

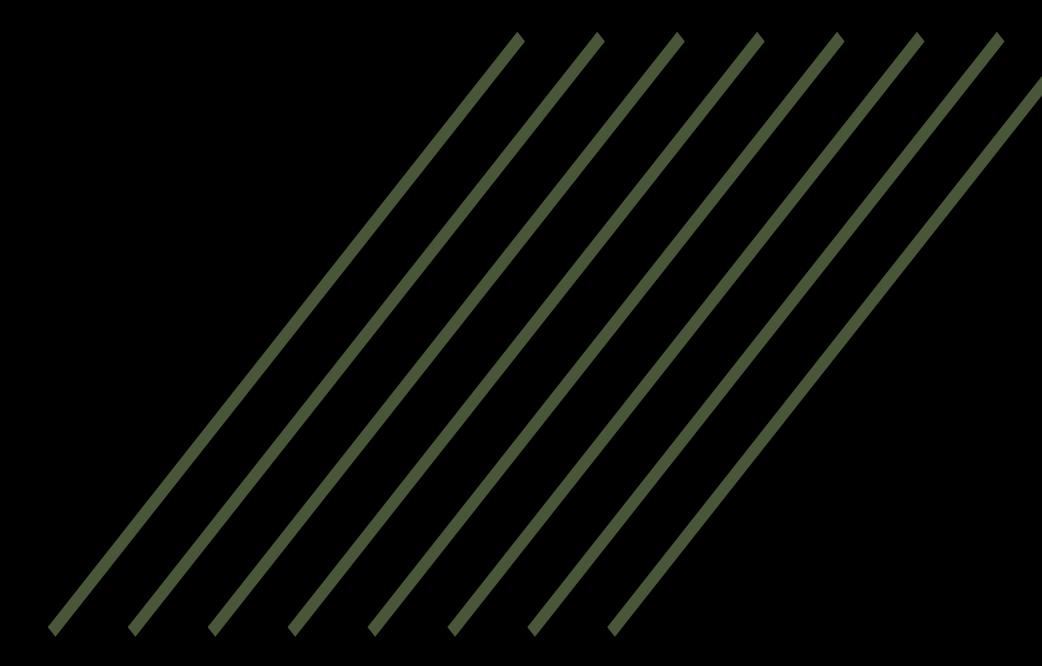
مدرستنا الثانوية، الورقاء
OUR OWN HIGH SCHOOL, AL WARQA'A



OFF CENTRE

PROJECT PORTFOLIO

Meet the Team



Abinav Pallathoor

Team Manager



He is a skilled coder, known for his unwavering dedication, he persistently refines his ideas to achieve perfection. His commitment to excellence consistently delivers high-quality solutions.

Liam Coutinho

Software Engineer



With a comprehensive understanding of various programming languages, coupled with advanced proficiency in artificial intelligence, he stands out as a leading figure in both fields.

Vaibhav Arepaka

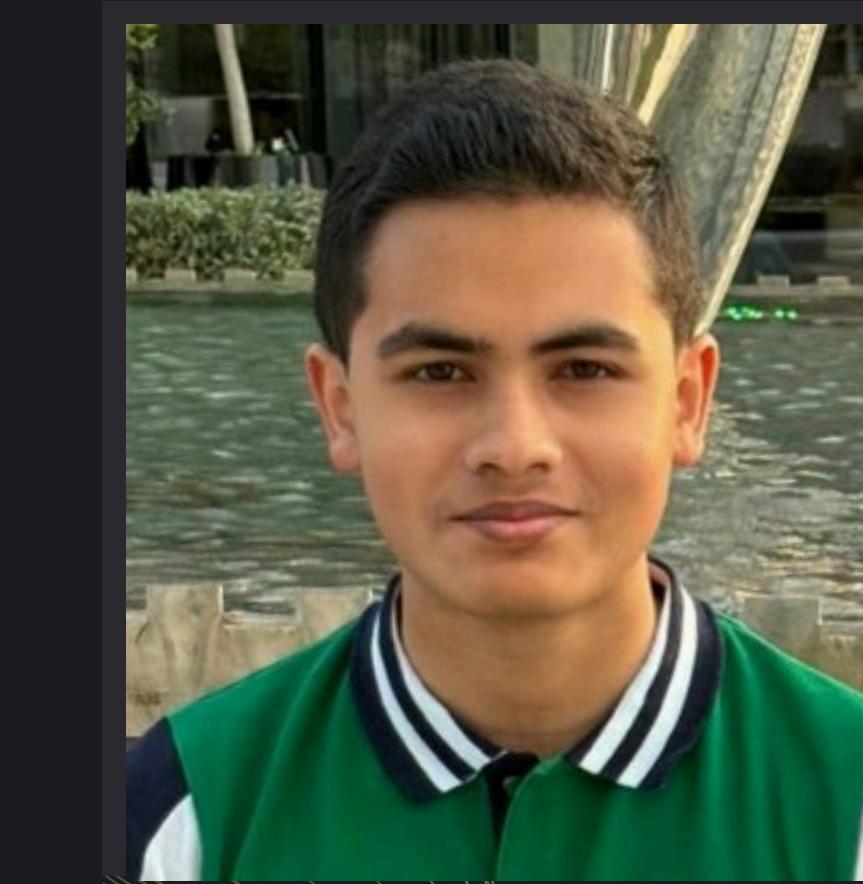
Manufacturing and
CAD Engineer



Renowned for his proficiency, he excels in generating intricate and sophisticated designs, leveraging his knowledge and experience to push the boundaries of innovation.

Muhammad Shadan

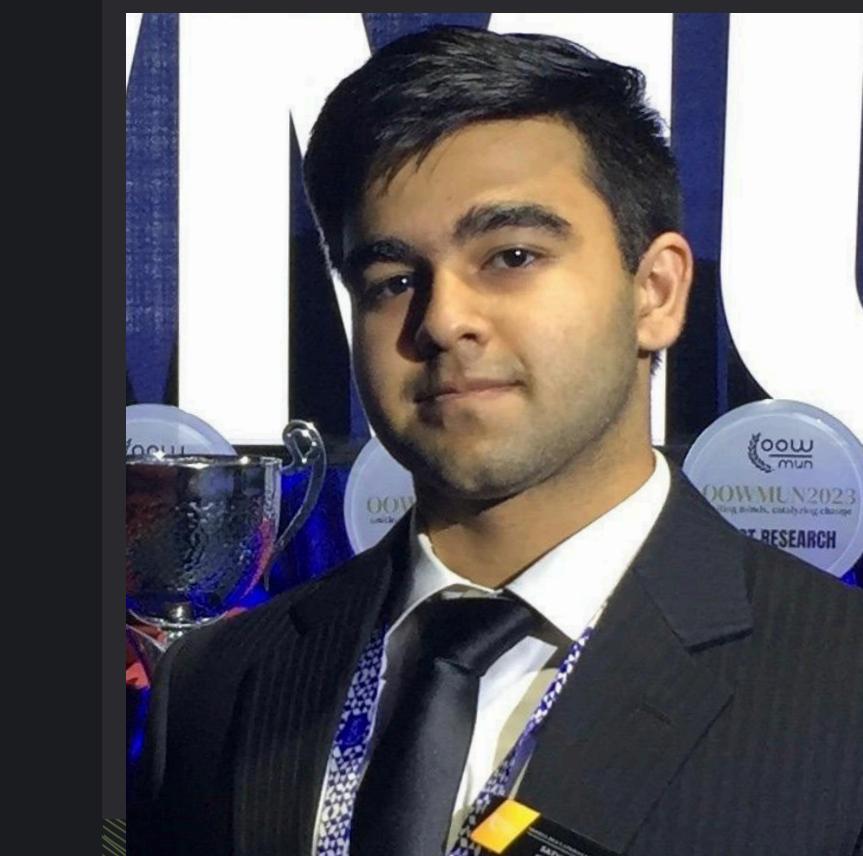
Hardware Engineer



In the realm of hardware engineering and coding, he showcases unparalleled expertise, particularly in Arduino and electronics. His mastery extends to a wide range of skills and knowledge.

