Engineering Portfolio

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Major : MEng Mechanical, Materials & Manufacturing Engineering

Position Applied : Mechanical/Design Engineer

Engineering Projects :

1. Microchannel Heat Sink Simulation
2. Aircraft Potable Water Serving Cart
3. Two-stroke Engine
4. Pit Stop Challenge
5. Disc Brake System
6. Crankarm Design Study
7. Beach Cleaning Device
8. Bottle Advanced Modelling

Welcome to my engineering portfolio! As a mechanical engineer, I have gained practical experience in designing, analyzing, simulating and optimizing various mechanical systems. This portfolio showcases the projects I have worked on, highlighting my technical skills and problem-solving abilities. It is my hope that this portfolio will demonstrate my competence and passion for engineering and provide a glimpse into my potential as an engineer.

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Microchannel Heat Sink Simulation (Final Year Project)

Problem statement & Aim: The escalating power densities of electronic devices have necessitated the development of efficient cooling systems. In this context, the current project aims to design a microchannel heat sink (MCHS) that can effectively dissipate heat compared to conventional designs.

Justification for design: Efficient operation of the MCHS can be achieved by preventing the formation of thermal boundary layers and promoting fluid mixing. Such effects can be achieved by introducing flow interruption and inducing vortices via the incorporation of steps along the channel of the MCHS. Therefore, a novel MCHS design featuring variable steps along its channel has been proposed.

Design:

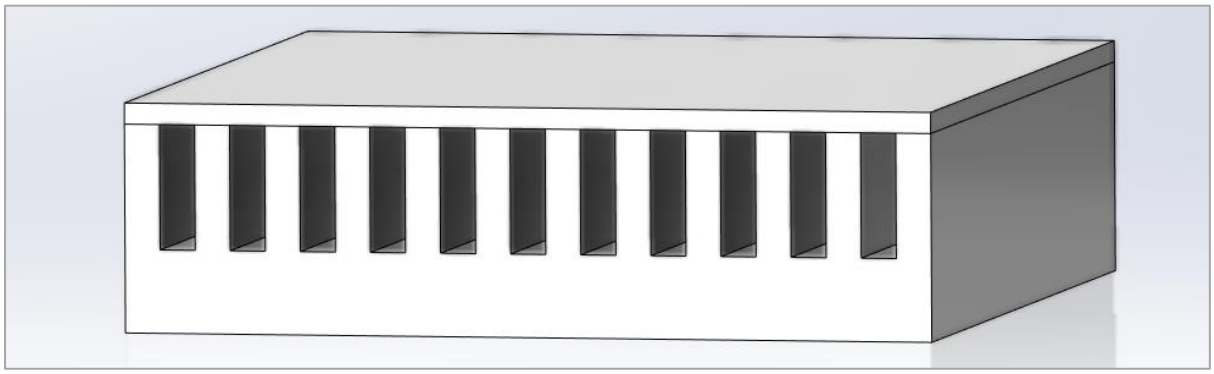


Figure 1: Physical model of the MCHS design (modelled using SolidWorks)

