Integrated Design Project

Lent 1, L2, 2022-23
Lab Groups 85-119

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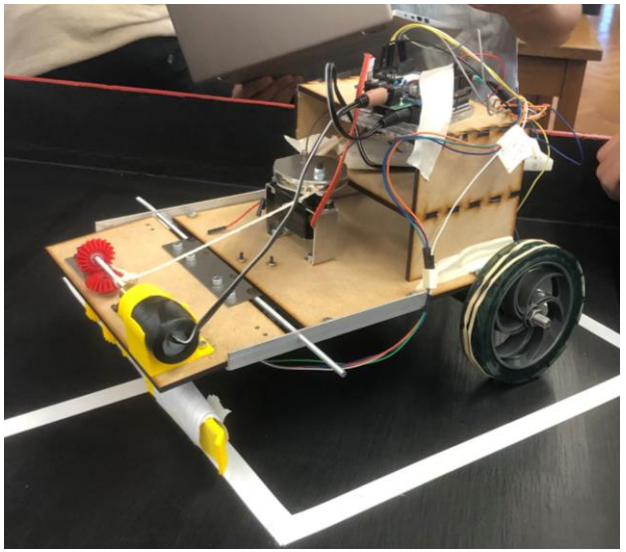
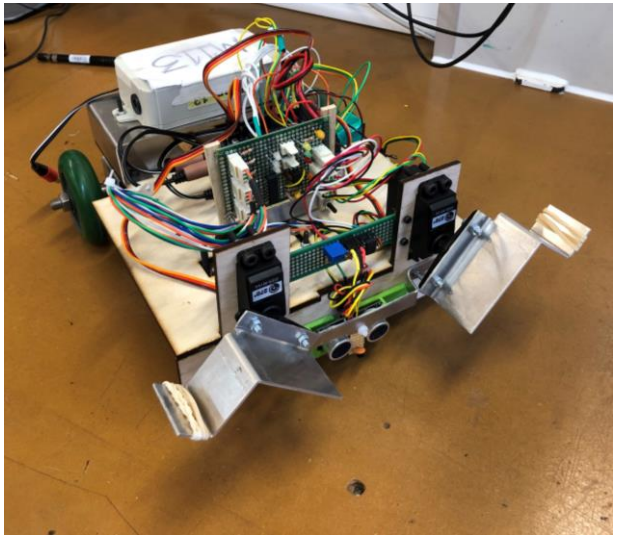
All details and resources can be found at:

- **Moodle: 2CW Integrated Design Project v.2**
- Keep checking back, new information being added
- Make sure you receive announcements
- Morning labs and competition are compulsory – rearrangements are possible but must follow Teaching Office process

IDP: Aims & Objectives

- Mobile AGV design
- Teamwork
- Construct and testing
- Integration
- Project Management
- Competition