Satvik Bagul

Marketing Manager



He stands out as an exceptionally hardworking individual, consistently demonstrating the ability to effectively reach audiences and sponsors, thereby fostering meaningful connections.

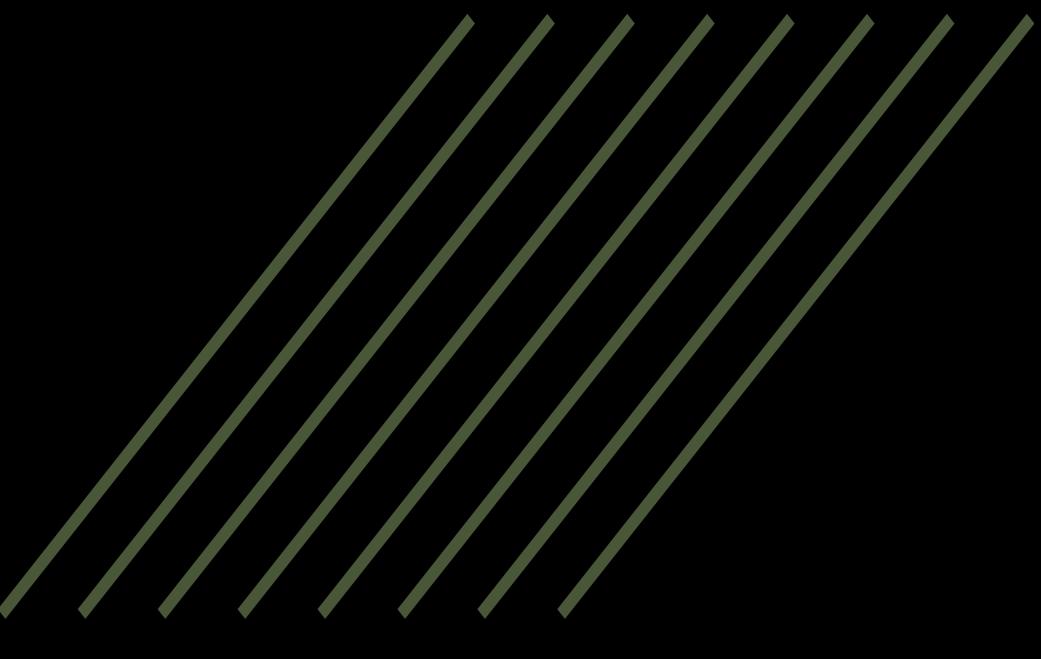
Hishaam Abdul Razik

Design Engineer



A talented designer with a flair for creating stunning visual experience with the ability to blend aesthetics with functionality. Additionally, he is proficient with WebDev and Network Administration

BRAND IDENTITY



» The Brandmark



Our logo showcases unconventional thinking coupled with precision and accuracy, symbolized by two concentric circles, one offset, with two centered lines. It represents our commitment to innovative ideas that diverge from norms while ensuring accuracy.

» Typography

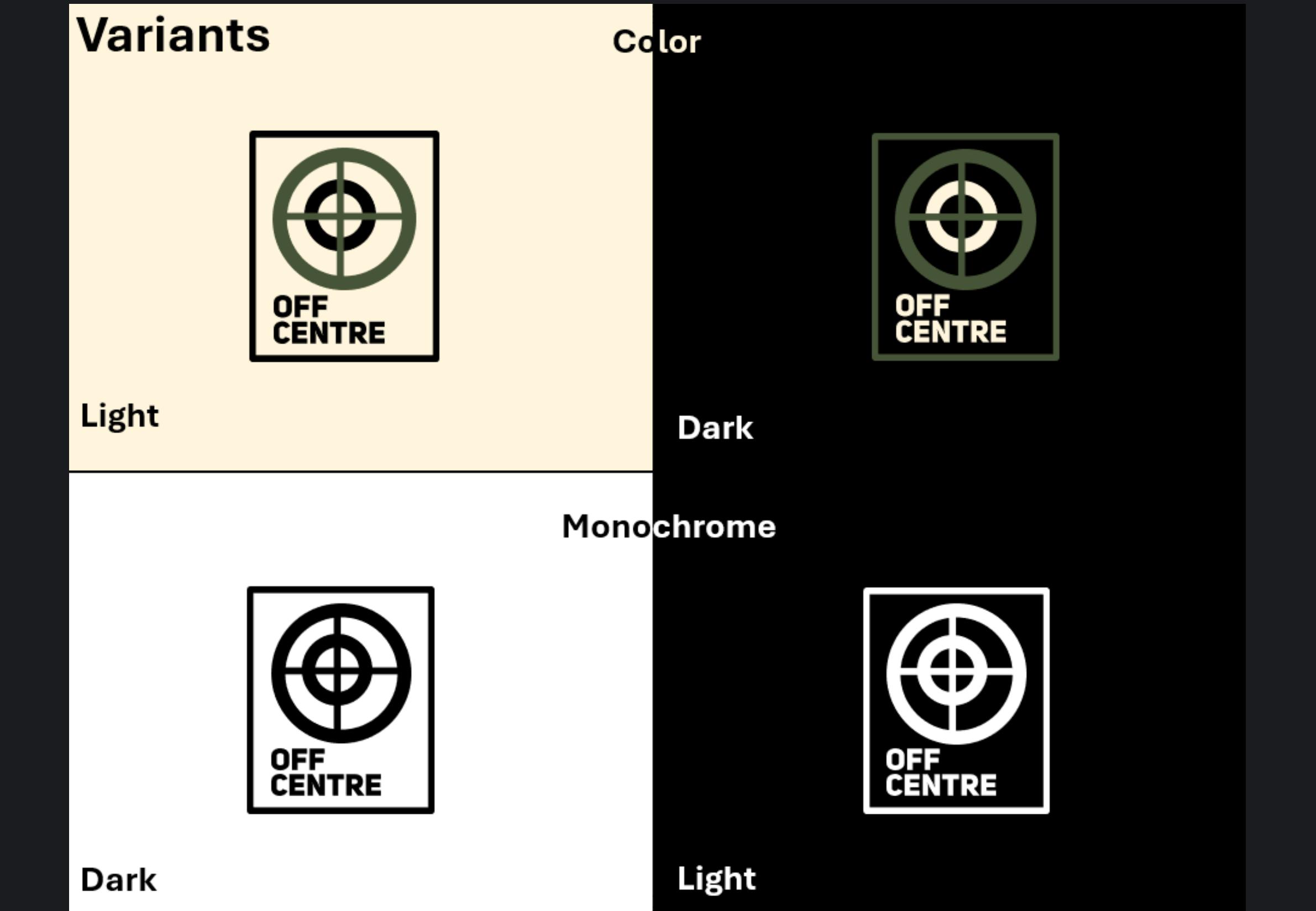
UNI SANS

Aptos

Nunito Sans

- Primary
- Secondary
- Alternate

» Color Scheme



» Tone of Voice



» Logo Evolution



Design 1
The first logo, already embodies the meaning of "Off Centre", but wasn't what we envisioned.



Design 2
This logo experiments with the positioning of the text as well as trying out a dual color theme.



Design 3
This design, introduces the iconic border and we were still experimenting with the layout.



Logo 1
The Final Design, was perfect, in encompasses what Off Centre means, and is simple.