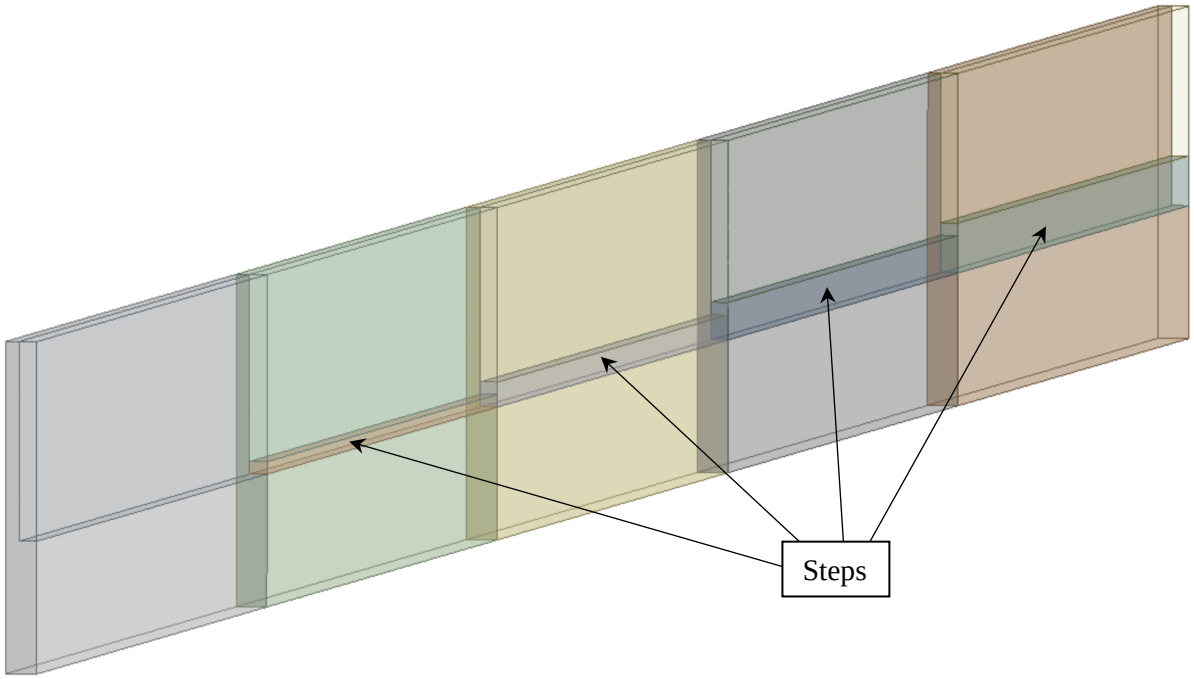


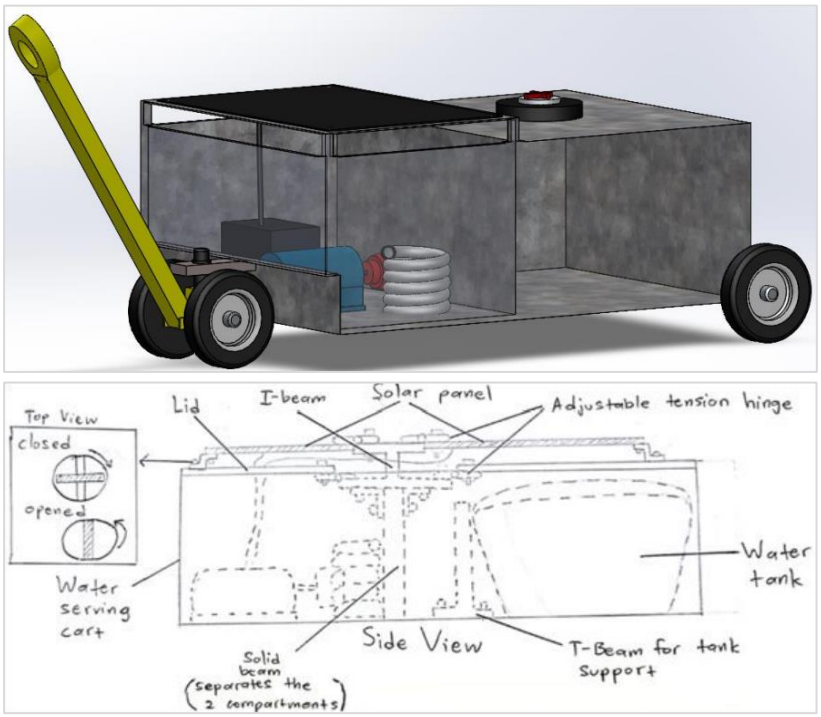
Figure 2: Schematic of a single half-section channel with steps (symmetric boundary conditions were applied). ANSYS Fluent was used to simulate and analyse the MCHS's performance.

Final outcome: The comparative analysis reveals that the proposed design with steps along the channel exhibits inferior thermal performance in contrast to the conventional flat channel design. The performance deterioration is due to the inclusion of steps which increased the pressure drop and friction factor, reduced the effective area for heat transfer, and induced flow separation. Thus, it can be inferred that the inclusion of steps along the channel negatively impacts the MCHS's thermal performance.

Aircraft Potable Water Serving Cart (Group Project)

Problem statement & Aim: Aircraft potable water serving carts are used to refill the water tank of aircrafts. Current equipment in the market is prohibitively expensive, with prices reaching up to RM 70,000. Furthermore, they do not comply with the current trend towards sustainable energy usage in the aviation industry. As a solution, my team and I have designed a prototype that operates on solar power and costs only RM 4,000 to manufacture. End product will cost approximately RM 12,000.

My preliminary designs: Based on project requirements



Final design: Based on project requirements & British standards

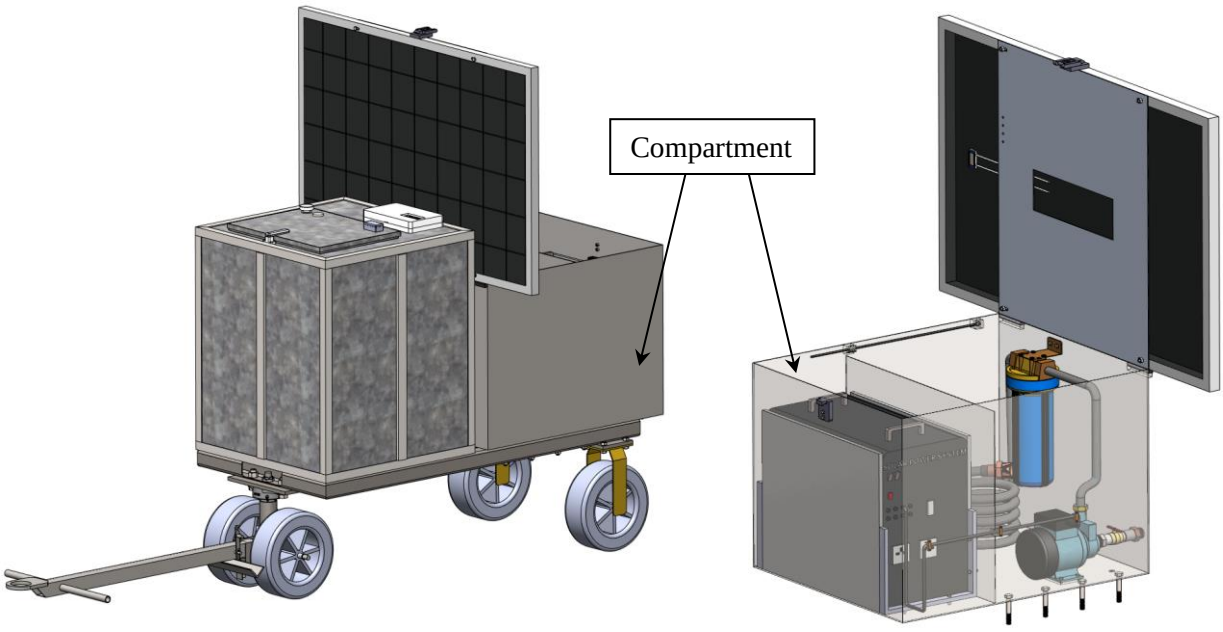


Figure 1: Final design of the water cart (left) and final design of the compartment (right) which houses the pumping & piping system and the solar system.