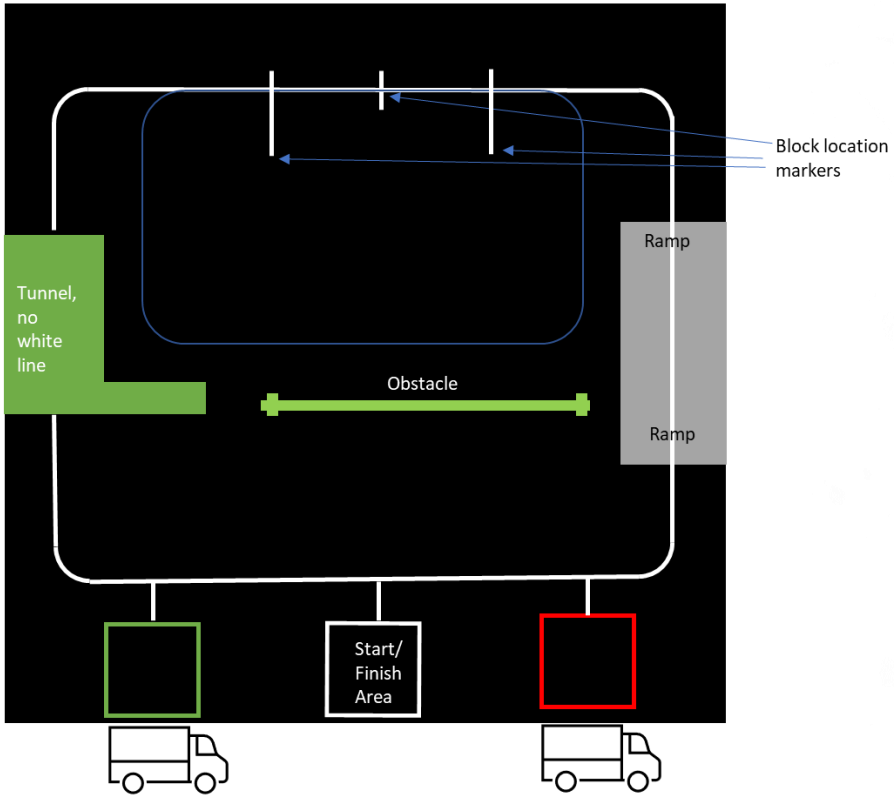


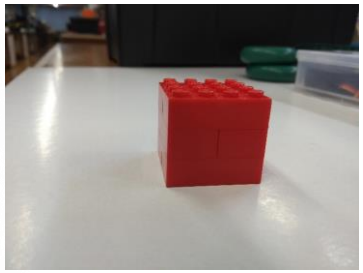
Key Dates

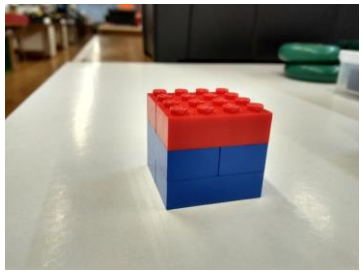
Thurs 9th Feb: First Competition

Wed 15th Feb: Final Competition

The Task: Find, Recover, Sort Colours



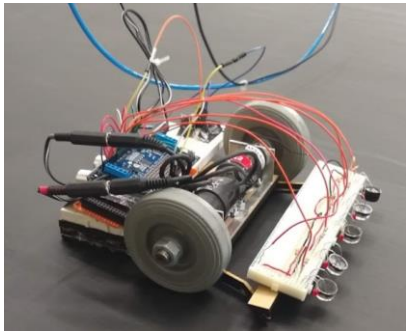




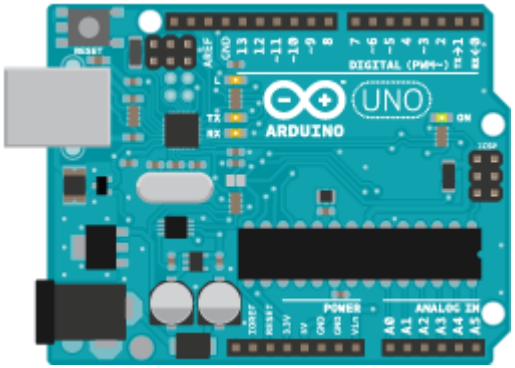
- Competition – points for various parts of task – see specification
- Can restart with 5 mins allocated, score and table reset
- No limit on number of blocks, after 3 they will be randomly place on markers

