Integrated Design Project

Michaelmas, M1 2021
Labgroups 43-84

All details and resources can be found at:

- Moodle: 2CW: Integrated Design Project v.2
- Keep checking back, new information being added

Integrated Design Project

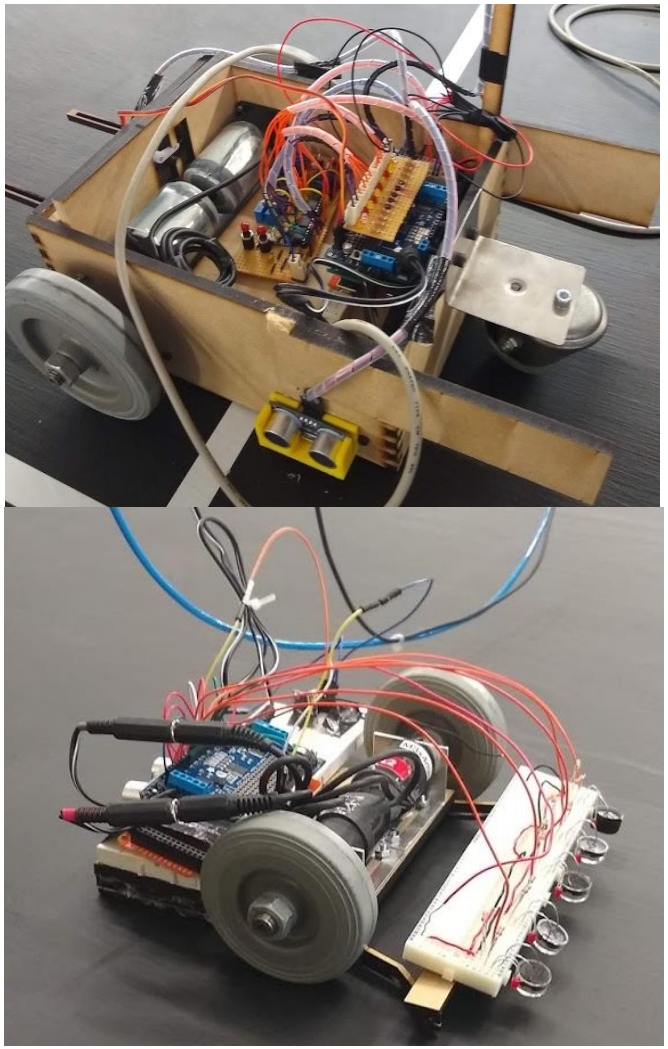
IDP focusing on **rapid prototyping** with an increased focus on **integration.**

- Looking to return to ‘normal’
- As always constantly evolving tasks and kits.
- Few restrictions still in place.