Manufactured prototype:

My contribution: Designed and modelled the compartment, pumping & piping system and the solar system using SolidWorks. Conducted analytical calculations and simulation to determine the losses in the system to select an appropriate centrifugal pump. Conducted material selection for the entire water cart, generated CAD drawings and process sheets for manufacturing. Manufactured the complete compartment, assembled the pumping & piping system and the solar system.

Project outcome: 7 out of the 8 project requirements were successfully fulfilled. However, the requirement stipulating the use of a renewable source of energy to charge the battery was not met. This was due to the unforeseen shipping delays resulting from the pandemic, which caused the ordered solar system, to be delayed. As an interim measure, a placeholder solar panel system, which did not meet our power requirements, was used instead. Finished top 3 in the James Dyson Foundation Design Award.

Two-stroke Engine Design (Individual project)

Aim: To design a two-stroke engine that produces 1500W of power at 6000 rpm. The scope of this project involved generating preliminary designs, carrying out calculations to justify the finalised design, producing CAD drawings of the selected design and conducting material selection.

Preliminary design:

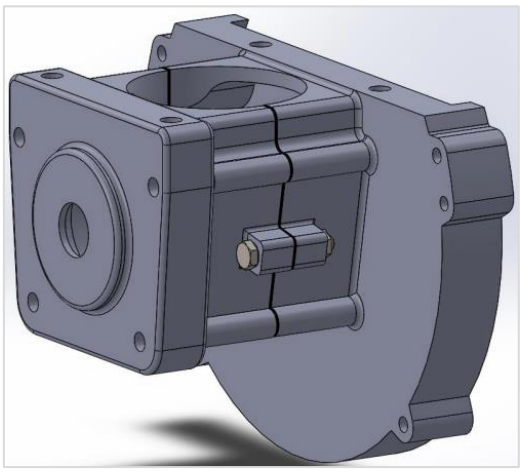


Figure 1: Preliminary design of the crankcase

Final design:

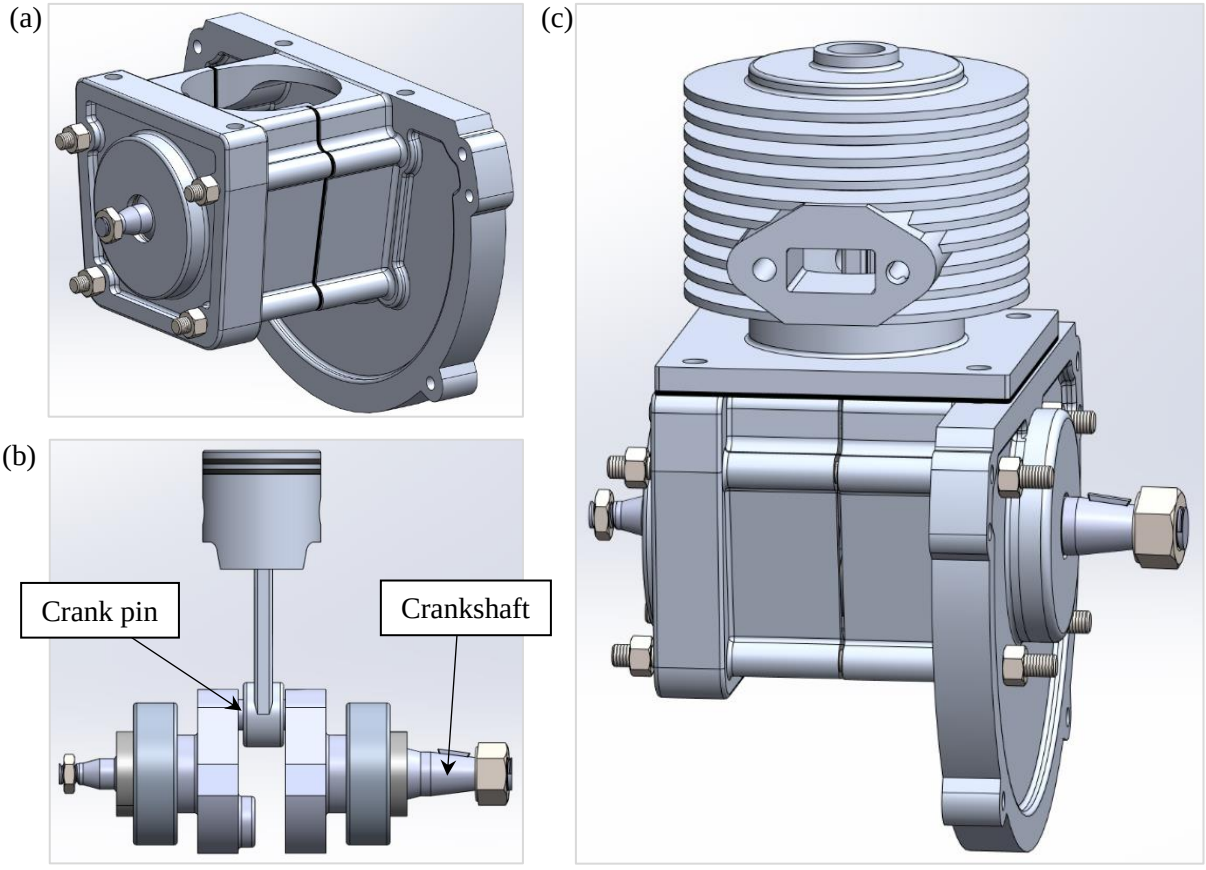


Figure 2: (a) Final design of the crankcase (achieved 8.7% weight reduction) (b) Assembly of piston, con-rod, crank pin, crankshaft and bearing (housed inside crankcase) (c) Final design of 2-stroke engine

