SPECIES

D4 System Design Exercise 2015

Super Professional Ergo Classy Integrated Electronic System

Synergistic Programmed Electronics Controlling Integrated Environmental Sensors

Stupid Pile of Extremely Complex, Inefficient Electronic Shit
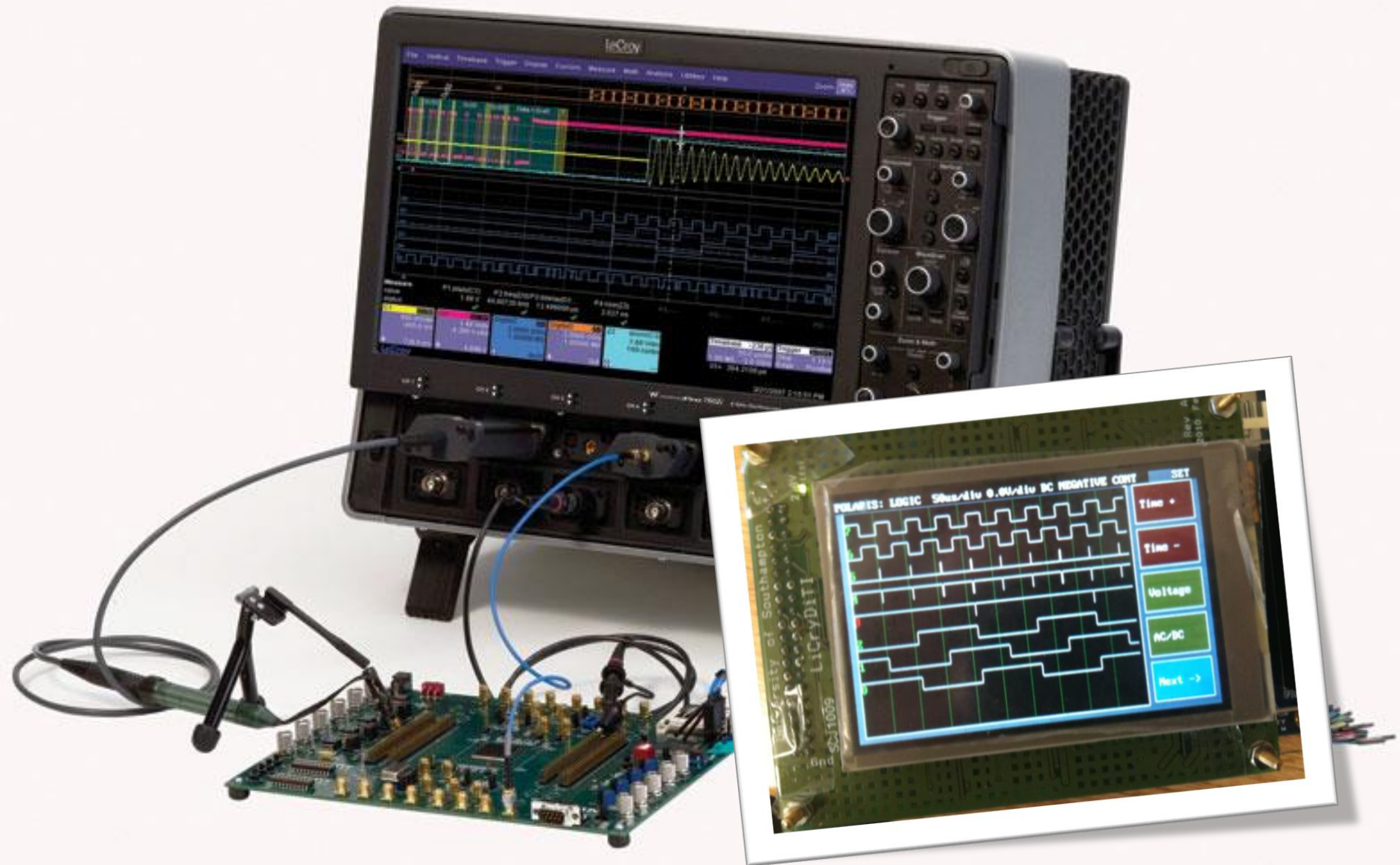
SPECIES