- Be prepared for changes at short notice

IDP: Aims & Objectives

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



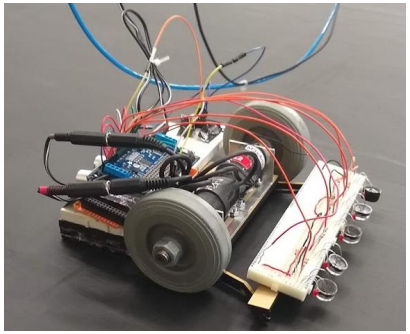
Key Dates

Thurs 27th Oct: First Competition

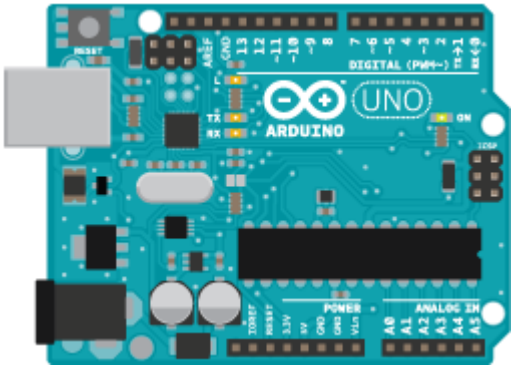
Wed 3rd Nov: Final Competition

IDP: Rapid Prototyping Approach