IDP: Rapid Prototyping Approach

Rapid Prototyped AGV



Microcontroller: Arduino



- C++ IDE
- Analogue, Digital I/O
- PWM
- Wifi

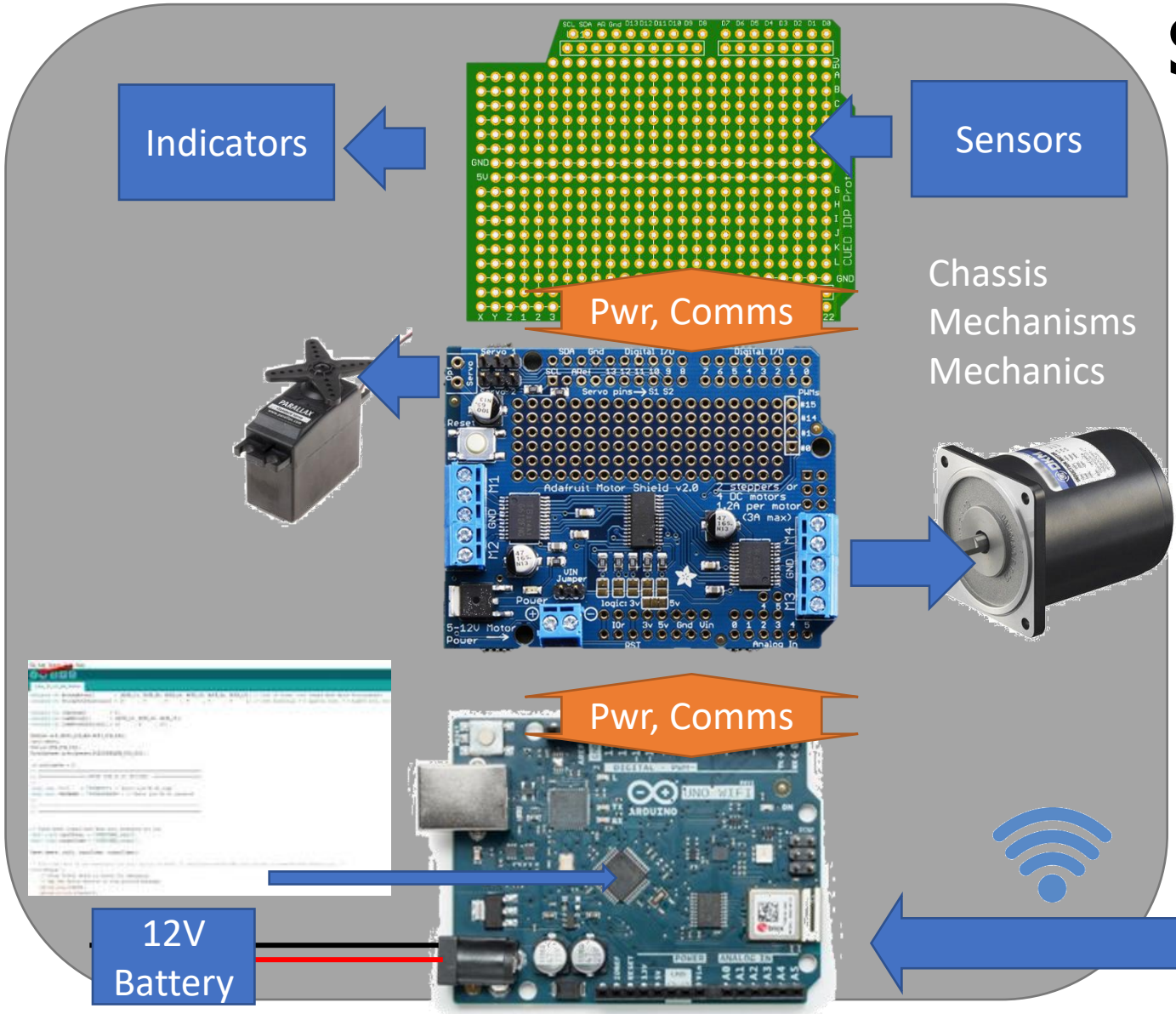
Mechanics: Chassis Development

- Laser cutting (MDF/Plywood)
- 3D printing (PLA)
- Metal parts (right angle section, tubing)
- Fastenings – bots/glue
- Wheels, castors, other parts provided

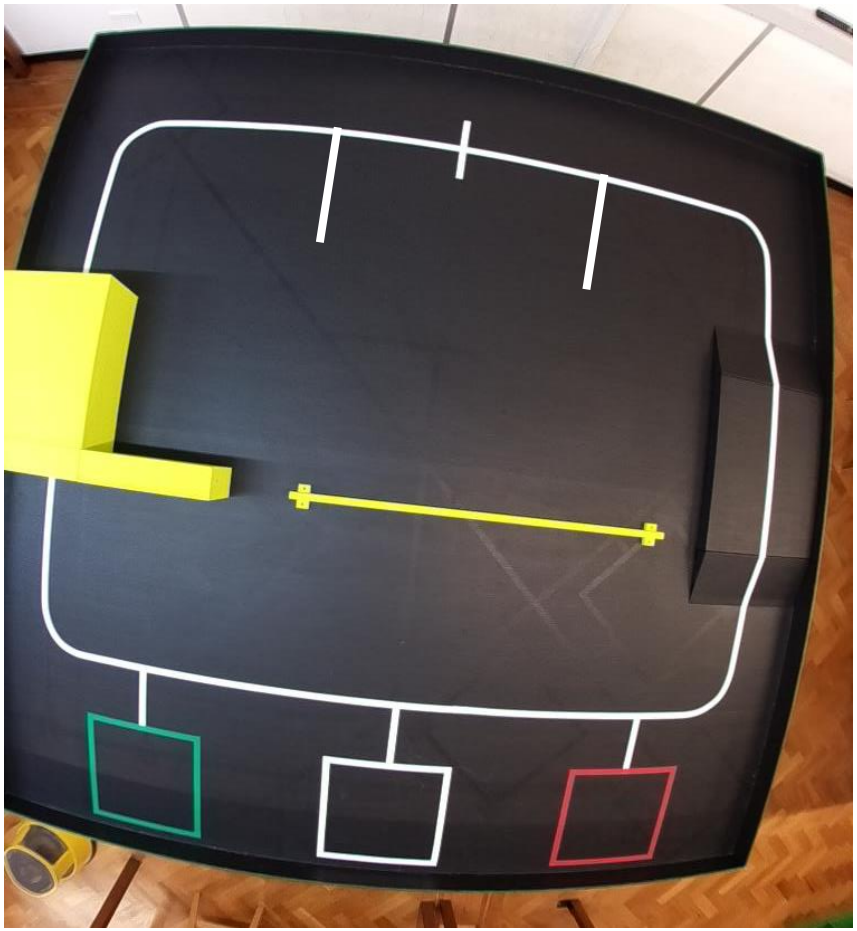
Interface electronics

- Motor shield provided
- Prototyping shield/strip board
- Bank of standard electronics given
- Sensors: Ultrasound, IR, compass, accelerometer, microswitch + many more
- 1A kits

IDP: AGV System

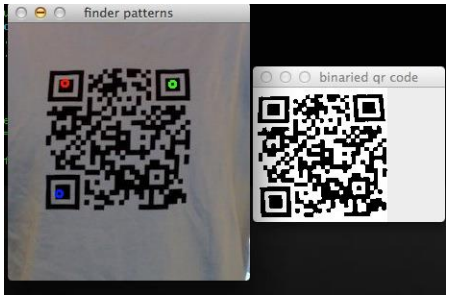


Camera above the field...