Solar Powered <incomplete> (some kind of new solar powered robotic species)

Smart Program for Energy Controlling with Integrated Electronic System

Smart Phone Entertainment Control with Integrated Electronic System

POLARIS

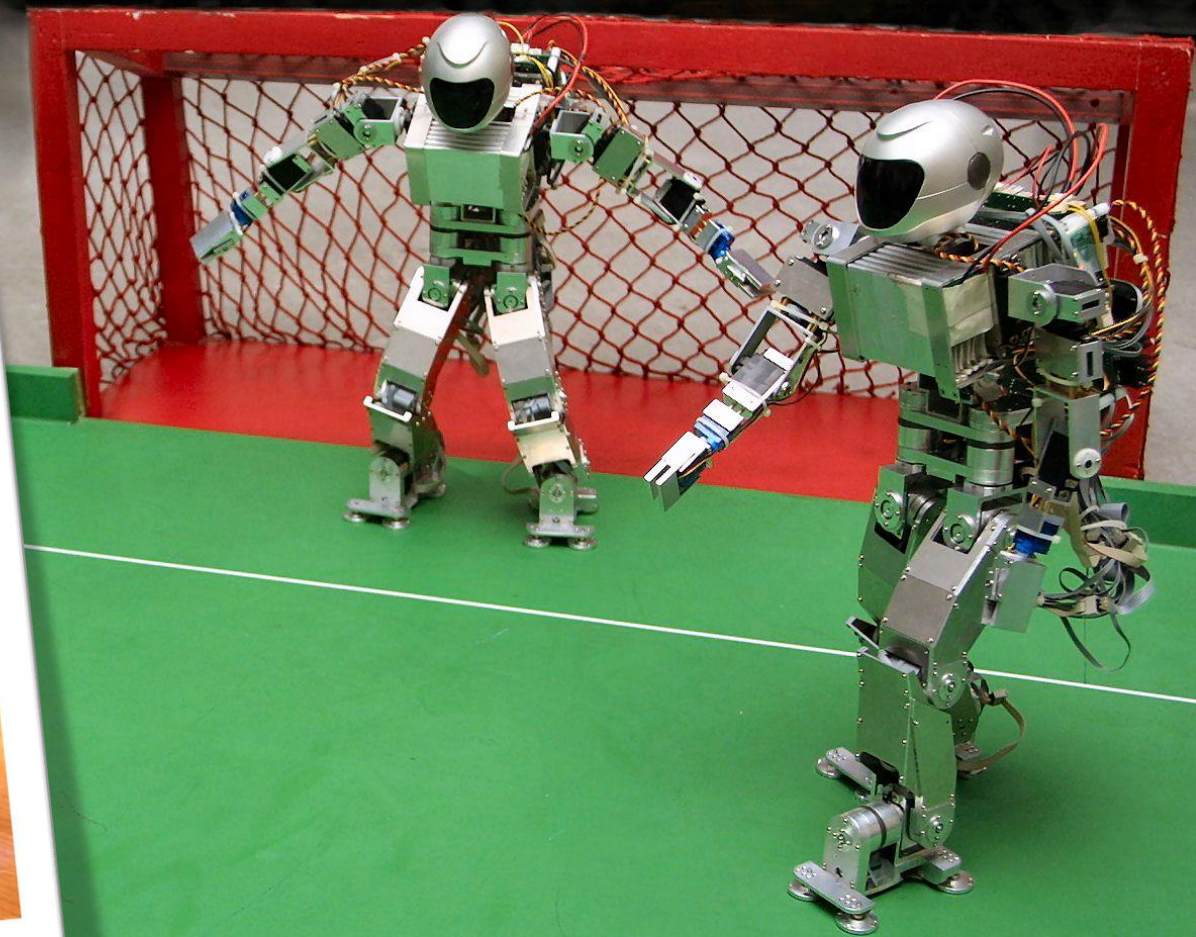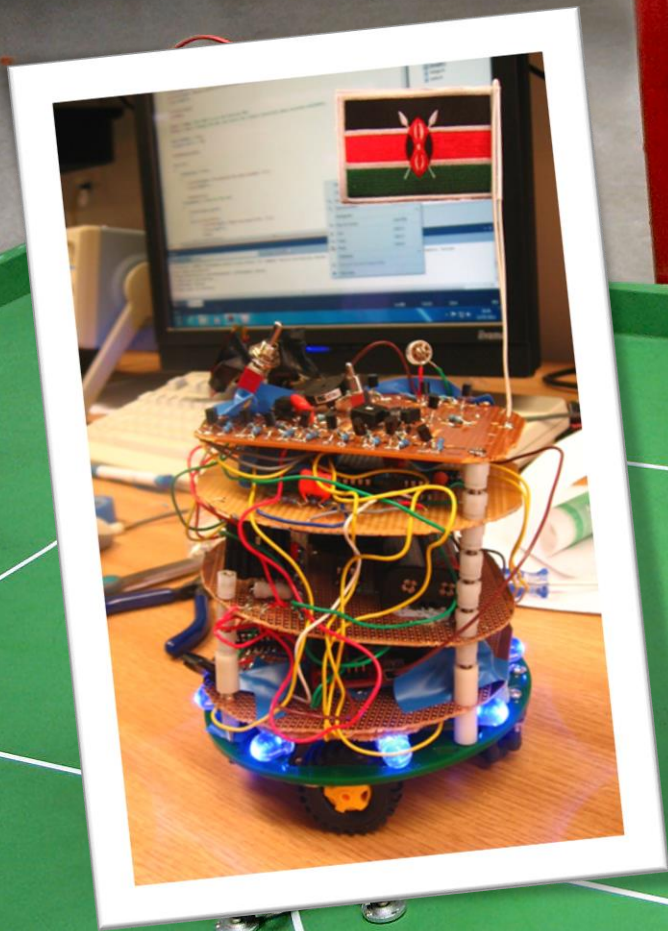**Portable Oscilloscope, Logic Analyser, Robust Instrumentation System**