Theme 1
We revamped our old color scheme, opting for a change from the overused generic blue color scheme.



Theme 2
We tried out red color scheme, but still it felt generic and didn't fit our vision.



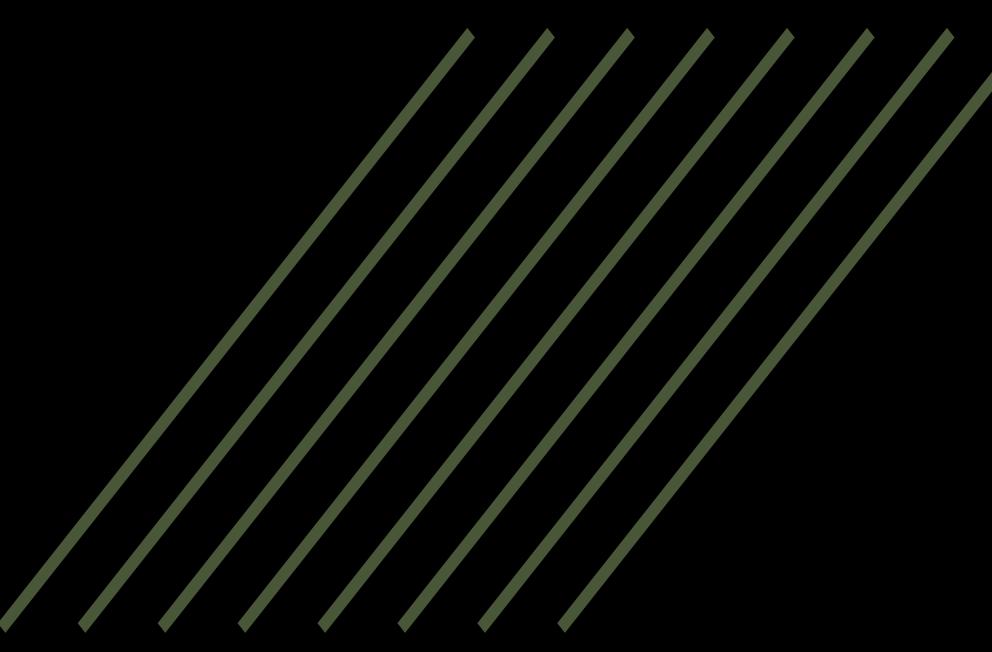
Theme 3
The green and purple color scheme is bold but was still not what we wanted from our logo.



Theme 4
This color scheme suited our vision for sustainability, featuring earthy green tones in alignment with our goals.



CAR BREAKDOWN



AI Detection

The car has a phone which is used for bluetooth communication as well as AI Detection which helps in aligning the towbar system.

[Page 8](#)

Acrylic Top Shell

The top shell is a detachable acrylic panel, that allows us to have quick and easy repairs.

[Page 5](#)

LED BAR

The car has an led bar with addressable led strips which enables us to have unique led animations, such as turn indicators.

Electronics

The Arduino nano, Accelerometer, PCA9685 Servo Driver, and PCB mounted on custom electronics enclosure.

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Moving Towbar System

This system consists of a moving towbar that moves side to side, for fast and efficient towing.

[Page 8](#)

Automatic Suspension

The automatic suspension system helps level the car on uneven surfaces using four servos and a gyro sensor.

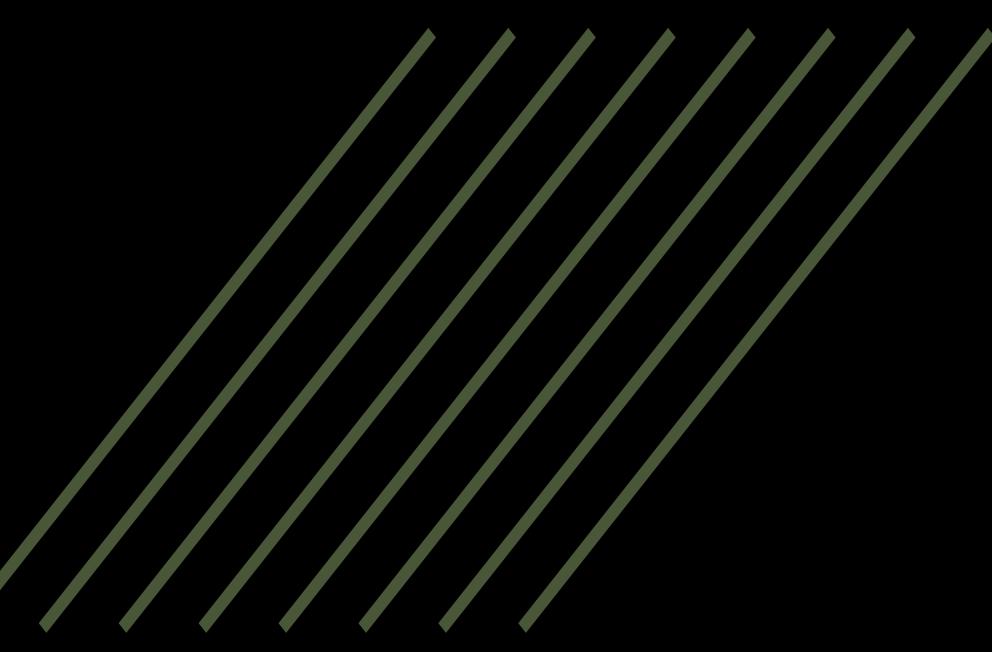
[Page 7](#)

Dual Steering

We have a system that enables the rotation of the front and back servos, enabling tighter turns and crab walk mode.

[Page 5](#)

