PROJECT AND CAD

Institution of MECHANICAL ENGINEERS

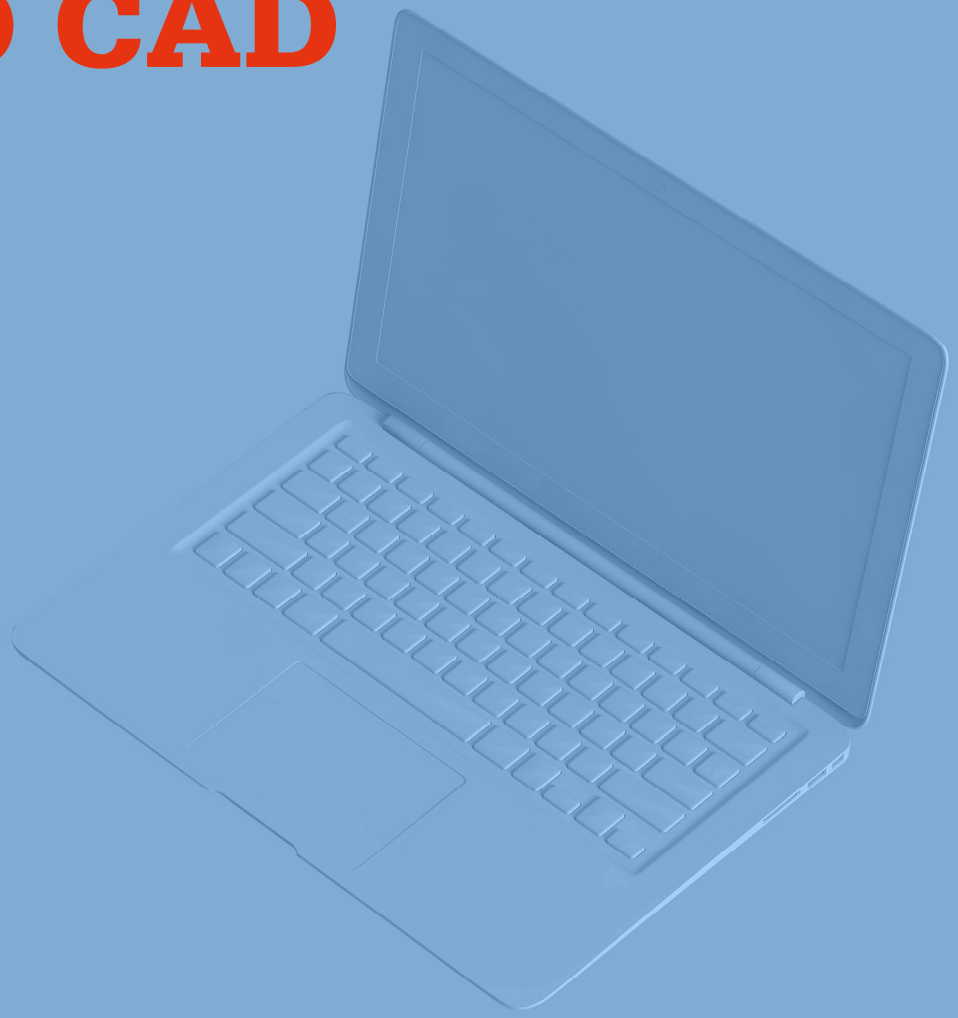
4th March 2026

13:00-14:00 GMT

Eur Ing Davide Migliorini D Migliorini
Ceng FIMechE
Design Challenge Chairman

Evolito
The Power of Electric Flight

Captain Matt Lister RN
BEng MSc PGDip psc(j) MA CMarEng
FIMarEST
Design Challenge Head Judge



Improving the world through engineering

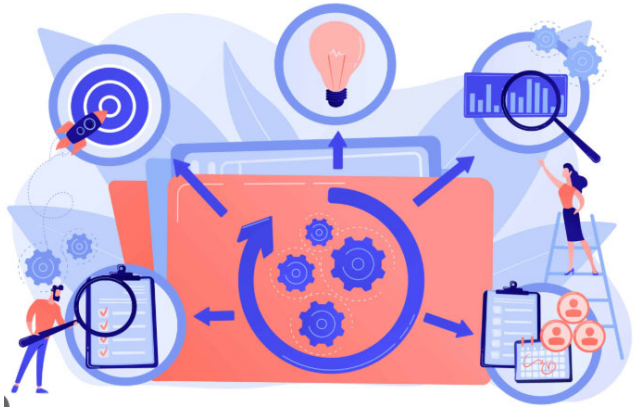
OPTIMISE THE EFFORT: EFFECTIVE PROJECT AND CAD MANAGEMENT

Project management is an important part of any design, development, test and production activity.

