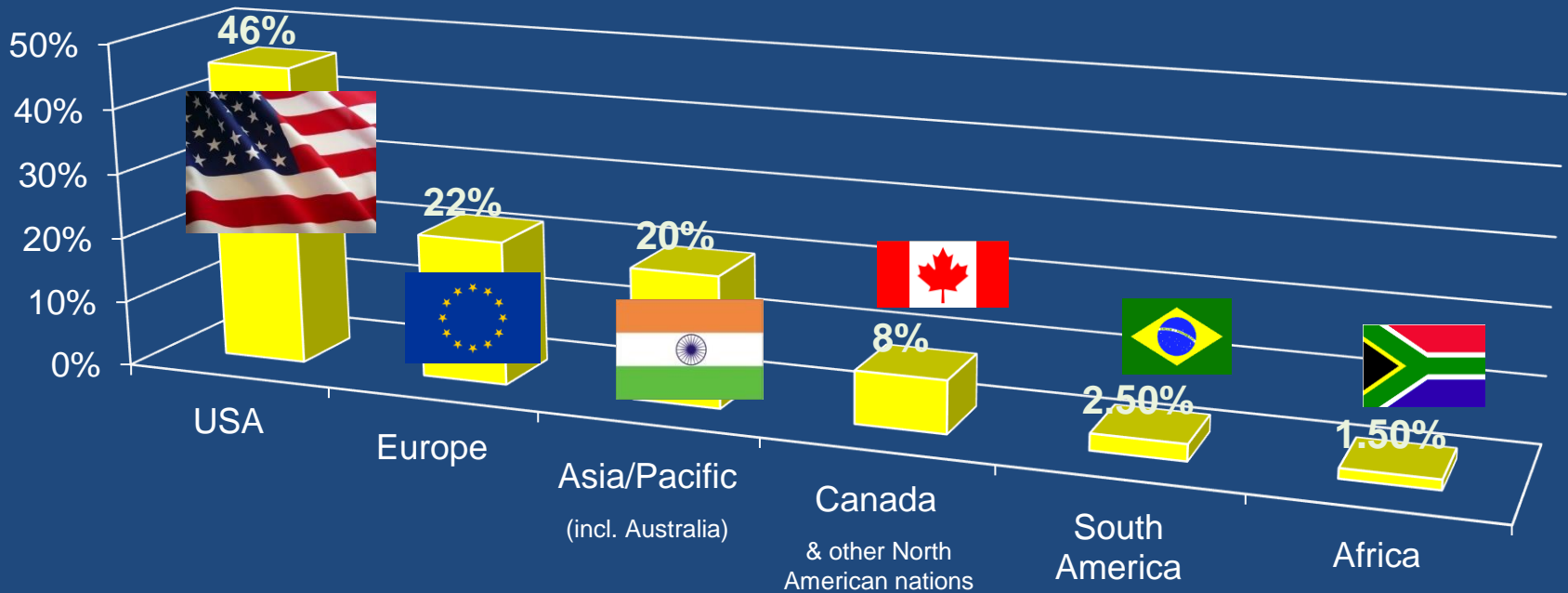


(Most especially high-paid ones!)

Map of the world – where are the EC jobs?



Where the jobs are...



Oh, really?! Well, I'd like a second opinion...
I wonder who or what I should ask for that?

Data based on: Cass, S. 2007. "Where the jobs are", In *IEEE Spectrum*: 44(2). pp 51-57

Note: in the case of continent the flag represents the country with the largest electronics industry

... Probably the same who or what to ask
spring to all of your minds too...





Which country has the most need for embedded systems developers?



The demand for embedded systems developers varies by country and is dependent on several factors such as the size and growth of the technology and manufacturing industries, government investment in technology, and the development of new technologies in the field of embedded systems.



That being said, some countries that have a high demand for embedded systems developers include:

USA

1. United States: The US has a large technology industry and a thriving startup culture, which creates a high demand for embedded systems developers. Major technology companies like Apple, Google, and Intel have a significant presence in the country, and there are also many smaller companies that specialize in embedded systems development.

Europe

2. Germany: Germany is a leading country in the manufacturing industry, and as such, has a strong demand for embedded systems developers. German companies in the automotive, aerospace, and industrial automation industries are among the largest employers of embedded systems developers in the country.