HG WELLS

Hand-held Game With Electronic Levers, Lights and Sound

SAILORS
Sensors, Autonomy and Intelligence at the London 2012 Olympics: Robotic Soccer
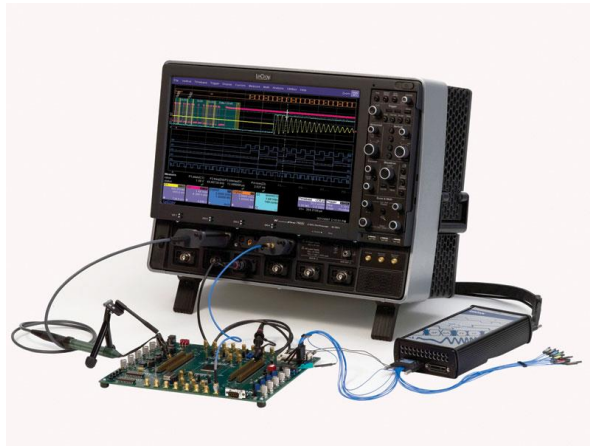
SPRING CHICKEN

**Sensing Providing Reliable, Independent, Next Generation Care at Home
– Intelligent Communication Keeping the Elderly out of a Nursing Home**
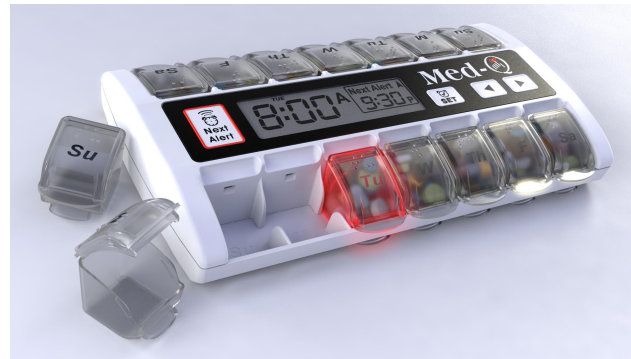
BOOMBASTIC