Understanding what are the requirements the IMechE Desing Challenge is fundament to plan correctly the steps for a successfu execution.

Designing the product, starting from first principle calculations and evolving it into a full CAD model, aligned to the device that may get built are crucial elements of achieving the best outcome, together as performance and overall final score.

HOW TO ORGANISE YOUR TIME?



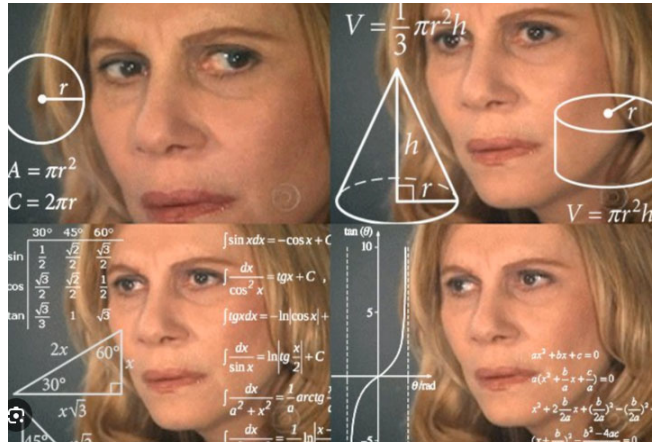
There is no one size fits all time split, however the suggested activities breakdown could be a good start for planning.

Be mindful to organise your project and the time you allocate to each area carefully, so that you can complete entry submissions in accordance with the rules!

Crucial that all the team is onboard: all the members to have preliminary read the specifications and are ready to share time, tasks and take ownership.

- 5% - review the regulations and allocate tasks / roles to team members
- 15% - brainstorm concept ideas
- 30% - mature concept to design, align the BoM, calculate performances
- 15% - build and re-run the CAD & BoM (to ensure they reflect your finished product)
- 25% - test, validate, improve, sign off
- 10% - wrap up, finalise your documentation and presentation review and final submissions

WHERE DO I START? THE POWER OF MAKING AN ASSUMPTION:



Performance of the vehicle is key: it is needed to perform initial calculation and process; results shall be summarised in poster and presentation. How can I start without a CAD model? Let's go back to the basic principles:

1) Each physical device has a mass: start with a reasonable assumption.
2) You need energy is required to make the mass climb, with the increasing load attached. Calculate an initial mission speed profile.
3) What are load and torque transfer on the pipe? Make an assumption and develop calculations.
4) Data are now available (torque, speed, rotational speed) for a preliminary motion system selection.
5) CAD can be iterated: if design and materials are correct, it will return a more accurate mass value.
6) Update calculations, verify selection of component, mature the loop and decide when it's time to stop and build.

Our estimate for the Foundation device is 800g and we want it to reach the top in less than 5 seconds for climb and descent.

FIRST CALCS: TIME AND ACCELERATION?

We are targeting 5/2=2.5 sec. Let's add some safety margin, sparing at least 20% of the time. It leaves us with 2s to perform the climb, assuming the descent will be executed in a similar time.

What is the acceleration to do this journey in the given time? 1.1 m/s^2

What is the maximum vertical mass at the top of the pipe? With the initial mass estimate of 800g, it totals to 1141g.

Now we can find the minimum torque profile to guarantee the climb with lifting the variable load in the given time.

With an estimated coefficient of friction of 0.2 static between traction wheel and the pipe, the minimum force normal to the pipe to generate such traction is 56N. We will then ensure the clip system and chassis will deliver and withstand this load.