Asia

3. Japan: Japan has a strong technology industry and is home to many companies that specialize in electronics and embedded systems. The country is also at the forefront of the development of new technologies in the field of embedded systems, and as such, has a high demand for embedded systems developers.
4. China: China has a rapidly growing technology industry and a strong focus on developing new technologies in the field of embedded systems. The country has a large number of technology companies, including embedded systems development, and the demand for embedded systems developers is projected to

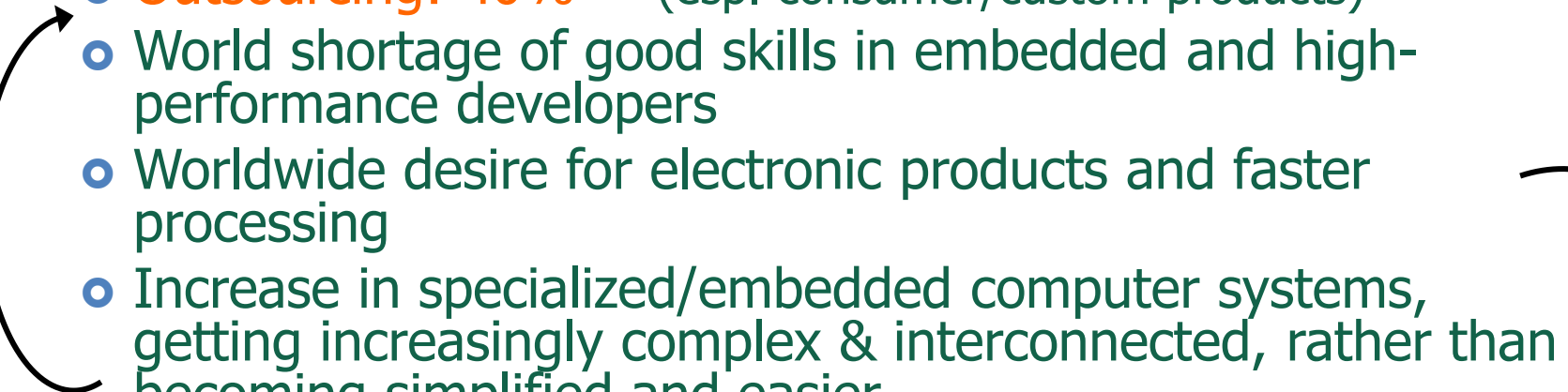
Regenerate response

embedded systems



Pretty much agreement!

Some realities

- Where is work for computer engineers?
 - Most in: USA, Europe (& UK), China and India
 - But opportunities in RSA ... (see next slide)
 - Good news: – *if you're skilled*
 - Outsourcing: 40% * (esp. consumer/custom products)
 - World shortage of good skills in embedded and high-performance developers
 - Worldwide desire for electronic products and faster processing
 - Increase in specialized/embedded computer systems, getting increasingly complex & interconnected, rather than becoming simplified and easier...
- 

Embedded Systems/HPES in SA?

- A range of industries doing work in this area
 - Government e.g.:
 - SA Radio Astronomy Observatory (SARAO) / SKA
 - South African National Space Agency (SANSA)
 - iThemba LABS, CSIR
 - Private e.g.:
 - Reutech, Denel Dynamics, Tellumat (Defence, Air traffic, Security, ...), Cybicom Atlas Defence
 - Anglo American (mining tech & IoT), DetNet SA (mining tech)
 - SCS Space, BlueCube, Alphawave, Simera-Sense (IoT and processing)

Where to start a business?



Certainly there is serious work happening in this area locally!
And it could skyrocket* if business conditions were favourable ... at present SA does not offer very favourable business conditions, too many risks etc. This also restrains expansion of existing business.
*and achieving skyrocketing, in the physical sense, tends to need a good bit of power.

Are these job statistics something to worry about?

What, Me Worry?



o That depends...

- o Graduate in engineering/CS that did well seem to find work wherever they would like to be (with some obvious limitations*).
- o Although many of our graduates end up doing nothing related to their degree (e.g. financial consultancy), it doesn't mean there aren't plenty jobs out there that would use the skills you have learned in your programme.
- o In all, getting your BSc will most likely be worth all the effort 😊

* Certain countries have next to zero – or less – work going on related to computer system development (by 'less' you can interpret however you like; which could be smelting down old machines to extract metals).

Reminder...
try quiz0 if haven't done yet

End of lecture 1

Summary:

You and I have (hopefully) managed to find the correct venue 😊

We discussed a number of relevant, and some not-so pertinent, issues

You're hopefully been fired up with ideas of

- considering projects to work on this year
- thinking about postgrad study
- considering your own business / finding work & gaining experience

Lecture 1: Meet & Greet