Body-Operated One-Man Band with Amplification,
Storage and Transmission Integrated Circuits

Scenario + Challenge
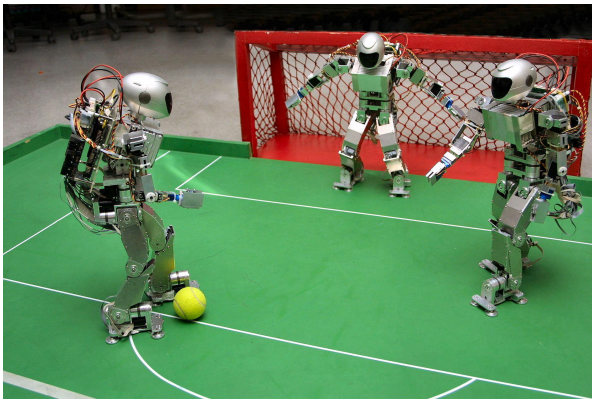
Scenario + Challenge

- Your team is a small (5-6 ppl) electronic design consultancy

- The human race urgently need a **secure, portable communication system** to ensure its survival

- You have been approached by a customer (the human race) to create a prototype of this...

- ...in only 12 working days (design, build and test)

- The customer has also contacted 10 other design consultancies to produce competing designs

- You will market your product at a trade fair held by the customer, where it will be judged on innovation, features, performance, price, aesthetics and marketing

SPECIES

a

Secure

and

Portable

Electronic

Communication

Invention

to

Ensure

human

Survival

Requirements

Your product must include the following aspects:

User Input – i.e. capturing data to communicate, e.g. keypad, microphone, camera etc. MUST capture human voice (at least 4kHz BW), but encouraged to supplement this!

User Output– received data MUST be presented to the user, e.g. display screen, speaker, headphone, tactile feedback etc.

Wireless Communication– MUST be capable of real-time, low-latency, short-range (10s of m) wireless comms

Security– Communication MUST be secure (i.e. safe from eavesdropping or malicious modification). Authentication?

Resilience – You MUST ensure that multiple communications can occur simultaneously (inc other teams!)

Power management – MUST be portable, and operate for extended periods. Size/weight/lifetime trade-off.

What else can it include?

Pretty much anything you like - be as creative as you wish

- Additional handsets
- Data compression
- Adaptive audio capture
- Speakerphone
- Ringtones/notifications
- Appearance, mechanical operation, ruggedisation
- Peer to peer communication
- Hand free operation
- Storage
- Sign language recognition as an input
- Speech recognition and tactile (morse code) output

Be Creative!

Evaluation

The following points will be considered:

- Difficulty of the problem addressed
- Creativity and innovation
- Electronic design
- Ease of use of the device
- Aesthetics
- Cost
- Reliability
- Documentation

Team Working

- Key components of D4 are:

  - Working in (new) groups of 5-6 individuals

  - Partitioning a large task effectively amongst the group

  - Initiative, creativity and innovation

  - Mixed-signal electronic design

  - Costing and budgeting

  - Managing risk and adapting to unexpected events

  - Time management

  - Troubleshooting

- It is artificial, but it is good preparation for the individual project in year 3, and especially the group project in year 4.