VEHICLE ENVELOPES

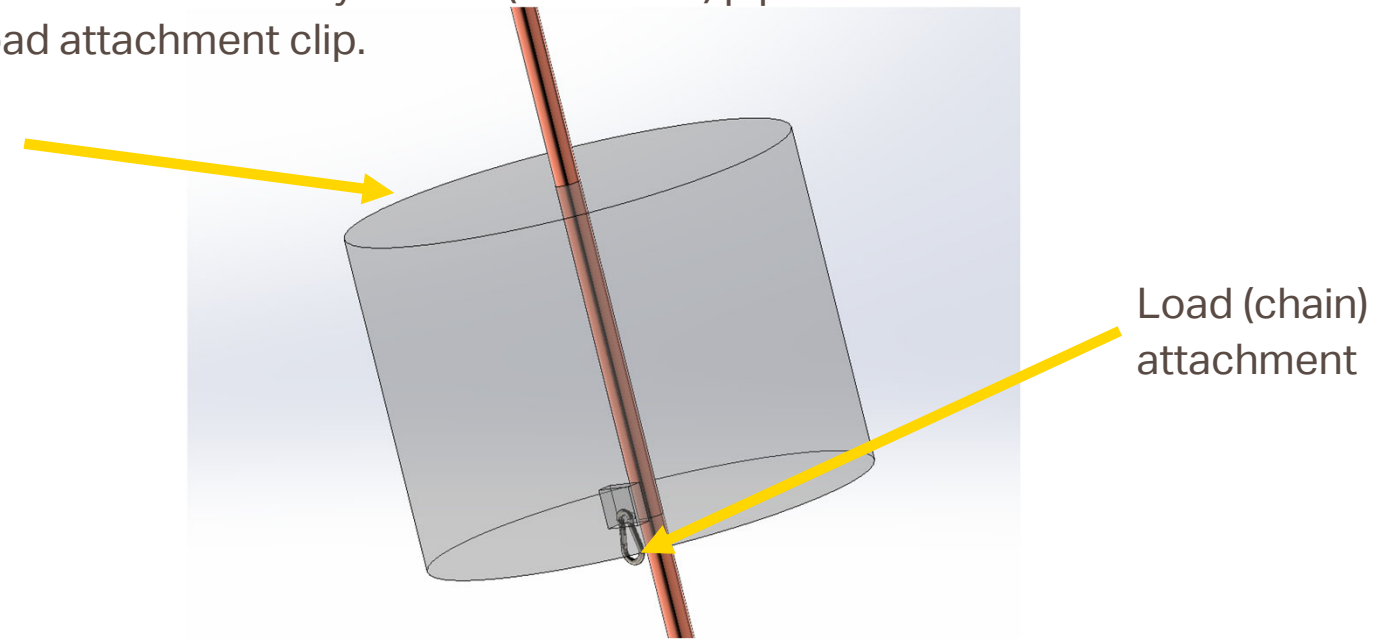
- The device should not exceed an envelope of 400mm diameter x 300mm length (IMechE Design Challenge - Project Specifications and rules 2026 – Section 4.1);
- The device top is the datum and should be flat (IMechE Design Challenge - Project Specifications and rules 20260 – Section 4.3);
- The bottom side should locate a specific quick release device (IMechE Design Challenge - Project Specifications and rules 2026 – Section 4.7);
- The device shall be capable of connecting onto a 22mm commercial copper pipe (IMechE Design Challenge - Project Specifications and rules 2026 – 4.6), lift a variable load that has some tolerances (IMechE Design Challenge - Project Specifications and rules 2026 – 4.8).
- Between runs there is a limited time to swap from a pie onto another one of the rig provided and connect to the other variable load available at ground (IMechE Design Challenge - Project Specifications and rules 2026 – 5.9 or 6.11).

Let's use CAD to help us!

MAIN ENVELOPE

CAD could help us not exceeding the allowed envelope. We can design a “transparent box” showing the maximum size allowed for the device and use it to challenge our design while we mature the CAD itself.

Recommended to create the maximum allowed envelope with a flat-top surface to be used as alignment, concentric with a dummy 22 mm (nominal…) pipe and to include the maximum allowed location for the load attachment clip.

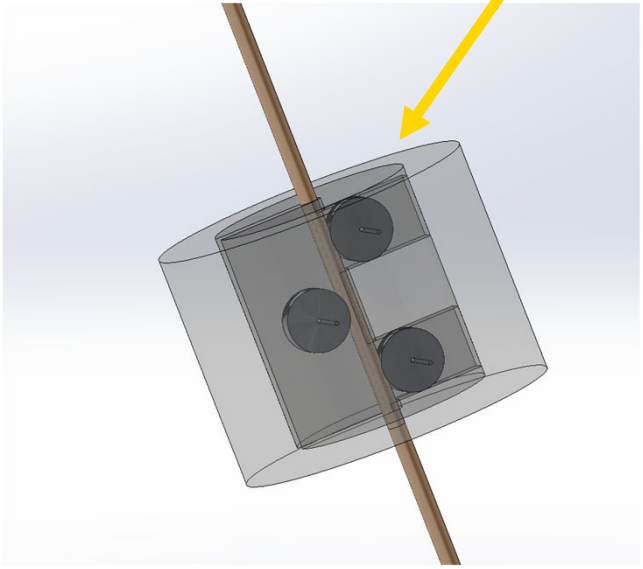


FIRST DEVICE: HOW COULD IT LOOK?