Use of computer vision isn't mandatory
Additional complications from changing lighting
2 tables have different cameras and positions

- Determine orientation of robot



- Determine location of robot (challenging!)

IDP: Rapid Prototyping Mechanics

Mechanical Development

- Cardboard will be provided (which can be used in the laser cutting) to test develop a Chassis
- 2 sheets of 300x600 MDF/Ply (3mm, 4mm or 6mm) can be obtained from the Dyson Centre Technicians for laser cutting.
- Once **trained** laser cutter keys can be obtained from the Dyson Centre technicians
- 3D printers (self service) and waterjet cutters – 'order' via Moodle forum.
- Think about best approach use manual processes along with lasercut/3D print.
- Be mindful that there are other students using the Dyson centre facilities…
- If there is something you believe you can't do MDF/Ply and want to use metal, come and talk to us!

Plan scheduled lab sessions to do mechanical work in the Dyson centre to make best use of this time.

Health & Safety: Think about risks, use appropriate protective equipment (inc. fans when soldering), use common sense and if in doubt ask!!

IDP: Rapid Prototyping

Arduino software can be downloaded for free:

https://www.arduino.cc/

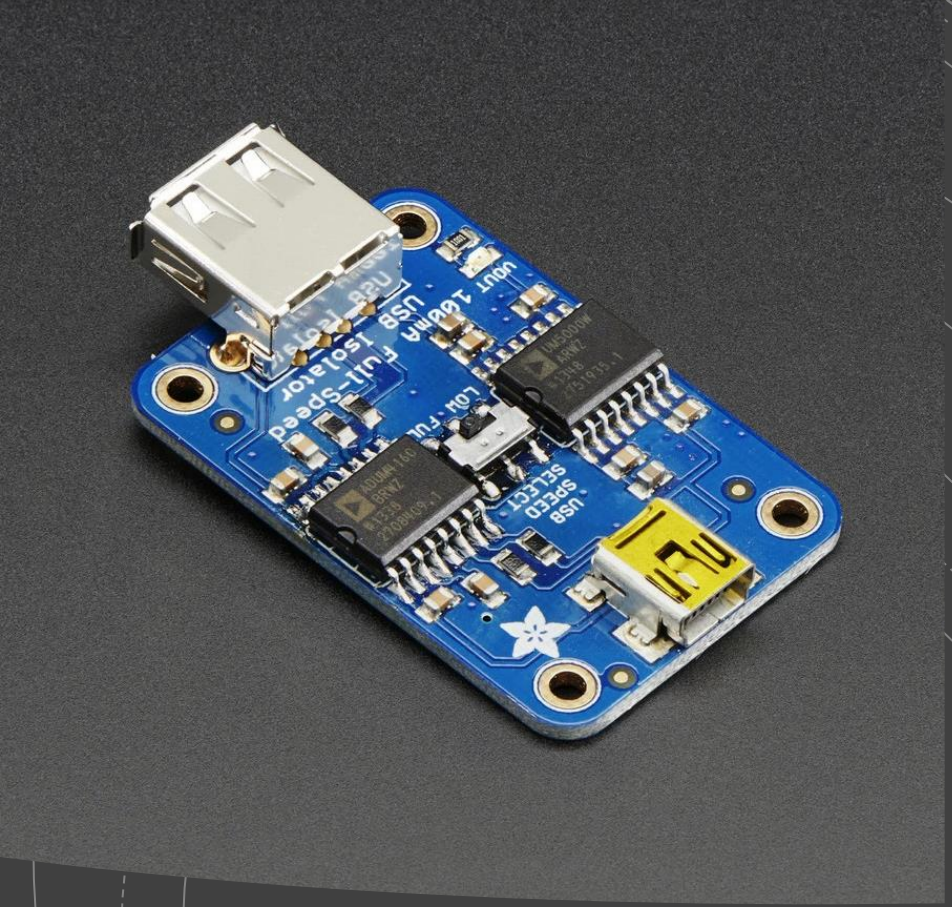
Student editions of CAD software can be downloaded for free:

- SolidWorks
- Fusion 360
- Eagle PCB (electronics)

Component lists on moodle, lots of bits in box. Ask about others, limits on problem statement

Laser cutting/3D printing information can be found on the Dyson Centre website: https://www.dysoncentre.eng.cam.ac.uk/

Use Google! Much support for Arduinos/CAD online.