Week 0: Introduction

Day	Time	Location	Activity
Thur 19/2	10:00-12:00	46/2003	Kick-off Presentation
	Outside Lectures		First Team Meeting
Fri 20/2	Outside Lectures		Initial investigation and design

Week 1: Design and simulation

Day	Time	Location	Activity
Mon 23/2	Outside Lectures		Refine initial design, and draft first versions of software (SystemVerilog, C, …) Collect box of bits from the Zepler Lab Support Hatch
	Appendix G	Laboratory	Design Clinic (20 minute slot per team)
Tue 24/2	Outside Lectures		Refine design, prepare project proposal form and draft first versions of software
	14:00	Zepler Lab Support Hatch	Deadline for submission of kit & component requisition form to David Kemmish/Mark Temple and ECS Electronic Handin System.
Wed 25/2	Outside Lectures		Refine design, prepare project proposal form and draft first versions of software
Thur 26/2	Outside Lectures		Refine design, prepare project proposal form and draft first versions of software
Fri 27/2	10:00	Electronic Handin System	Submit project proposal form to the ECS Electronic Handin System.
	10:00-13:00	Laboratory	Teams Armageddon – Halo: initial investigations in the lab. Negotiation of design completion form with Geoff, Steve or Rob.
	14:00-17:00	Laboratory	Teams Independence – Terminator initial investigations in the lab. Negotiation of design completion form with Geoff, Steve or Rob.

Week 2: Prototyping and construction

Day	Time	Location	Activity
Mon 2/3	10:00-13:00	Laboratory	Teams Armageddon – Halo prototyping in the lab with supervision
	14:00-17:00	Laboratory	Teams Independence – Terminator prototyping in the lab with supervision
Tue 3/3	12:00	Lab Support Hatch	Scheduled delivery of kit & components ordered from Onecall and RS
	Outside lectures	Laboratory	All teams have an opportunity to work in lab without supervision, subject to the agreement of the lab support staff.
Wed 4/3	Outside lectures	Laboratory	
Thur 5/3	Outside lectures	Laboratory	
Fri 6/3	10:00-13:00	Laboratory	All teams prototyping and assembling sub-systems in the lab with supervision
	14:00-17:00	Laboratory	

Week 3: Final assembly, evaluation, and report production

Day	Time	Location	Activity
Mon 9/3	10:00-13:00	Laboratory	All teams completing final assembly and evaluation with supervision. You may like to capture some video footage and still imagery of your prototype(s) in action.
	14:00-17:00	Laboratory	
	16:30		All construction stops
	17:00		Deadline for finalising design completion forms, handing over your prototype(s) and returning other items to the Zepler Lab Support Hatch
Tue 10/3	Outside lectures		Fill out the project completion form (Appendix E).
Wed 11/3	Outside lectures		
Thur 12/3	Outside lectures		Your team should write the final report.
Fri 13/3	Outside lectures		
	16:00		Deadline for the final report. Each member of your team should submit their individual report to the ECS Electronic Handin System. One member of your team should submit the group report to the ECS Electronic Handin System and print out the receipt. The receipt should be bound to a hard copy of your group and individual reports, which should be submitted to the Zepler reception before 4pm on Friday 13th March.

Week 4: Trade Fair

Day	Time	Location	Activity
Mon 16/3	Outside lectures		Prepare trade-fair slides to detail the technical, marketing and costing aspects of your prototype. Prepare a video advert lasting no longer than one minute to showcase the features of your product to a commercial audience.
Tue 17/3	Outside lectures		
Wed 18/3	Outside lectures		
Thur 19/3	Outside lectures		
	16:00	Electronic Handin System	Deadline for submitting presentation slides and advert to the ECS Electronic Handin System
Fri 20/3	10:00-13:00	67/1007	All members of your team should attend the trade-fair. One member of your team should present your slides and advert.
	14:00-14:30	Laboratory	One member of your team should attend to setup your hardware, ready for demonstration to the judges.
	14:30-17:00	Laboratory	One member of your team should attend to demonstrate your hardware to the judges.
	17:00-18:00	Laboratory	All members of your team should attend the closing ceremony. Teams with working prototypes are invited to give a quick live performance and prizes will be awarded by the judges.

Think about your specification

- How will you test your designs?