Rapid Prototyped AGV



Microcontroller: Arduino



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

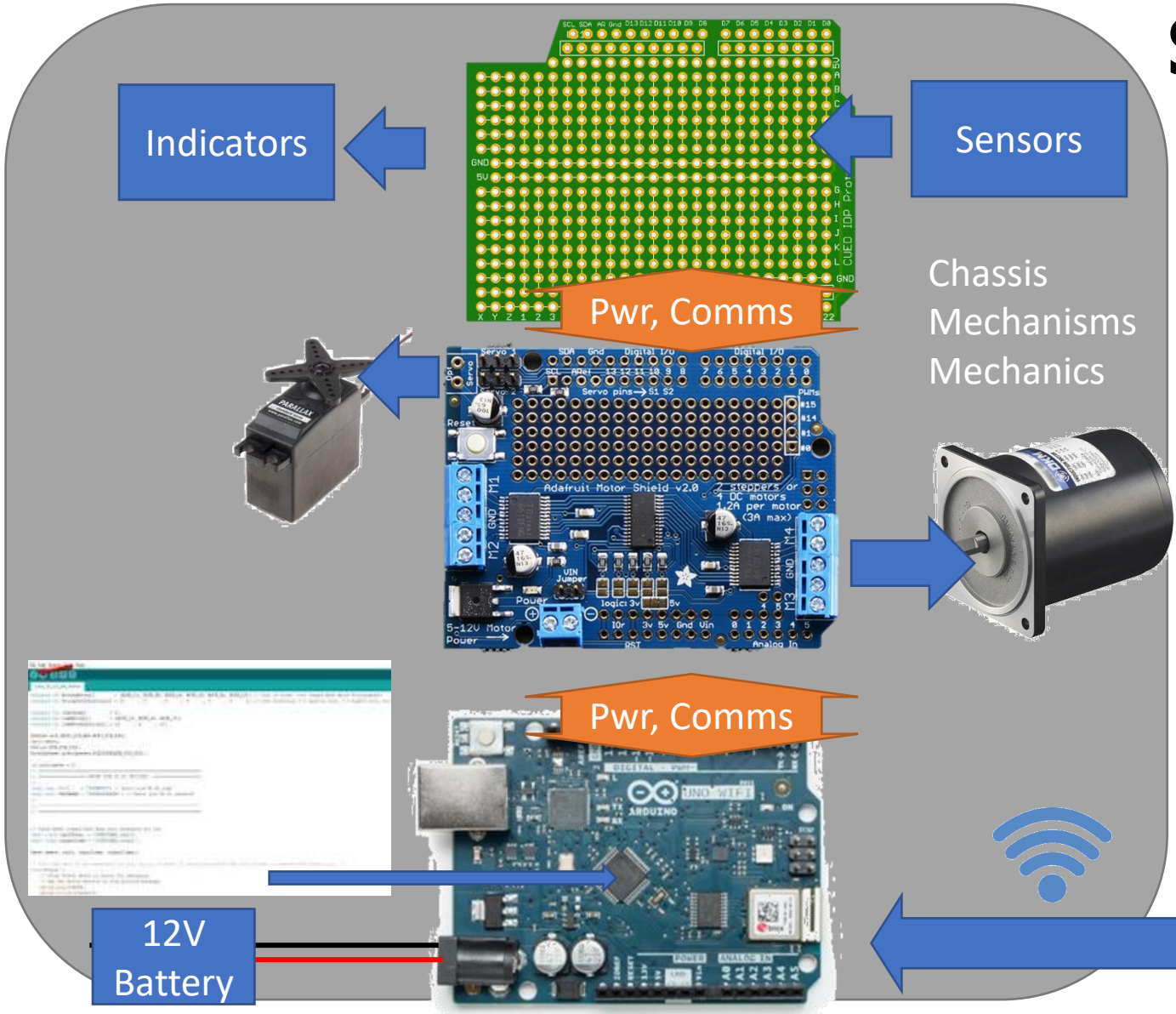
Mechanics: Chassis Development

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

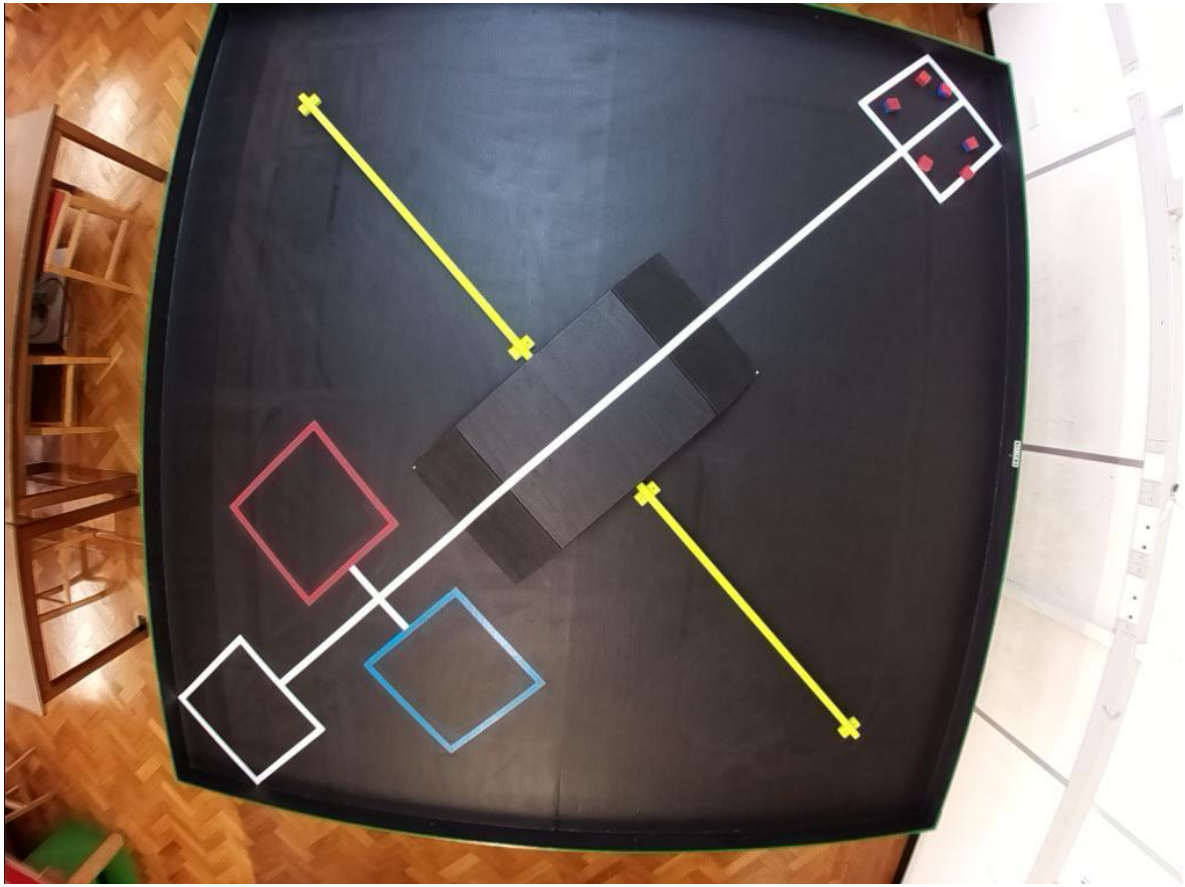
Interface electronics