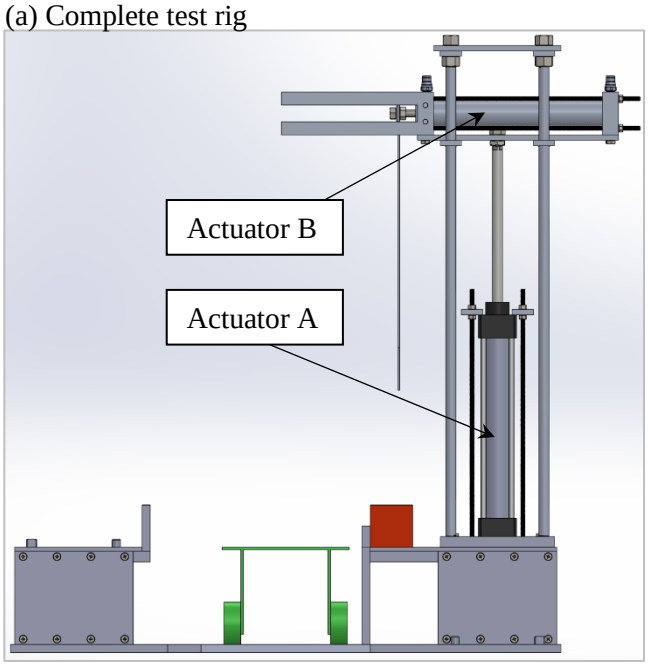
Project outcome: The final design of the engine is able to produce 1.5 kW of power at 6000 rpm. Through manual calculation, its determined that the crank pin and the crankshaft of the engine can withstand the maximum stresses experienced with a safety factor of 1.51 and 3, respectively.

Pit Stop Challenge (Group project)

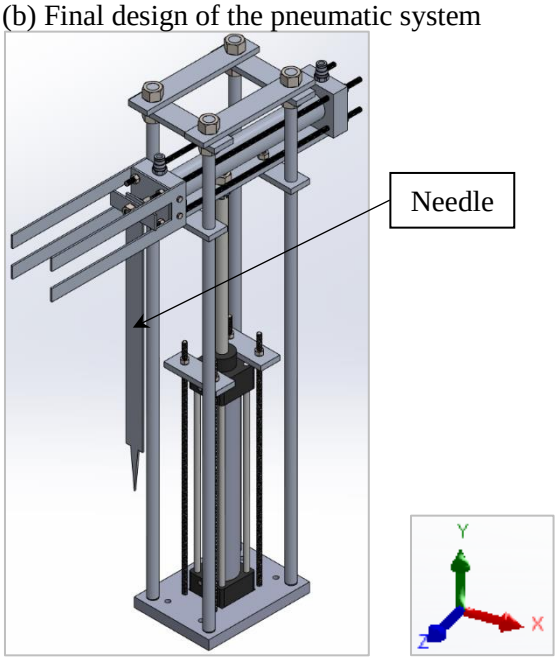
Aim: To design a system that uses pneumatic actuators to pick a foam block (red object in (a)) and place it on top of a model car (green object in (a)). My contribution involves designing the support system {(c), (d)}, creating CAD drawings, generating the material cutting list & process sheets.

Final design:

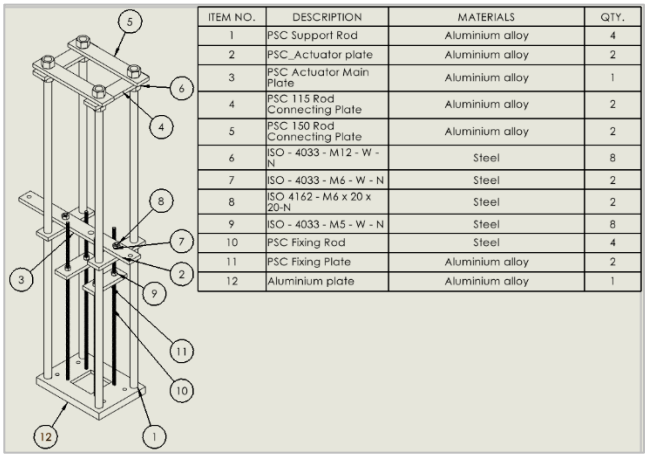
(a) Complete test rig



(b) Final design of the pneumatic system

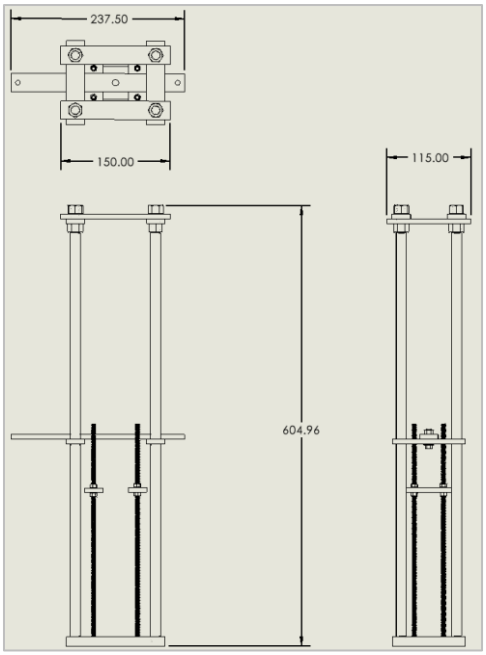


(c) BOM of support system



ITEM NO.	DESCRIPTION	MATERIALS	QTY.
1	PSC Support Rod	Aluminium alloy	4
2	PSC_Actuator plate	Aluminium alloy	2
3	PSC Actuator Main Plate	Aluminium alloy	1
4	PSC 115 Rod Connecting Plate	Aluminium alloy	2
5	PSC 150 Rod Connecting Plate	Aluminium alloy	2
6	ISO - 4033 - M12 - W - N	Steel	8
7	ISO - 4033 - M6 - W - N	Steel	2
8	ISO 4162 - M6 x 20 x 20-N	Steel	2
9	ISO - 4033 - M5 - W - N	Steel	8
10	PSC Fixing Rod	Steel	4
11	PSC Fixing Plate	Aluminium alloy	2
12	Aluminium plate	Aluminium alloy	1