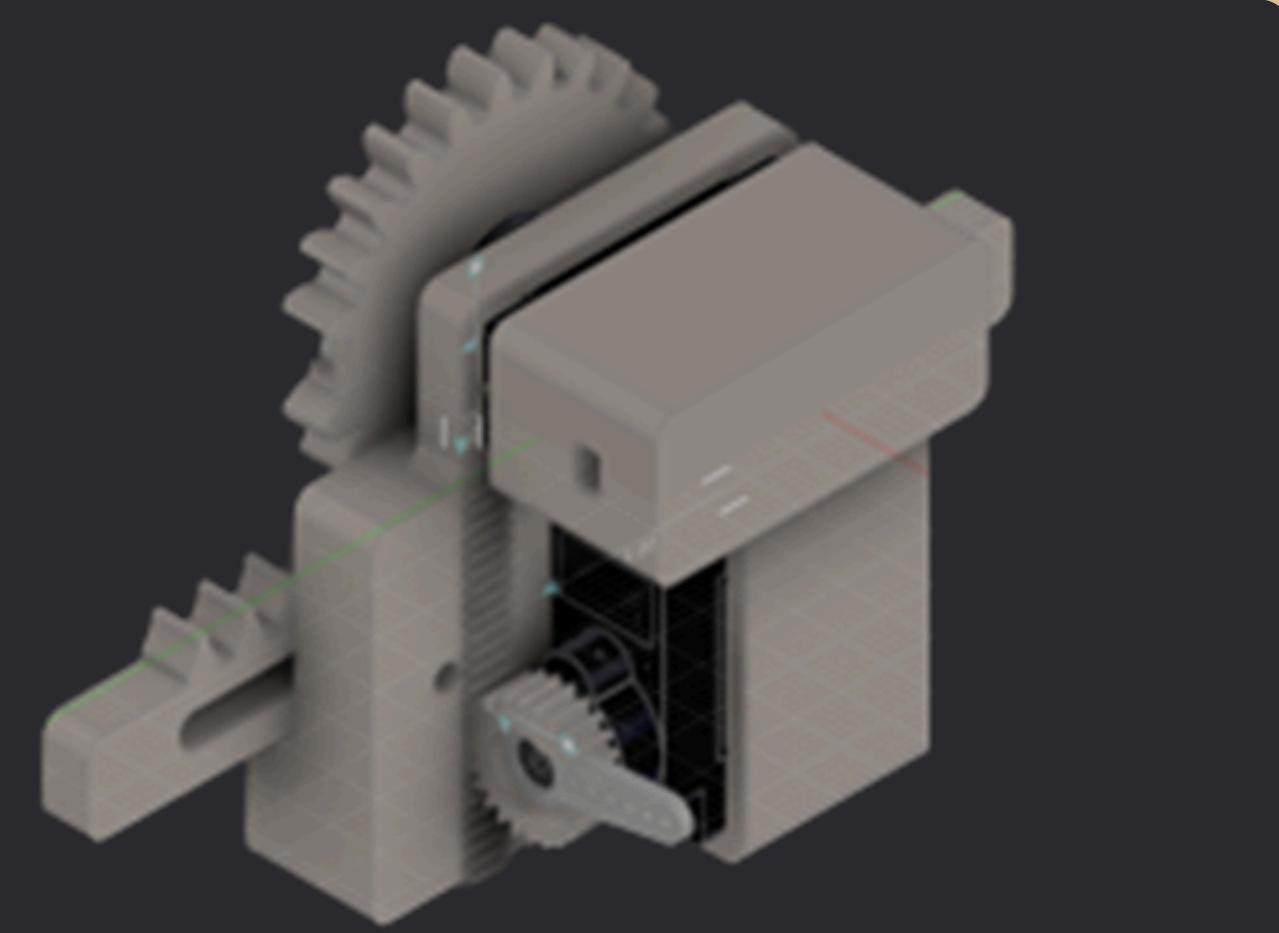
RESEARCH - Analysis



» Towbar Failing

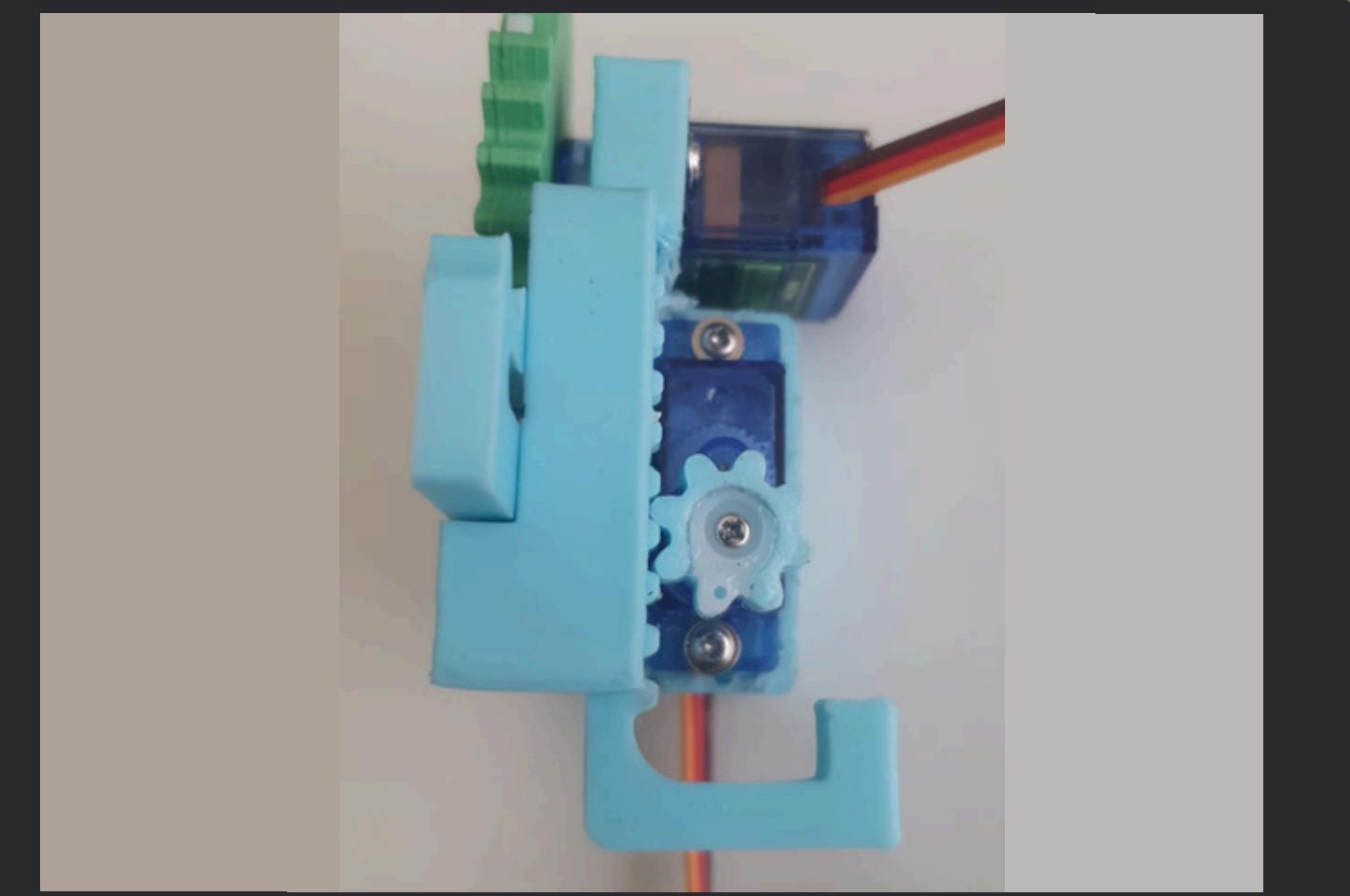
Problem

During our towbar mission our towbar system failed to hold onto the trailer and broke, due to the fact that the latching mechanism came from the top.



Solution

This year we made a different mechanism for the towbar, which latches from the bottom, furthermore we changed the print orientation which will make the mechanism stronger.



» Heavy Car Body

Problem

The car body was 3d printed for our previous competition, it was very heavy due to its thickness. Also due to the placement of the car body its centre of mass was on the top of the car, causing it to tip over very easily.