After all the brainstorming activities, we may have an idea of how the vehicle could look like. Let's get CAD to help us!

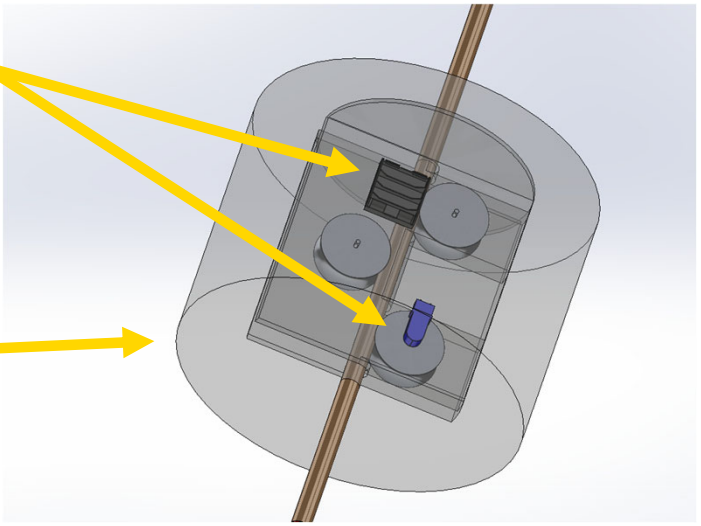
In the example below, the team winner idea is a 3-wheel vehicle, with main body 3D printed, with the third wheel as clipping device on the pipe. The traction wheel is 70 mm in diameter; same design kept for the other two wheels.

Datum surface flat = **OK**



Battery pack and motor with gearbox

Fits in the maximum envelope = **OK**



DOES IT FIT AND LOOKS RIGHT?

Let’s build the first assembly in CAD, just to check if it all fits.

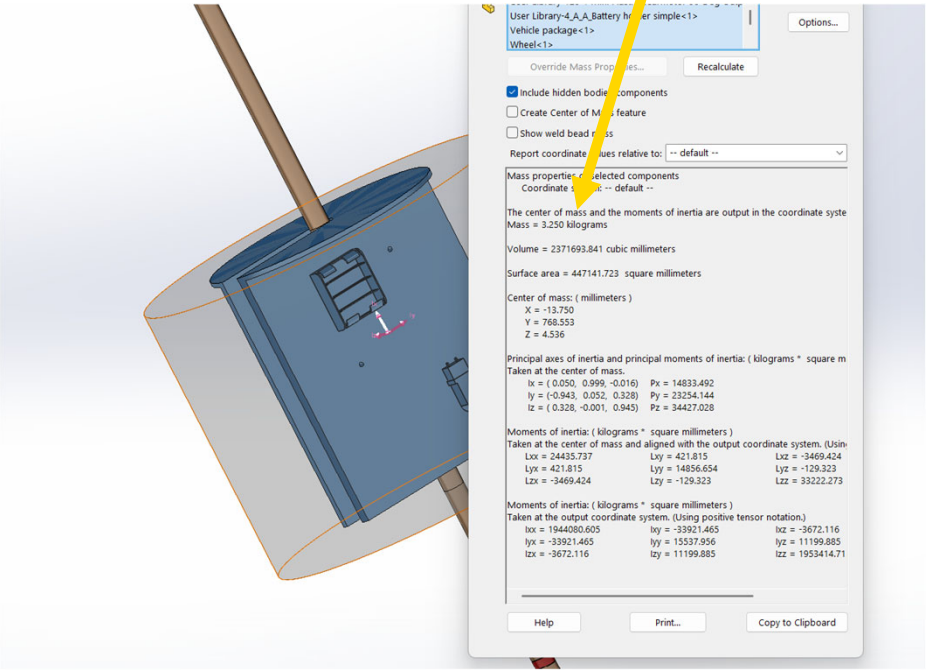
We need some mass to start some other preliminary engineering calculations and a package to see if it fits. Now we have a different mass!
Preliminary envelope check: with the upper datum in contact with the virtual envelope wall, the device still fits. No issues, we are good to go!