(d) GA drawing of support system (dimension: mm)

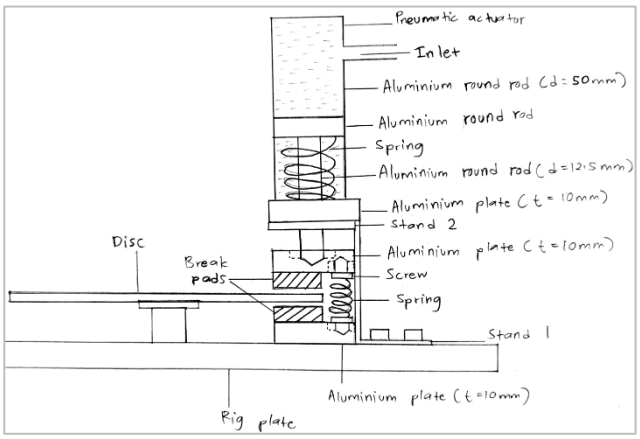


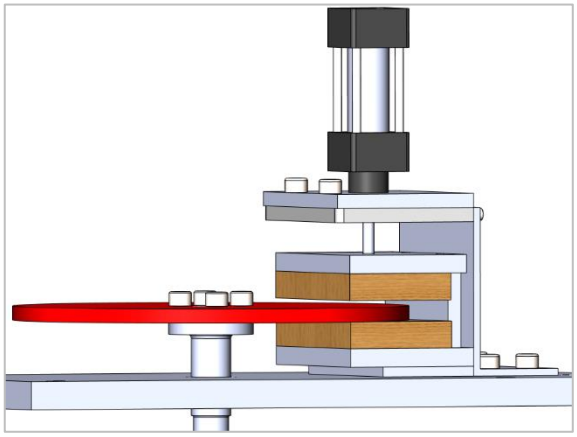
Project outcome: The final design comprises of two pneumatic actuators, Actuator A and Actuator B. The Actuator A facilitates the extension of its rod along the y-axis, enabling the Actuator B to move upward or downward. Upon the Actuator B's descent, its needle (shown in (b)) penetrates the foam block, following which the Actuator B's rod extends in the z-direction to position it on top of the car. Another system that functions to remove the foam block from the needle is not shown as it was designed by another team. The system functions as intended according to our manual calculations.

Disc Brake System (Group project)

Aim: To design a pneumatic disc brake with a single-acting cylinder capable of stopping a disk that rotates at a speed of 1500 rpm within a maximum duration of 1.5 sec. My contribution involves designing the cylinder, springs & rods, creating CAD drawings, material selection and process sheets.

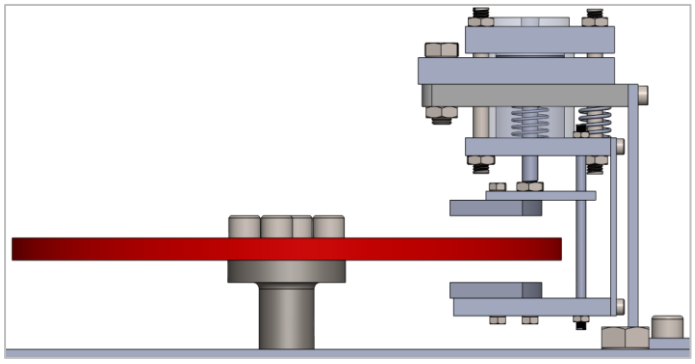
My preliminary design:

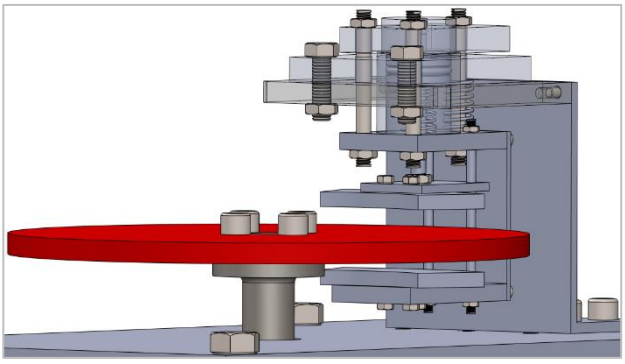




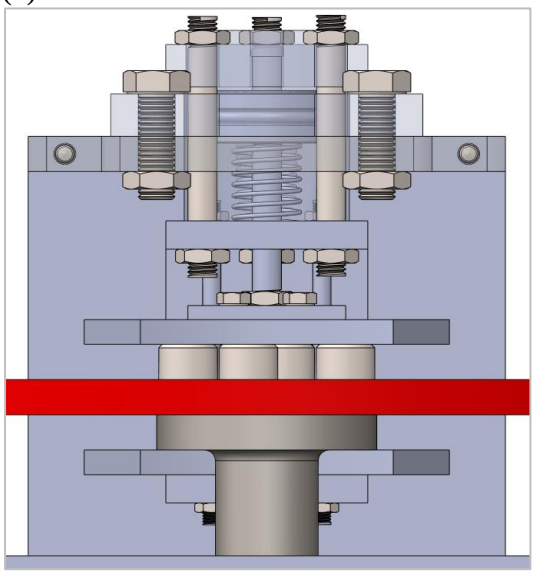
Final design:

(a) Side view

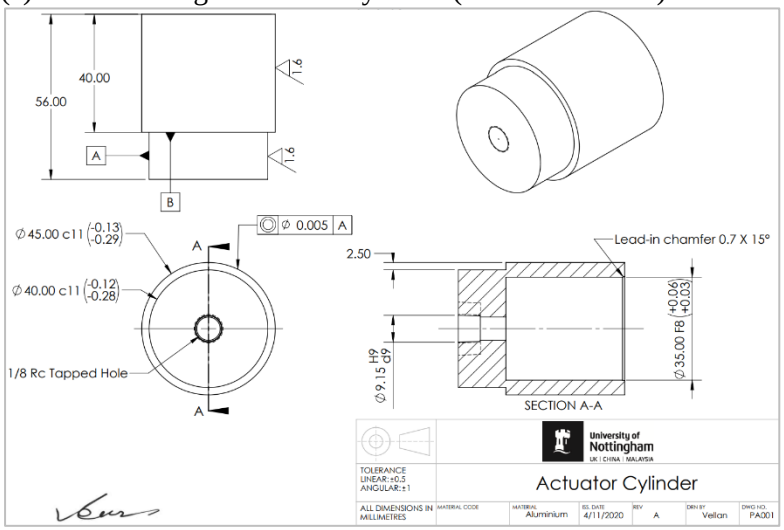




(b) Front view



(c)Detail drawing of actuator cylinder (dimensions: mm)



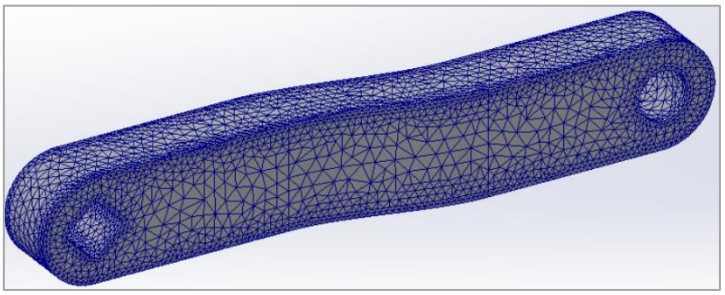
Project outcome: The final design is able to stop the rotating disc brake within 1.214 sec as per our manual calculation. We were not able to manufacture a physical prototype due to the pandemic.

Crankarm Design Study (Individual project)

Aim: Evaluate and redesign a bicycle crank arm for a 'high street retail level' mountain bike. Apply knowledge of weight saving design combined with design for manufacture along with software design analysis tools to optimize the crankarm's design.

Original crankarm design:

(a)



(b)

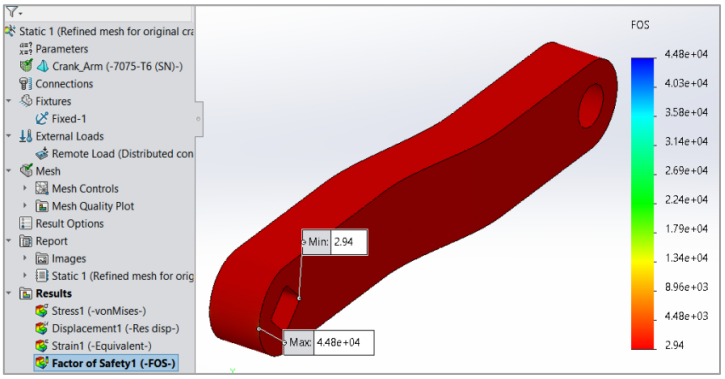
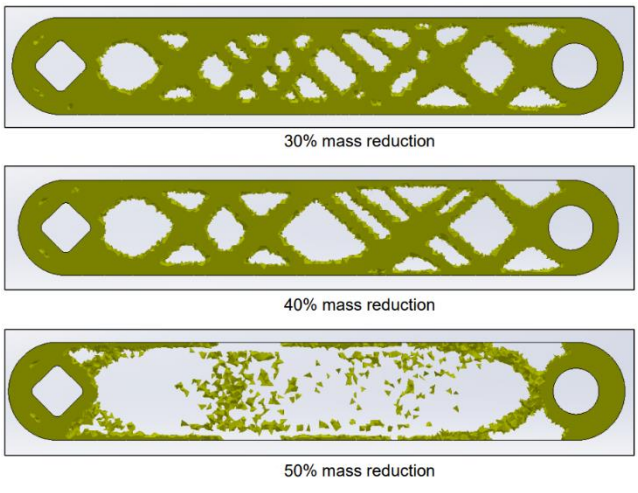


Figure 1: (a) Mesh applied to the original design (b) Safety factor of the original design > 2

Final optimized design:

(a)



(b)