Solution

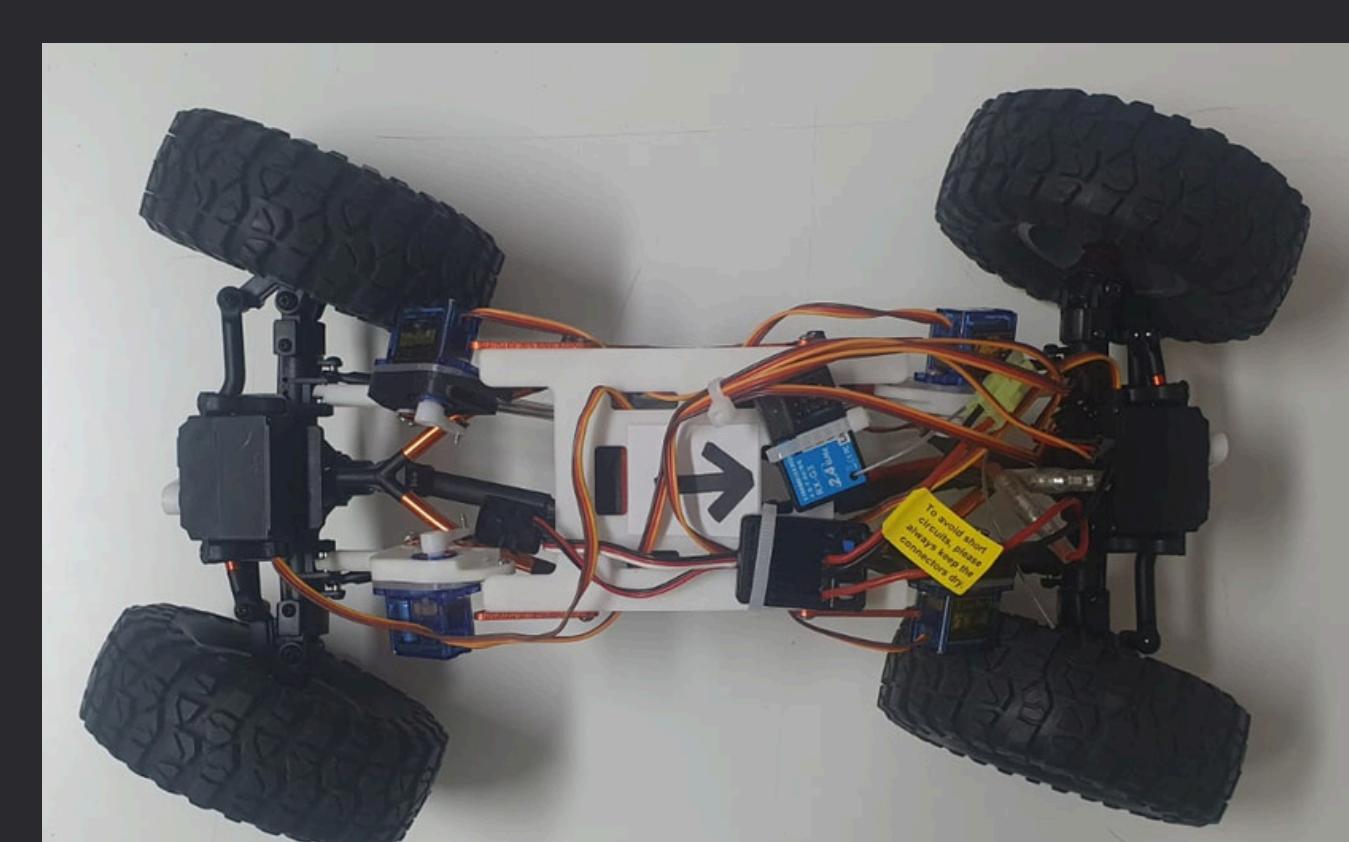
We decided to use a cardboard shell this time, as it is light weight, and environmental friendly. We sourced most of the cardboard from the boxes that came along with our electronics kits.



» Restricted Maneuverability

Problem

Last year, our car was not able to make tight turns, and rather had to reverse multiple times in order to make a turn.



Solution

The dual axis steering system enables our car to turn both the front and rear steering mechanism enabling us to make tighter turns, an added advantage is, when the crab walk mode is enabled the car is able to move laterally as well.



» Repairability

Problem

The problems faced at the competition, was made worse by the fact that our car was very hard to repair, and often required disassembly of many parts to access crucial parts.

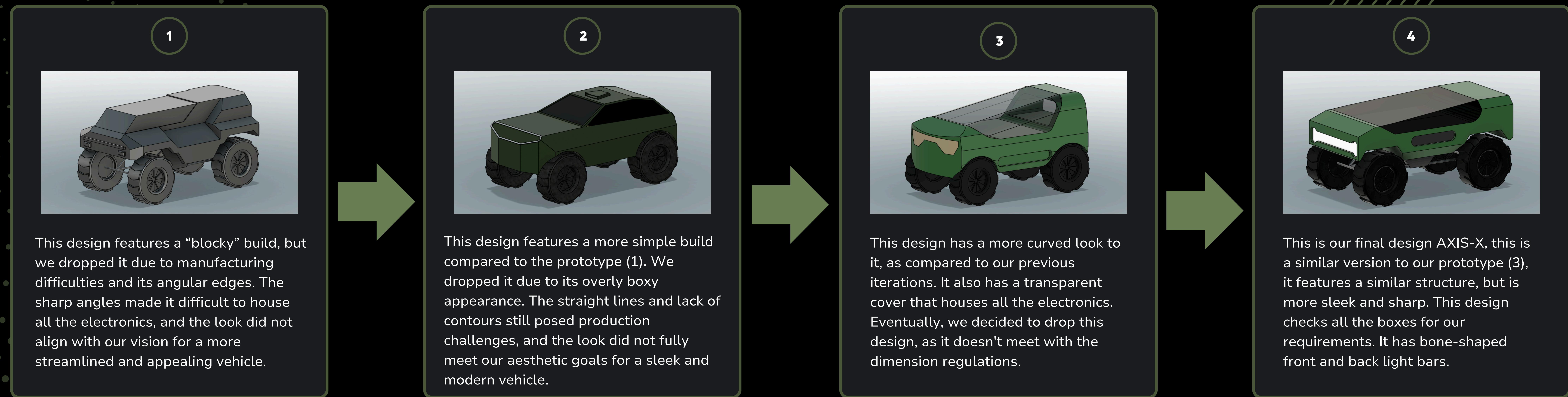


Solution

Due to this we made all our electrical components hot swappable, and batteries easily accessible. Furthermore, our car design facilitates ease of repair by having a detachable top.



CAR BODY DESIGN



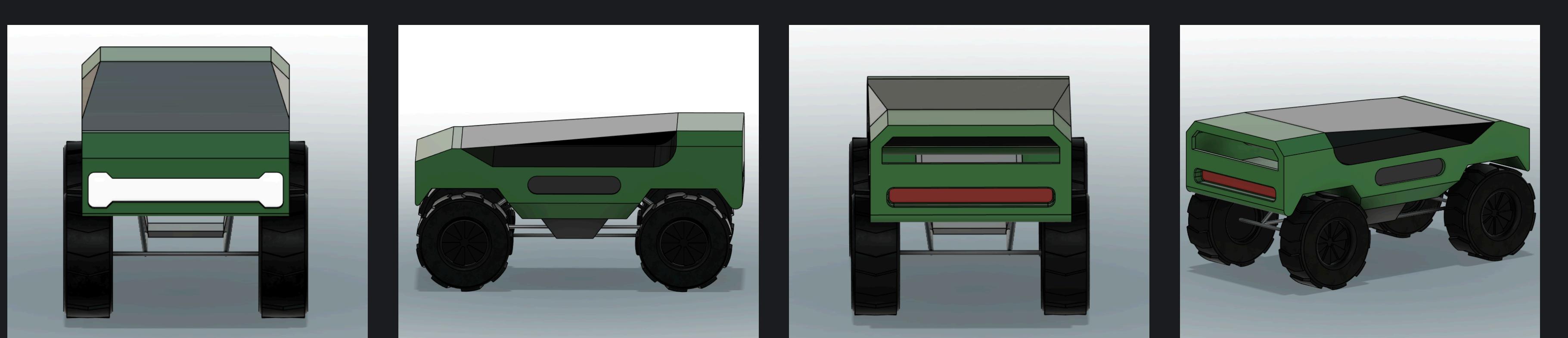
» Introducing AXIS-X



Off Centre presents to you AXIS-X, our next generation all-terrain vehicle, built and perfected from the ground up.

AXIS-X, the successor to the AXIS-01, addresses all the issues we faced last year proving it to be the ultimate off roader.

With a lower centre of mass, new features, and newer parts, AXIS-X enters the competition to dominate the terrain challenges.