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

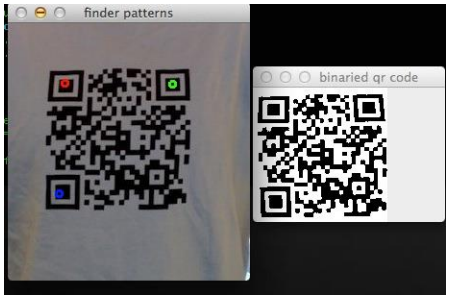
IDP: AGV System



Camera above the field…



- Determine orientation of robot

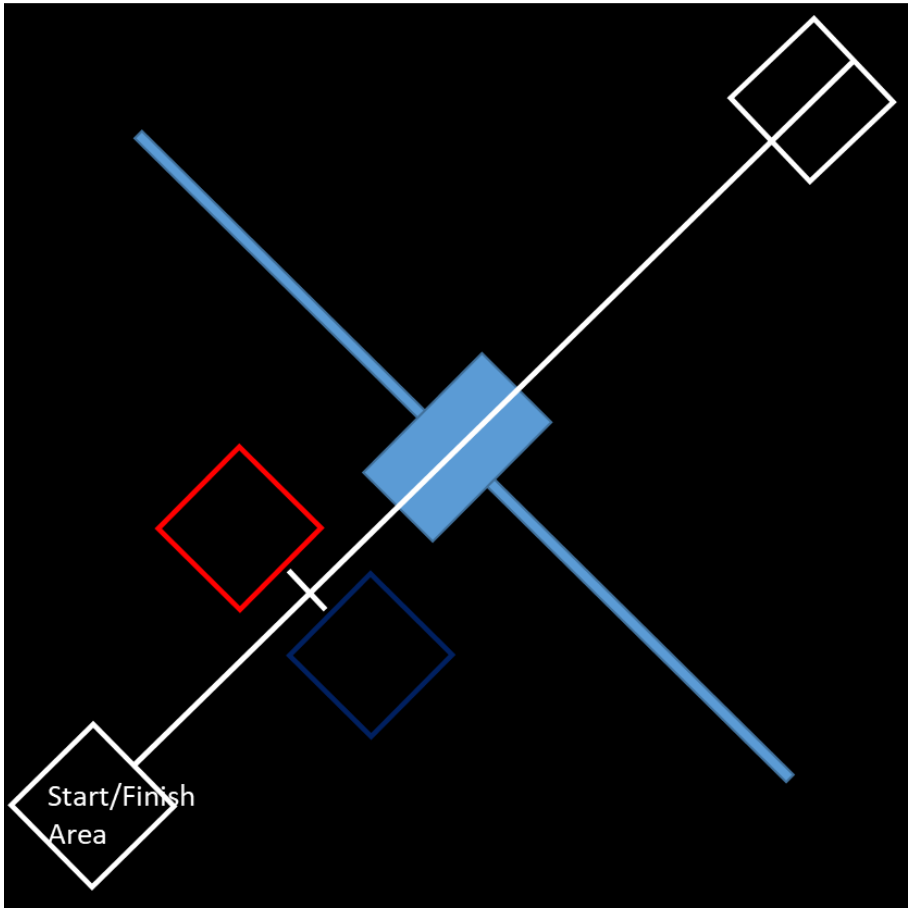


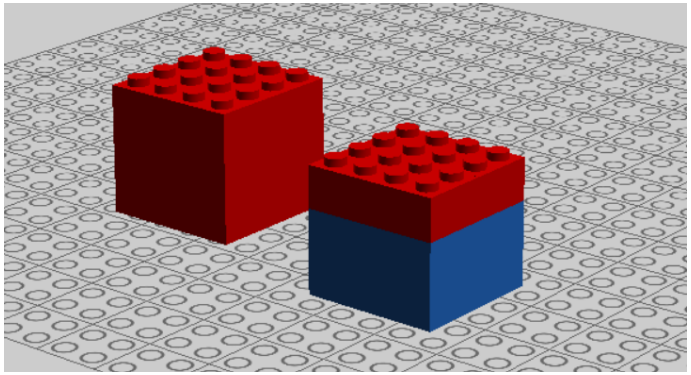
- Determine location of robot (challenging!)