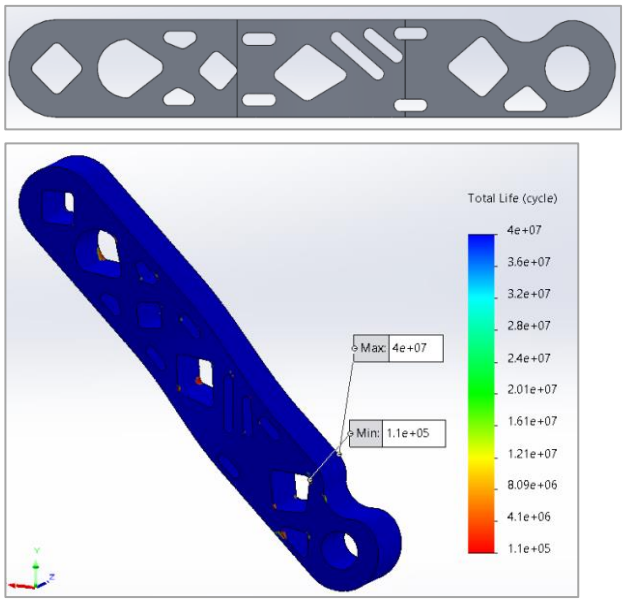


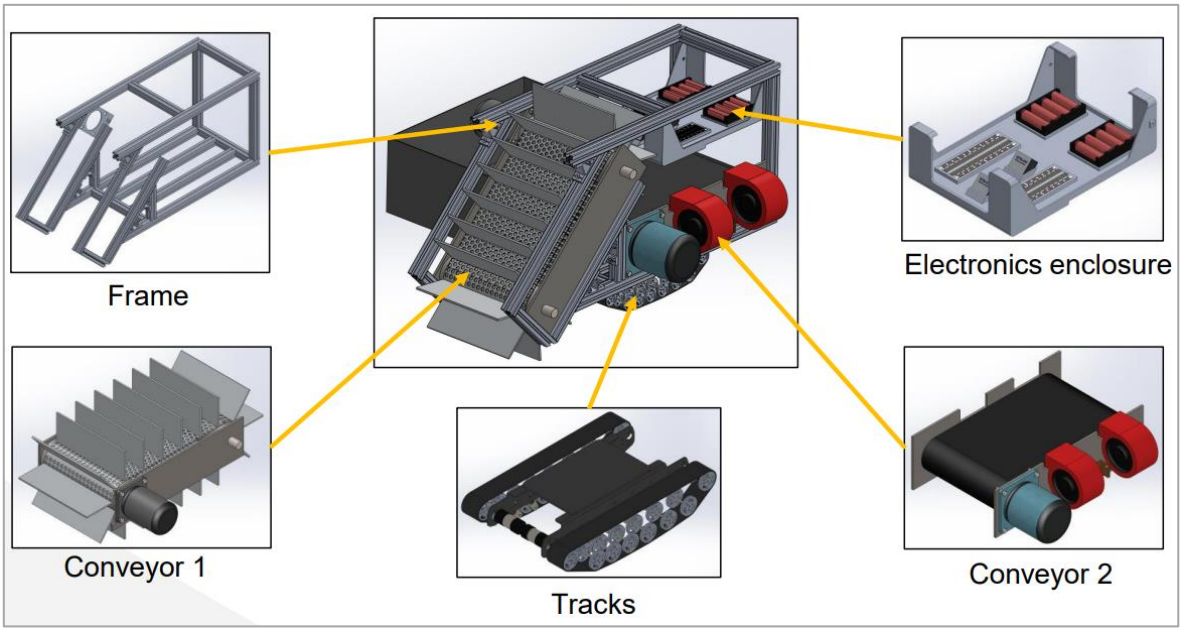
Figure 2: (a) Result of topology study (b) Final design of the optimized crank arm

Project outcome: A topology study was performed in SolidWorks to identify potential locations for removing mass from the original design. The study yielded a design with a 40% reduction in mass, which was subsequently optimized. The final design achieved a static safety factor of 2 and a life cycle exceeding 100,000, in accordance with the British Standard requirement. Manufacturing method: CNC.

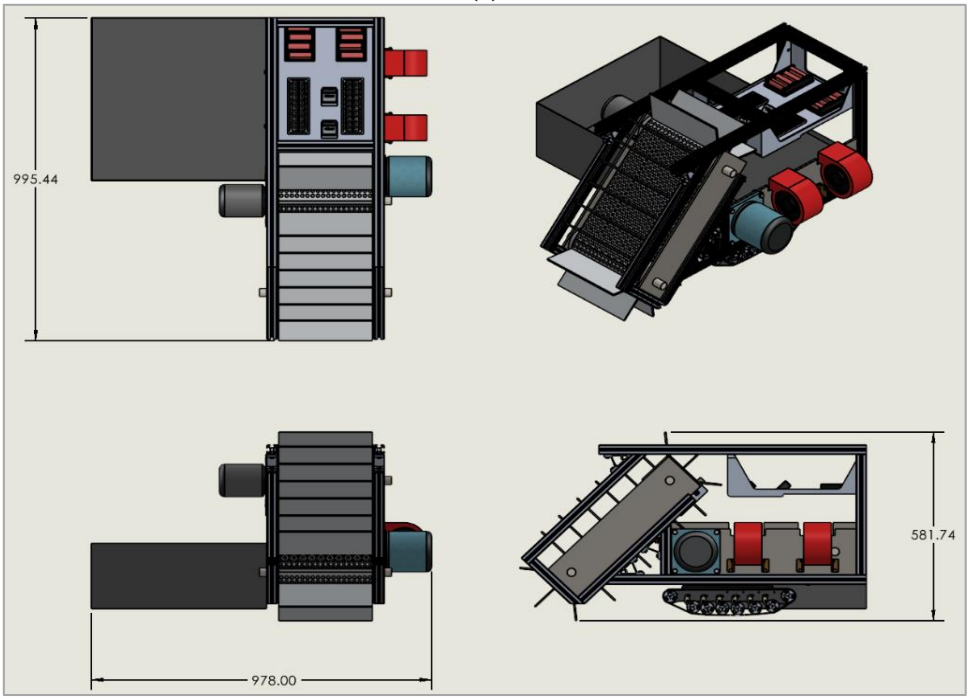
Beach Cleaning Device (Group SolidWorks Design Competition)

Problem statement & Aim: Littering activities in the beach has become a significant issue, warranting concern due to the potential risks it poses to the environment. We have been tasked to design a beach cleaning device that can collect the litter while not affecting the living organisms in the process.