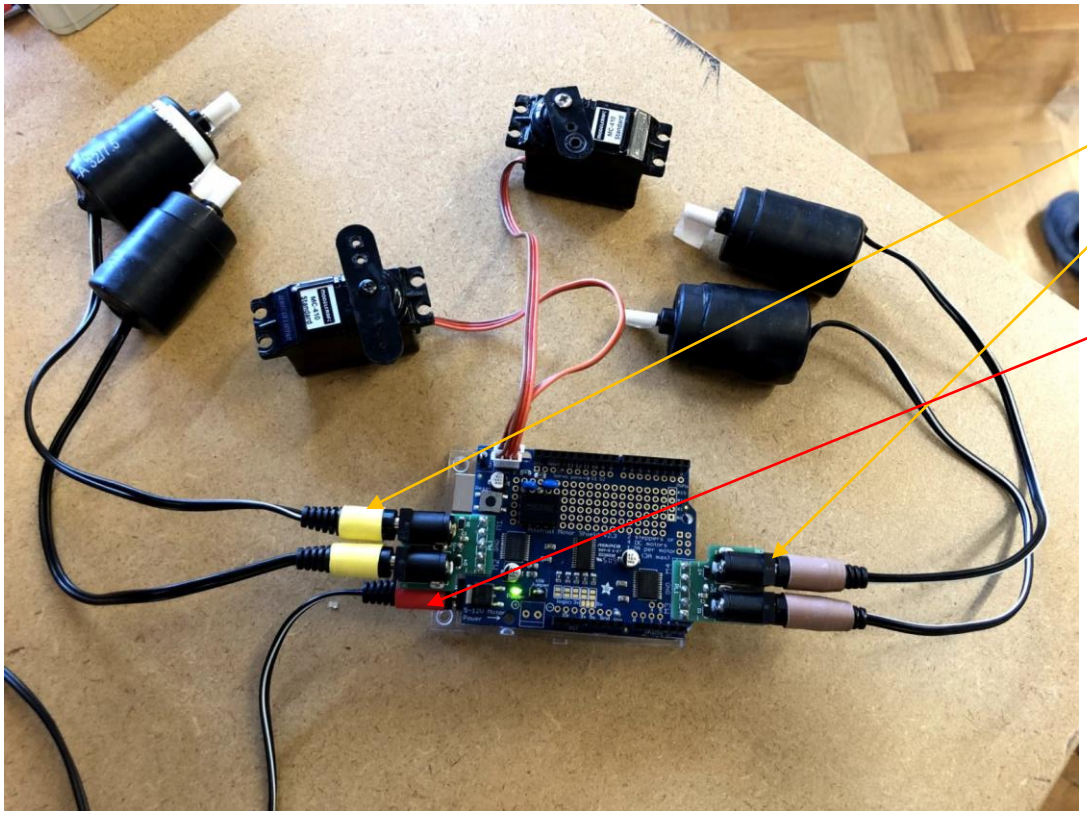


USB Isolators

Will be connecting PCs and Laptops to homemade electronics.

Strongly recommend use of USB isolator when connecting external instruments, power supply or battery. Protects both Arduino and PC/Laptop.

Take Care



Motor connectors on Motor Shield are for motors (Yellow/brown)

Battery connector on Arduino for battery (red)

Same plug type!

Always connect battery last.

24 hour delay on any replacement Arduino/motor shield post RMA with details

Arduino has been modified to prevent powering from USB. Requires 12v battery or adaptor to be connected.

Motors vs Servos

Standard 12V brushed motor.
Datasheet on moodle – 2 gearboxes
Motor shield allows PWM control – voltage applied proportional to set value.

Can't instrument current
Don't remove Al plate – there to prevent damage

5V RC Hobby servo.
Servo = DC motor + encoder + feedback.
PWM input sets position.
Will fail if held stalled for >1s
Can instrument current (look in your 1A kit!)

5V must come from motor shield not Arduino!