- Keep it simple

- Break into smaller pieces – and think about the interfaces!

- Timing. What is the data rate, bit rate etc? How does this fit with the performance of different components?

- Wiring, the less wiring the better, less chance of failure.

- Simulation is a tool, use it

Design Clinic

- Run by Tim Forcer who has much past experience with D4.

- Arrive on time to your allocated 20-minute slot on next Monday.

- What to bring?

  – A sketch of your envisaged product

  – A 150 word summary describing what it does

  – A high-level block schematic

  – Some Questions

Risk Management

- To successfully manage this intensive/demanding project, you'll need to carefully manage risk throughout, e.g.:
    - You can't get components to work (2012)
    - You can't get access to the lab (2014)
    - Team dynamics (most years)
    - Technical and System integration (all years!)

Evaluating risk

Likelihood

Severity		1 Remote	2 Unlikely	3 Possible	4 Likely	5 Certain
1	Trivial	1	2	3	4	5
2	Minor	2	4	6	8	10
3	Lost time	3	6	9	12	15
4	Major	4	8	12	16	20
5	Fatal	5	10	15	20	25

Hazard	Severity	Likelihood	Risk	Control	Controlled Severity	Controlled Likelihood	Controlled Risk
Components are damaged/broken through misuse	3	4	12	Comply with ESD handling guidelines. Confirm correct wiring with datasheet before applying power. Turn off power before rewiring. Order a spare of key components, if budget permits.	2	2	4
							24

Box of Bits

- To help you get started we provide each team with some components:
  - 2 AVRs

  - 1 SD card and SD card adapter

  - AVR Dragon

  - 2 RFM12B Wireless Transceivers (untested!)

  - Connectors and cables

  - Il Matto (x2) and Il Bagatto (x1) prototyping boards

- There is no obligation to use any of these components

- You will need other components to meet the requirements

What other components can I use?

- Anything we have in stock?

  - *Yes (e.g. accelerometer, TFT display, camera, FPGA, etc.)*

- How do I find out?

  - *Ask stores, but make a list and be prepared. Don't waste their time. Nominate one member of your team to interact with stores.*

- Will components be ordered?

  - *Yes, tell us what you need, but don't go for "canned" solutions. Your team has a budget up to 50 pounds for non-stocked components.*

- Can I buy my own?

  - *Yes, if you can make a good case for it in your project proposal form.*

- What components are banned?

  - *Complete canned solutions or design kits*

- What programming language must I use?

  - *Anything you like that gets the job done*

Deliverables and Assessment

- The weighting of the deliverables is approximately:

    - 5% Project Proposal Form,

    - 15% Constructed Prototype & Design Completion Form,

    - 5% Project Presentation,

    - 10% Team report (3000 words)

    - 65% Individual report (3000 words)

- At the end of the project, your team will have to agree on the effort contributed by each team member. This will be used as an indication of how team marks should be allocated across the team.

How do I get a good mark?

- You should expect to put in 75 hours of effort each

- You are a team – work as one.

- The lab is closed during lecture hours, but make good use of it when it is available to you (**don't skip Lectures**).

- **Good**: Innovative, simple, working, maybe partially, but most elements work.

- **Bad**: Complex, faulty, complete system where nothing works.

- Testing is more than just 'does it work?'!!! *How well* does it work?

- Good project management:
  - Use forge.ecs.soton.ac.uk and/or sourcekettle.ecs.soton.ac.uk
  - Skills audit; breakdown tasks; prioritise tasks;
  - Manage risk, and adapt when things don't work!

Academic Integrity

- You may wish to use elements of hardware or software of other designs you may be able to find. This is <u>only</u> acceptable provided you follow the standard procedures for academic integrity (https://secure.ecs.soton.ac.uk/kb/entry/35/).

- Simply copying large parts of another design will result in a low mark for the exercise. However, re-using and referencing an element from another design because you understand it and think it is good is fine. With software make good use of libraries where they exist – do not write a low-level graphics library for your display if one already exists – use it!