» Car Construction

Principles

SUSTAINABILITY

TIMELESS

STRENGTH

VERSATILITY

LIGHT-WEIGHT

Material

Cardboard

This year's 4x4 project focuses on using lightweight, recyclable materials. Our decision stems from past issues with heavy 3D-printed car body causing the car to tip. Despite the plastic being biodegradable, recycling them remains a challenge. Therefore, we've chosen more environmentally friendly materials



Factors

Centre of Mass

As future engineers, we learn from our mistakes, last year our design had a major flaw in terms of centre of mass making it “top-heavy”. That is why this year we have given a huge importance to lowering the centre of mass

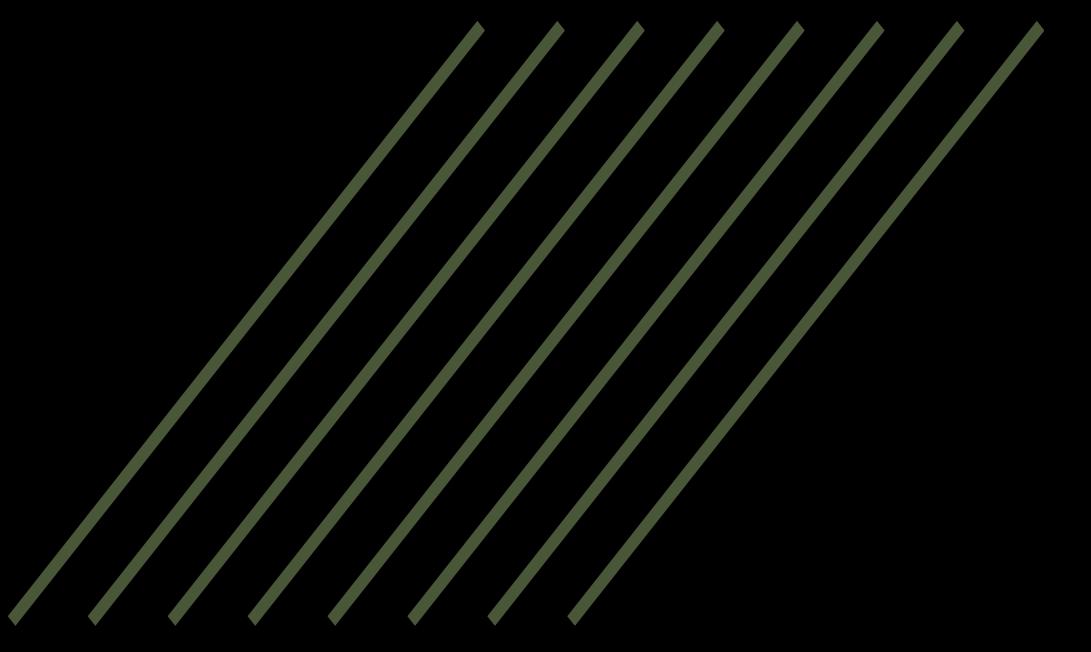
Inner Electronics

While managing the centre of mass, it was also important to design a body that would efficiently fit in all the electronic components without breaching the competition regulations.

Rigidity

Similar to a traditional 4x4 vehicle, we wanted to use materials that would ultimately be rigid but also light.

FEATURE - Auto Self Leveling



>> Initial Ideas

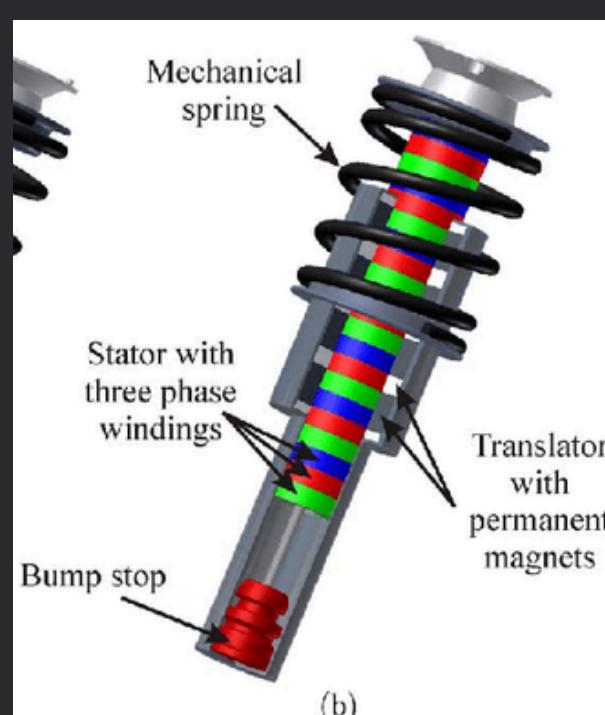
Pneumatic System

This is a system based on pressurized air, and it was considered due to its high strength and controllability but was eventually rejected due to its complexity, high mass and high-power demand.



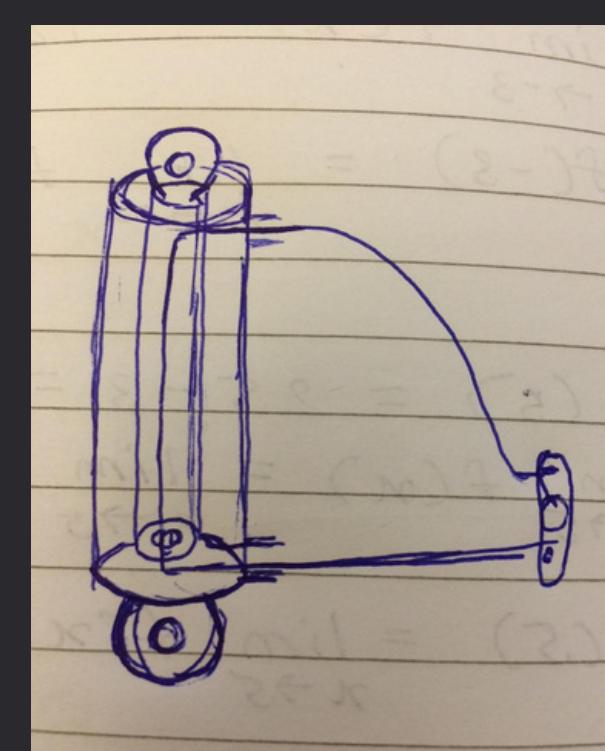
Electro Magnetic System

This system provides actuation using electromagnets and this was considered because of how it's relatively easier to control but was eventually disregarded due its very high complexity.



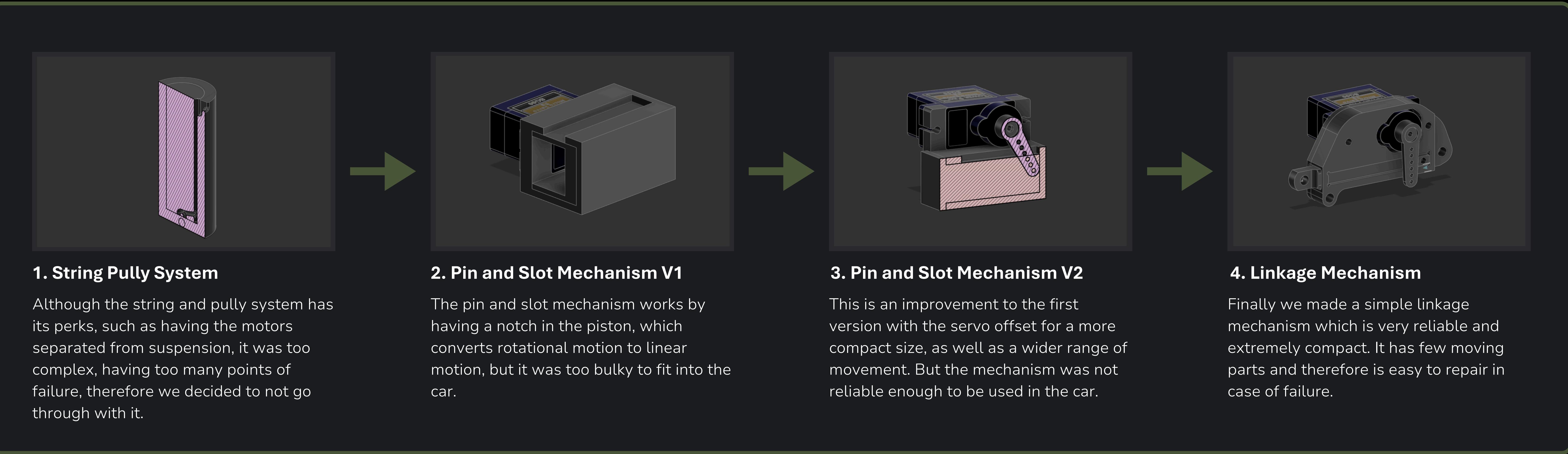
String and Pulley System

This system was disregarded by us because the string can't hold tension when being pushed, thereby requiring a spring which further complicates the system.