Advice, Hints and Tips

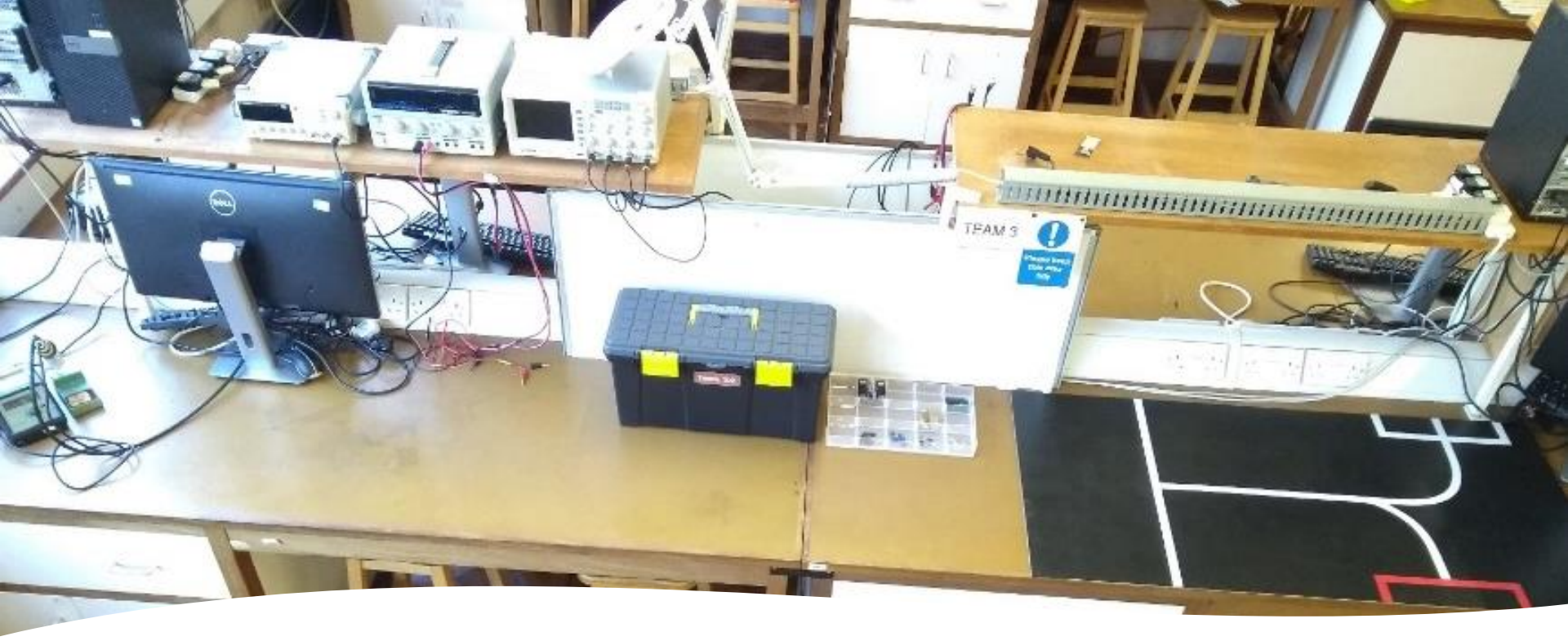
- Watch Moodle videos, look for information.
- 5 mins of calculation saves hours of ‘rapid’ prototyping
- Reliability is key – simple but effective is a good approach
- Walls are useful as they don’t move – you could use to align, or ensure the robot is straight or physically track along
- Sensing - think outside the box:
  - Touch/limit switches to detect walls/obstacles/objects
  - Position of sensors is key!
  - Redundancy/diversity is good
  - Test and try different approaches, don’t stick with the first which happens to work
- Only change one thing at a time
- Test, test, test, test and test again. Start testing early.
- Error recovery? Error Reporting?
- Take care, parts take time to replace
- Don’t drop your robot…

Project Management / Teamwork

- Communication between the team is key.
- Consider using slack/messenger or other tools for communication and organisation, BUT **remember to talk to each other**!
- Group file space, consider GitLab

- Make sure you have a team leader
- Team leader to record attendance at morning lab sessions!
- Plan the time (Gantt chart) set realistic goals. **Leave enough time for integration**
- Gantt chart – think about key dependencies, priorities, information others need, milestones, who has robot when?

Make sure you attend the project management lecture, LT1 2pm today. Sit in teams



Testing

- Test board provided with line features
- Tape to add your own tests – not for use on the robot
- Robots, test boards etc can be taken home with care
- Don’t take the batteries, Bench equipment, soldering iron!
- 1A Electronics kits!

Academic Mentors

Mostly available on Tuesday morning sessions, but many will be happy with emails at other times.

Won't be experts in all areas, but should track team progress and sign post areas where advice of others should be sought.