- Ultimately, the balance between your own ideas and those of others will moderate the marking of your design.

Design completion form

- You will define your own milestones which will be signed off by members of staff as you progress. Example below:

Component of system/Milestone	Supervisor	Time/Date	Comments (all/part/none working; protoboard/constructed)
Wireless modules interfaced with embedded devices			Data rate _____ kbps
Wireless communication of speech between devices			Audio bandwidth _____ Hz -> _____ kHz, Typical range _____ m
Bi-Directional Voice communication between devices			Latency _____ ms
Offline encryption/decryption of data on embedded device			
Encryption/decryption of transmitted audio			
Encryption/decryption of transmitted messages			
Sinusoidal input to audio amplifier can drive 8 Ω load			Gain _____ Bandwidth _____ Hz -> _____ kHz
Amplifier driving speaker with volume control			
Interfacing of LCD with processor to present basic GUI			
Data messages entered via keypad			
Data messages transmitted, received and displayed on LCD			
Peer-to-peer transmission of messages via a third device			
Processor can record FAT formatted wav files to SD card			
Processor can replay audio recordings from SD card			
Power management of complete system			_____ mA , at _____ V = _____ mW. Batteries should last for _____ hrs.
Complete system is integrated			Mass _____ g (per device), Dimensions _____ x _____ x _____

Trade Fair

- 21st March, to pitch your design to the customer and your classmates.

- Five minute presentation of your final design, describing:
  – your target market and costing of your device,
  – your design,
  – the problems you encountered,
  – and the performance of the final prototype.

- One minute video advert

- Elect one team member to give the presentation

- Think how you might make it stand-out from the others.

BAE Systems Applied Intelligence

System Design Prize

- This exercise is competitive: £100 Amazon Voucher for each member of winning team

- Judging panel made up from ECS and BAE Systems Applied Intelligence staff

- The judgement will be made on the submitted hardware, design completion form and presentation.

- The winners will be announced at the trade fair on the afternoon of 21st March.

ELECTRONIC SYSTEMS GROUP

Applied Intelligence
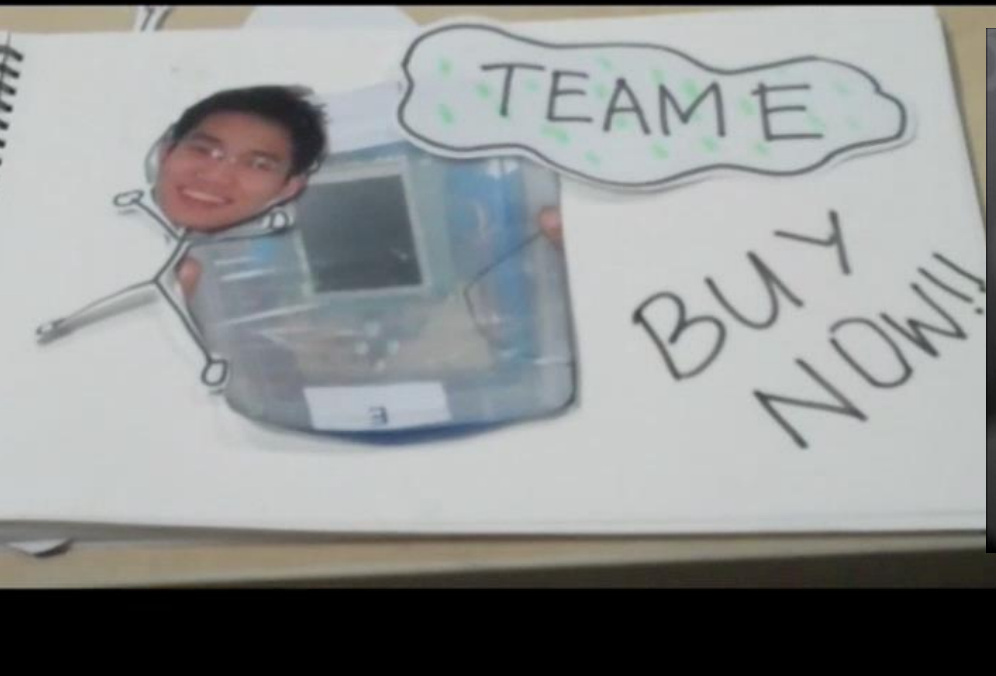
BAE SYSTEMS
INSPIRED WORK