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

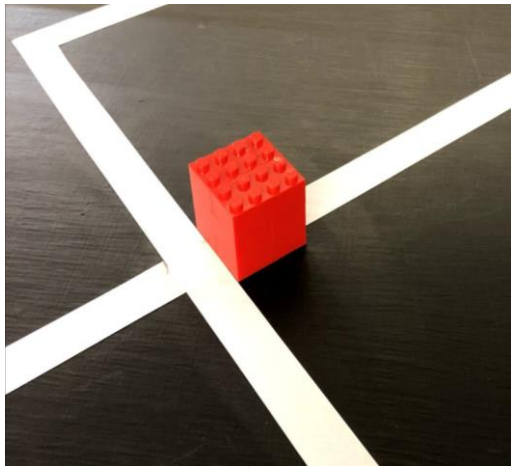
The Task: Metal sorting

- Packages contain metal (lego ‘holes’ filled with mild steel)
- Colour coding to help testing, not to be used by robot or camera.
- Deliver back to correct square.





- 1st block placed at intersection
- Subsequent blocks anywhere in square



Competition

Demonstration Task

Teams will be given 5 minutes to complete

Teams must make a sporting attempt to complete the task – if in doubt about what is consider a 'sporting' attempt they should consult with the teaching staff.

Can restart as often as you like, but scores don't accumulate (highest counts). Clock does not restart.

Action	Score
Robot reaches collection side of the table (scored once)	+10
Robot reaches collection area (scored once)	+20
Metal / Non-metal status correctly displayed (per block)	+10
Block delivered to correct area and completely inside lines (per block)	+20
Robot finally returns to a start/end box and stops such that it is entirely inside the box	+20

IDP: Rapid Prototyping Approach

Mechanical Development

- Cardboard will be provided (which an 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 Approach

Arduino software can be downloaded for free:

https://www.arduino.cc/

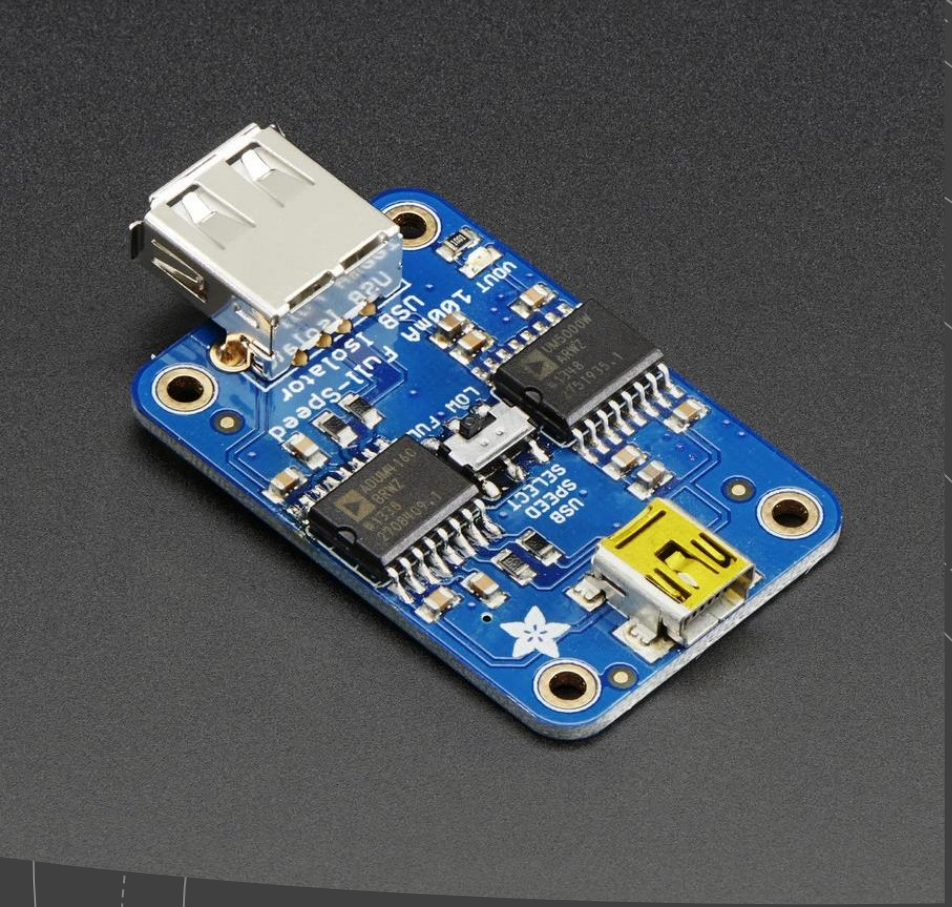
Student editions of CAD software can be downloaded for free:

- 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.

Advice, Hints and Tips

- 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:
  - Encoders to detect distance moved
  - 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?
- Don't drop your robot…

Project Management

- Communication between the team is key. Although you are arranged in sub-groups by labgroup, this is an integrated challenge.
- Consider using slack/messenger or other tools for communication and organisation, google docs could be useful for group presentations
- Group file space, consider gitlab

- Make sure you have a team leader
- 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, 2pm on 1st Thursday

Covid Safety

- Working towards ‘normal’
- Restrictions on numbers in EIETL and Dyson
- Don’t come in if feeling unwell, tell your team work around problem.
- If you have to isolate, let me know. Try to continue remotely
- Keep you team informed so they can plan mitigations.
- Wear a mask
- Keep testing

Key Dates

Date	Day	Activity
7th Oct	Thursday	9:00: Introduction Session, Teams 14:00: Project Management Lecture Zoom
12th Oct	Tuesday	First Presentation, online – details from mentor (9-11)
14th Oct	Thursday	First Report Due (submit on Moodle 4pm)
19th Oct	Tuesday	1st Progress Meeting with mentor (9-11)
26th Oct	Tuesday	2nd Progress Meeting with mentor (9-11)
28th Oct	**Thursday**	**1st Competition (9-11)**
2nd Nov	**Tuesday**	**Final Presentation (9-11)**
3rd Nov	**Wednesday**	**Final Competition (2-4)**
7th Nov	Monday	Final Report and Documentation (submit on Moodle 4pm)

Start early, don't leave things late. 4 weeks is VERY short.

Work Areas

EIETL

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

Open 9-17 Mon-Fri

Max 4 Team members in Lab sessions

MUST wear a badge

Dyson Centre

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

Open 9-13, 14-17 Mon-Fri

Max 2 Team members

DPO

- Limited workstations (16 max) for CAD work.

Health & Safety

EIETL

- Observe battery rules
- Keep working areas tidy
- No eating or drinking
- Use extraction and safety glasses when soldering
- Book online

Dyson Centre

- **Safety Glasses worn at all times**
- No open toed shoes
- Long hair and loose clothing tied back.
- No Lone working
- Technicians to support fabrication, demonstrators advise on design

If in doubt ask!

Storage & Team Tables

- Robots under construction and kits to be kept on bench in EIETL
- Return used parts to your kits.
- Storage boxes in Dyson Centre

- Batteries – one always kept on charge, do not remove from EIETL (12v adaptors to take home)

Please try and keep your team tables/areas tidy!