Offer advice and assistance on where to get help, how to approach problems etc

Prof Fumiya Iida	Dr Michael Crisp	Dr Simon Corkery
fi224@cam.ac.uk	mjc87@cam.ac.uk	sjc276@cam.ac.uk
L101-L104	L105-L108	L109-L111

Key Dates

Week	Day	Time	Activity
1	Thursday	9am	Intro session
		10am	Dyson Safety Induction
		2pm	Project Management intro
1	Friday	4pm	All peer assessment submissions
1	Tuesday	9-11am	1st Presentation
2	Thursday	4pm	1st report due
2	Monday	4pm	1st peer assessment
2	Tuesday	9-11am	Progress Meeting
3	Monday	4pm	2nd peer assessment
3	Tuesday	9-11am	Progress Meeting
4	**Thursday**	**9-11am**	**1st Competition**
4	**Tuesday**	**9-11am**	**Final Presentation**
4	**Wednesday**	**2-4pm**	**Final Competition**
5	Monday	4pm	Final Reports
5	Thursday	4pm	Final peer assessment

Start early, don't leave things late. 4 weeks is VERY short.
Don't miss peer assessments!

Work Areas

EIETL

- Main base for the project – team desks
- Electronics work desk
- Competition Tables
- Some mechanical parts

Open 8:30-16:30 Mon-Fri

Dyson Centre

- Workshop Area
- Laser cutting + 3D printing
- Metal working facilities
- Technician Support: **during morning scheduled sessions**
- Bring own safety specs

Thursday	9am -11am	2pm-4:45pm
Friday	No am session	2pm -4.45pm
Monday	11am – 1pm	2pm -4.45pm
Tuesday	9am -10:30am	2pm-4:45pm
Wednesday	9am -11am	2pm-4:45pm

DPO

- Workstations for CAD work.

Health & Safety

EIETL

- Observe battery rules
- Don’t remove batteries
- Keep working areas tidy
- No eating or drinking
- Use extraction and safety glasses when soldering

Dyson Centre

- **Safety Glasses worn at all times**
- No open toed shoes
- Long hair and loose clothing tied back.
- No Lone working
- Don’t remove tools
- Technicians to support fabrication, demonstrators advise on design
- Must be Safety Inducted

Keep team areas and shared areas tidy
If in doubt ask!

Wear Safety Specs in Dyson Centre

Working in Teams

- Need to be aware of other's stfrengths and weaknesses
- Talk regularly and communicate honestly
- Unplanned events (e.g. illness) will happen, be prepared and support each other, don't blame
- Use your mentor for support
- This is a learning experience for everyone
- Remember this is for standard credit
- Be kind!

Group Assessment

Assessment	Mark Weighting	Deadline
Initial Report	15%	Week 2, Thursday
First Competition	5%	Week 4, Thursday
Final Presentation	10%	Week 4, Tuesday
Final Competition	15%	Week 4, Wednesday
Robot Quality	25%	Week 5, Monday
Final Report	30%	Week 5, Monday

All details of assessment and mark schemes can be found on Moodle
Team 39 marks, 28 Qualifying
Individual 15 marks, 11 Qualifying