The new mass is available, we can iterate calculations in the separate file to confirm if the performance is still achievable and the motor selection is still valid.

Where is the load attachment clip?

Forgotten!

Preliminary mass from CAD



COMPETITION BOUNDARIES

You are now enrolled, well done! How can you now design a product to try to compete and win? Let's try to start form the first principles and look into the regulations. What are the boundary conditions?

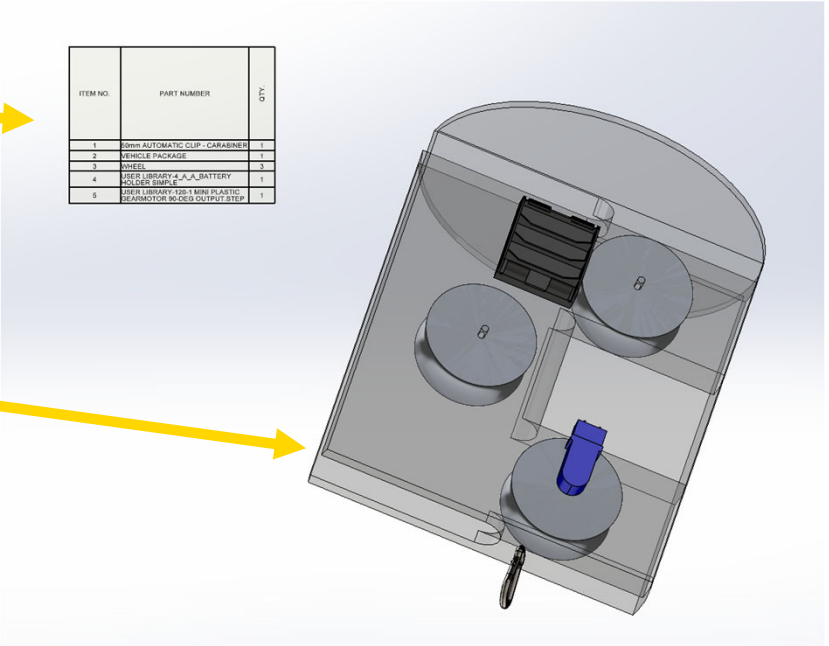
- The minimum time that will be measured is 5s (IMechE Design Challenge - Project Specifications and rules 2026 – Section 5.11 and 6.13)
- The device should contact the top barrier and stop for maximum 15s (IMechE Design Challenge - Project Specifications and rules 2026 – Section 5.4 and 6.4);
- It will lift a chain of up to 155g/m for up to 2m (IMechE Design Challenge - Project Specifications and rules 2026 – Figure 7 and Section 4.8);
- The top must be flat and even (IMechE Design Challenge - Project Specifications and rules 2026 - Section 4.3).

CAD AND BOM, LET'S ITERATE!

Looks like we have now found a battery holder and a motor. The CAD is now containing the clip previously forgotten, we may add the battery cells: the same assembly will give immediately up to date a BoM and mass, to verify both budget compliance and performance.

BoM from CAD

New assembly - developing



ITEM NO.	PART NUMBER	QTY.
1	50mm AUTOMATIC CLIP - CARABINER	1
2	VEHICLE PACKAGE	1
3	WHEEL	3
4	USER LIBRARY-4_A_A_BATTERY HOLDER SIMPLE	1
5	USER LIBRARY-120:1 MINI PLASTIC GEARMOTOR 90 DEG OUTPUT.STEP	1

UPCOMING EVENTS

13:00-14:00 GMT

- Get Ready for the Regionals – How do I win? - Wednesday 11th March 2026
- Let's move from the regional winners to the national winners! - Thursday 11th June 2026
- Get Ready for the Design Challenge National Finals – Wednesday 2nd September 2026

THANK YOU.

Institution of MECHANICAL ENGINEERS

+ 44 (0)20 7222 7899
designchallenge@imeche.org

/imeche
/imeche
/imecheuk
/imecheteam
/institution-of-mechanical-engineers

THE DESIGN CHALLENGE IS A COMPETITION TO ENJOY!