Group Assessment

Assessment	Mark Weighting	Deadline
Initial Report	13%	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

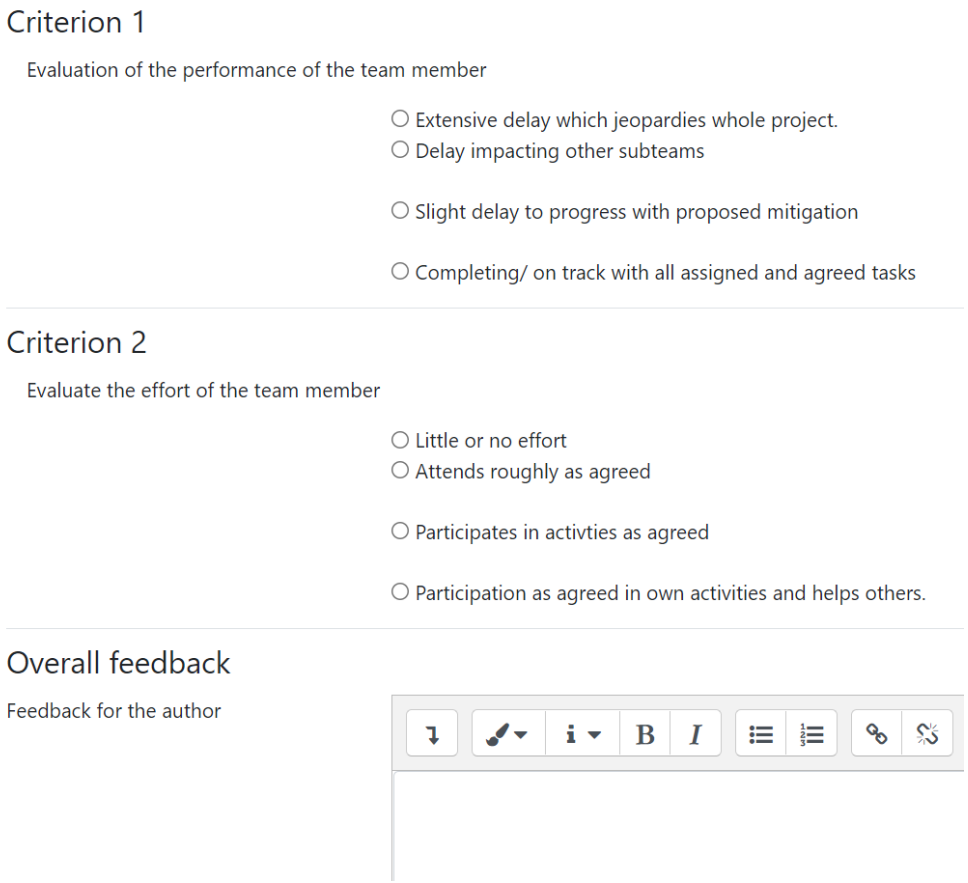
Individual Assessment

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 – short statement of your contribution can leave blank. Friday week 2, week 3 and Monday week 5. Reminders will be sent

Assessment – score your peers submissions, can use only the statement or your wider impressions. Option for ‘don’t know’. Closes Sunday week 2, 3, Tuesday week 5

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.

Presentations, Progress Meetings

Tuesdays in person look on moodle for timetable/location

- 1st Presentation
  - Introduce team
  - Gantt chart essential. What is your plan? Tool not a task
  - Concept generation / evaluation / testing across the 3 areas of mech, electronics, software
  - Risks and mitigation
  - Integration plan and interfaces

All team members to attend. 10 min presentation followed by discussion.

Progress meetings more dynamic, slides often useful. 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 dependancies

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

- 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 Michael (mjc87), 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

- Meet your team
- Agree on a team leader and structure
- Look through Moodle documentation
- Start generating concept ideas.

- Even Team numbers in EIETL 10-10:25, Odd team numbers stay here
- 11-1 please leave EIETL for 1st years!

- Dyson Centre Watch videos before Monday's session
- Intro videos on Moodle.

Any problems, ask on Moodle!
Final Hint – ASK A DEMONSTRATOR!

- General questions – Now

- Mech subteam to dyson now for a quick tour.