Class list

Armageddon
Presley,Samuel David
Casino,Andrea
Zaimuddin,Muhammad Arif Fikri Bin
Meng,Jiuxi
Carville,Christopher
Gevorkyan,Grisha

Cloverfield
Ruttley,Nathan Edward
Sturgeon,Joseph Michael
Moore,Fiona
Khoja,Alaa
Zhi,Yubo
Hu,Diwen

Doomsday
Hayes,Harry John
Upton,Joshua
Chan,Vincent
Taylor,Robin
Chien,Samuel Haozart
Liu,Yushuo

Godzilla
Fletcher,Benjamin James
Rowland,Aaron
Karatziolas,Georgios
Johnson,Ryan
Malik,Rohan

Halo
Middleton-Jones,James
Wilson,Henry Walter
Patel,Rinesh
Barber,Terra
Zeng,Junming
Lan,Tu

Independence
Borisevic,Artur
Sheppard,Gerry
Lau,Anthony Hok Bun
Aggarwal,Sumit
Hamlin,Peter
Shao,Shuai

Matrix
Cosslett,Jack
Maskell,Dominic
Harris,Kieran James
Hurst,Oliver Sebastian
Bengougam,Michael

Oblivion
Eyre,Patrick
Percival,Huw
Akurunwa,Chidi David
Clark,Thomas James
Fok,Tobias Tak Jing
Sun,Jiayang

Prometheus
Curati-Alasonatti,Emma Clotilde
Scheul,Tudor Emilian
Niven,Jonathan Gregory
Thomas,Katrina
Holbrow,Christopher Iain

Robocop
Saxby,Robert
Gonzalez,Nicholas
Scott-South,Michael
Woodward,Ciaran
Bashaagha,Ali Fathi Ali
Zhou,Fuxin

Terminator
Khorani,Edris
Agu,Kenechukwu Richard
Chahal,Hardeep Singh
Furlong,Timothy James
Mahendra Jain,Shantanu

Lab Bench Allocation

Design Clinic Schedule

Monday 23rd February in the D area of the Electronics lab

Team	Time
Armageddon	11:00 – 11:20
Cloverfield	11:25 – 11:45
Doomsday	11:50 – 12:10
Godzilla	12:15 – 12:35
Halo	12:40 – 13:00
Independence	14:00 – 14:20
Matrix	14:25 – 14:45
Oblivion	14:50 – 15:10
Prometheus	15:15 – 15:35
Robocop	15:40 – 16:00
Terminator	16:00 – 16:20

Contact Details

If you have any queries or problems, please contact:

Management Problems	Geoff Merrett (gvm@ecs.soton.ac.uk) David Oakley (do@ecs.soton.ac.uk)
Technical queries	Steve Gunn (srg@ecs.soton.ac.uk) Rob Maunder (rm@ecs.soton.ac.uk) Geoff Merrett (gvm@ecs.soton.ac.uk)
Kit & Components	David Kemmish (dk@ecs.soton.ac.uk) Geoff Merrett (gvm@ecs.soton.ac.uk) Mark Temple (mst@ecs.soton.ac.uk)
Equipment problems	Jeff Hooker (jh1@ecs.soton.ac.uk)
Construction issues	Jeff Hooker (jh1@ecs.soton.ac.uk)

(Mark all messages "D4 Query" to ensure a prompt reply.)

Further Information

- D4 website

  – Handbook

  – These slides

  – Requisition form

  – https://secure.ecs.soton.ac.uk/notes/elec2205/D4/