Final Design:



(a)



(b)

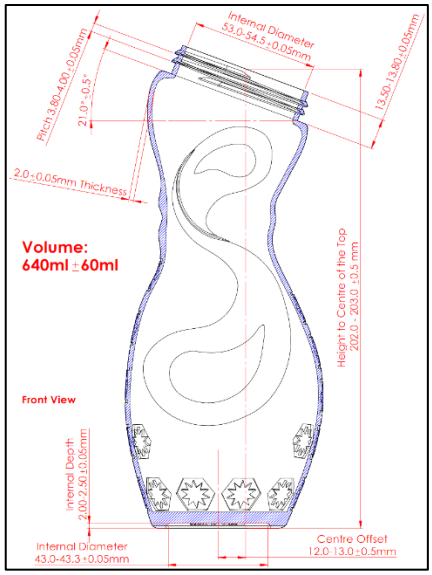
Figure 1: The final design of the device. My contribution was designing the Conveyor 1 and Conveyor 2 as shown in (a) and generating the CAD drawing (dimensions are in mm) as shown in (b)

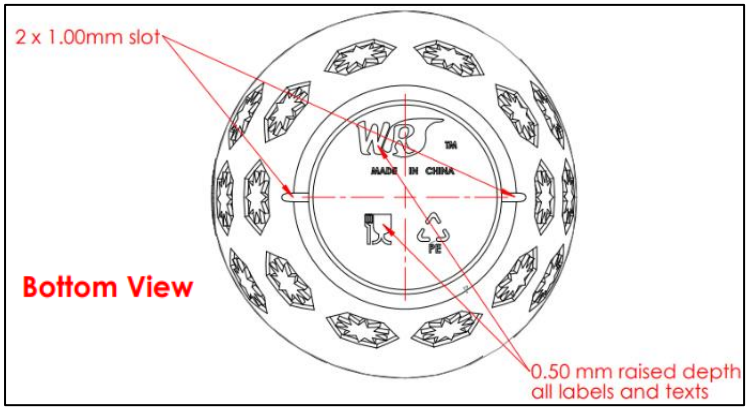
Project outcome: The device meets the requirements stipulated by the competition and has the capacity to filter waste such as plastics, from sand and store them separately while allowing non-waste materials such as stones and living organisms to pass through unaffected. Our design was awarded 2nd place.

Bottle Advanced Modelling (Individual Project)

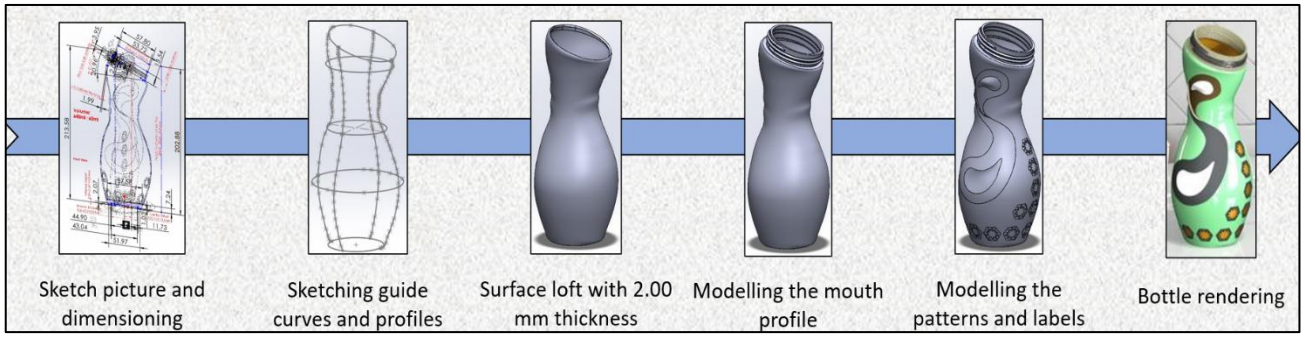
Aim: Reverse-engineer an intricate shaped bottle by modelling it in SolidWorks using its drawings and generate a rendered image of the bottle placed in a suitable background.

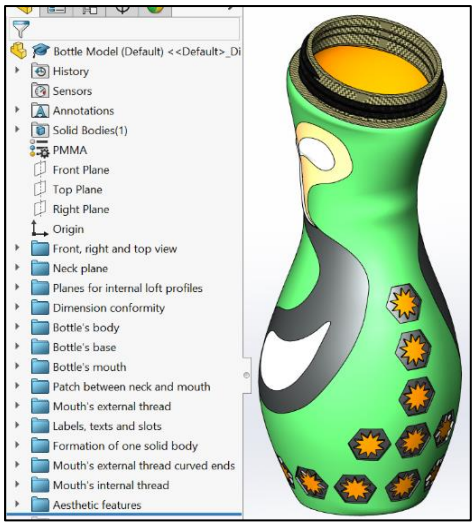
Drawings provided:





Modelling methodology and final design:





Project outcome: The bottle was modelled using advanced techniques, including tracing, surface modelling, Boolean operations, as well as employing features, such as spline, loft, pattern, and freeform. The final model adhered to the dimensions of the drawing.