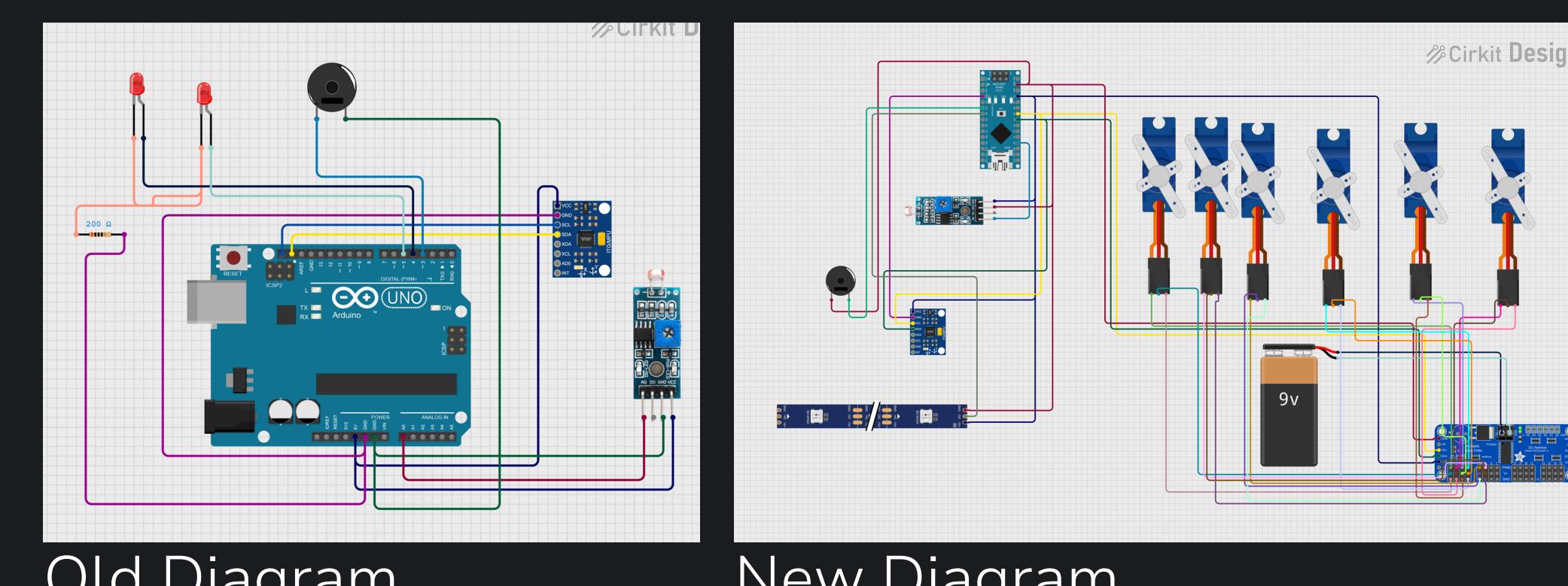
Arm and Linkage System

This is the system that has been selected to be implemented on the car. We choose this due to its simplicity, efficiency and most importantly it's durability, there simply isn't that many things that can go wrong with this system, hence making it more durable.