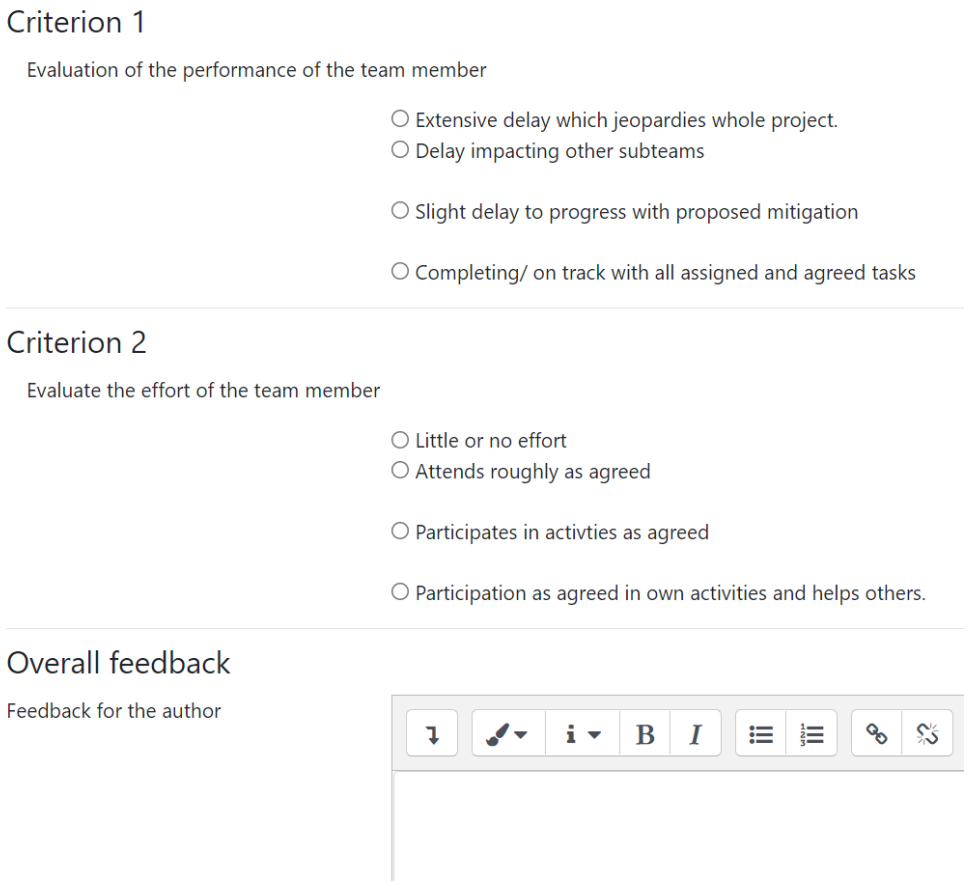
Individual Assessment

Individual 15 marks, 11 Qualifying

- Based on group performance
- Weighted by peer assessment of your contribution, both effort and performance
- Participation in peer assessment on moodle is mandatory.
- 3 assessments over project with feedback

- Submission phase – brief statement o your contribution, what you have been doing

- Assessment phase – evaluate your performance and your peers



Moodle Workshop Process

Submit – Do this for all assessments today! Blank entries.

Assessment – score your peers submissions, can use your wider impressions. Option for 'don't know'. Closes Monday week 2, 3, Thursday week 6

Evaluation – you get two scores:

Submission based on peer feedback.

Assessment based on the likeness of your feedback to others (not used). Timed to be ready for the mentor meetings

Remember, this is standard credit activity.
Mentors/ demonstrators etc. have full view of everything.
Be professional in giving and receiving feedback.
Remind each other of deadlines for submission & assessment!

Presentations, Progress Meetings

Tuesdays - in person. Look on Moodle for timetable/location

- 1st Presentation
  - Team Name and Management Structure
  - Summarise the problem - what will be key technical challenges.
  - Present concepts and approaches to the problem - what are the trade offs and impacts on other areas?
  - How will you organise yourselves, what is the timeline/ Gantt Chart for rest of project

All team members to present.

10 min presentation followed by discussion.

Progress meetings more dynamic discussion, not examined, slides only useful if they communicate something.

Updated Gantt chart always required.

Ask your Mentor what they expect.

1st Report (6 pages + diagrams)

Fundamentally a design proposal. Set out how as a team you will complete the task from technical and project management perspective.

- Concepts considered and evaluated
- Selected design with justification.
- CAD/schematics/algorithms
- Key decisions not yet taken.
- Risks and mitigation
- Updated Gantt with dependencies and key milestones

Documentation

Documentation

- Get feedback from Demonstrators as you go
- **Electrical** – circuit diagrams + layout diagrams
- **Software/Overall** – overall integration of system + algorithms
- **Mechanics** – CAD model and appropriate drawings

To avoid making unnecessary mistakes get feedback on your designs from mentors and demonstrators as you go along!
Without clear diagrams communication of ideas with demonstrators can be difficult.

We expect you to keep up-to date documentation as you go along…

Don't try to produce a robot, then make the drawings for the final deadline!

You will be required to submit industry standard drawings, models and diagrams at the end of the project, and you will be assessed on these under robot quality!

Robot quality

- Physical Build

Shake test

Appropriate methods / fixings

Meet specification

Logical layouts

No breadboard /cardboard /tape

- Documentation

Sufficient documentation to reproduce electronics/mechanical build

Software documented and maintainable.

Examples on moodle of good / bad practice in drawings and schematics

Final report (max 10 pages)

Single group submission, but all team members contribute. Summarise the outcome of the project with recommendations for the future.

Submit with design docs, but should stand alone so repeat key snippets.

- Overview of key design decisions of each sub-system and over all design. Trade offs in design and retrospective advantages/ disadvantages.
- Testing of the complete robot and subsystems both in competitions and independently. Report extent to which specification is met.

Final report (max 10 pages)

- Overview of project management discussing how it happened in practise, how well it worked in retrospect.
- Root cause analysis of any failures in competition or specifications not met. Recommendations for specific solutions and also to prevent recurrence in similar future projects.

Contact Points

Any problems:

- First point of call: Moodle forums (particularly task clarifications)
- Email **Gemma (gmb49)** or Dave (dip26)

Come and find us as soon as you have any problems/question

Any feedback:

- Come speak to us in a timetable session
- Send us an email
- There is always the department fast feedback

What Next

- Mechanical people exit into roadway for Dyson Induction
- Everyone else up to EIETL
- Look through Moodle documentation
- Start generating concept ideas
- Intro videos on Moodle

Any problems, ask on Moodle!

Final Hint – ASK A DEMONSTRATOR!

- General questions – Now

- **Good luck – Have fun!**