»» Electronics

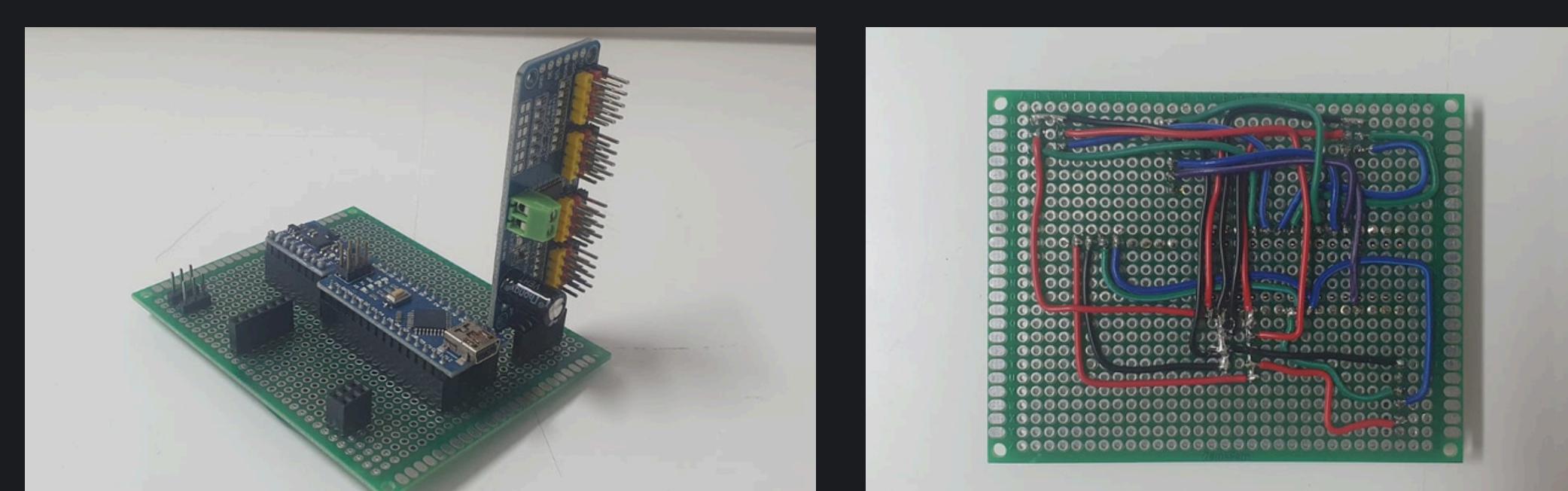
Circuit Diagram



Old Diagram

New Diagram

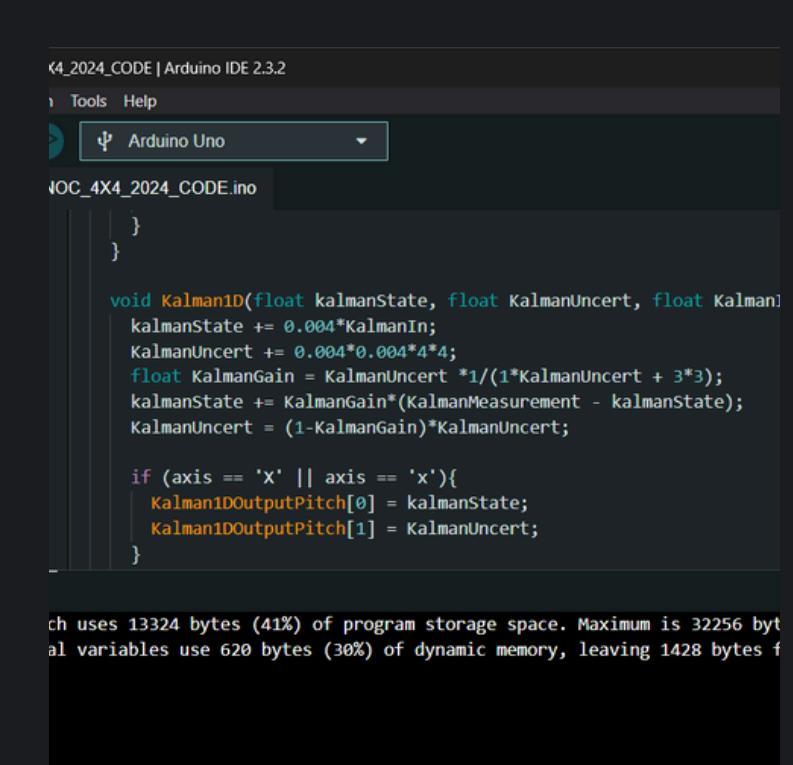
Final PCB Design



Our circuit has been built on a perforated circuit board padded on both sides and made from fiberglass which ensures structural integrity as well as makes the circuit more compact, allowing us the store all the electronics in a single assembly.

» Algorithm & Logic

The diagram illustrates a control system architecture. It begins with an 'Image from camera' block, which outputs a signal $s(k)$. This signal is processed by a decision diamond 'Are feature(s) inside FOV?'. If the answer is 'Yes', the signal is fed into a 'Kalman filter (noise filtering)' block, which also receives a 'Kalman measurement' $M(k)$. The filter outputs an estimate $\hat{s}(k)$. The error $e(k) = \hat{s}(k) - s_d$ is then calculated. If the answer is 'No', the signal $s(k)$ is fed into another 'Kalman filter' block, which also receives a 'Kalman measurement from (21)' $M(k)$. This filter also outputs an estimate $\hat{s}(k)$, and the error $e(k) = \hat{s}(k) - s_d$ is calculated. Both estimates $\hat{s}(k)$ and errors $e(k)$ are sent to a 'Robot controller' block.



>> Coding

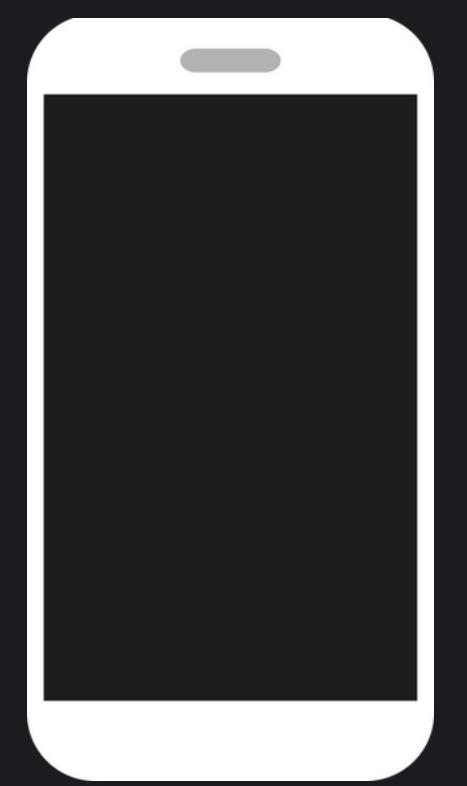
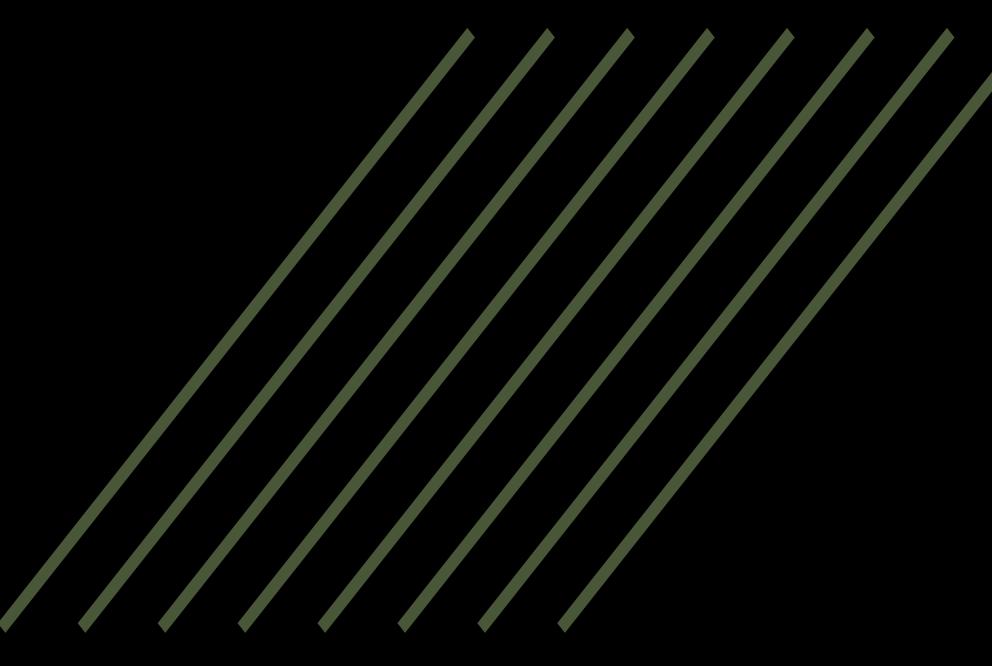
The codes for all the systems on the car has been done with C++, primarily on the Arduino IDE 2.0. We have used a minimum number of libraries for this project and made majority of the code by ourselves ensuring proper compatibility.

» Testing & Quality Assurance



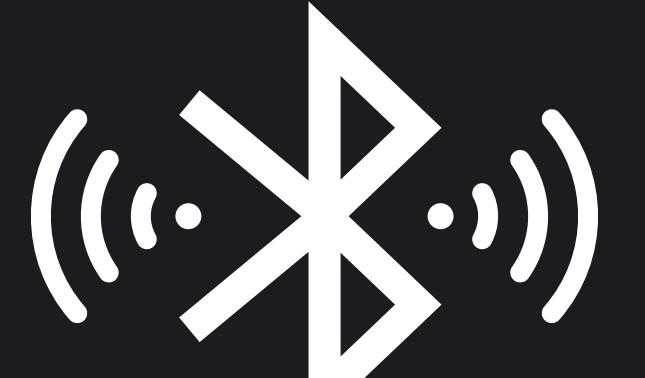
All systems in the car have undergone rigorous testing, through multiple sessions. One of the primary tests was about finding the absolute limits of the suspension system which involved setting the servo's to a near stall scenario that led to the failure of one of the servo's internal mechanism but gave us a huge amount of insight on the capabilities and the maximum limits of our system.

FEATURE - Smart Tower



Control Phone

The control phone utilizes a GUI for intuitive user control and establishes a bluetooth connection with the car phone

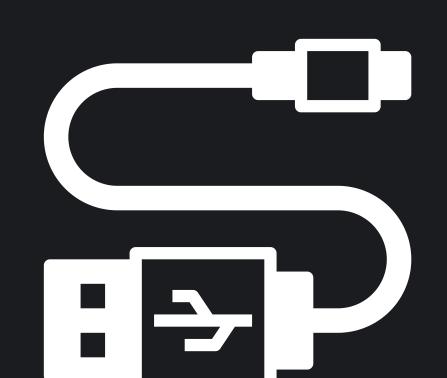


Bluetooth

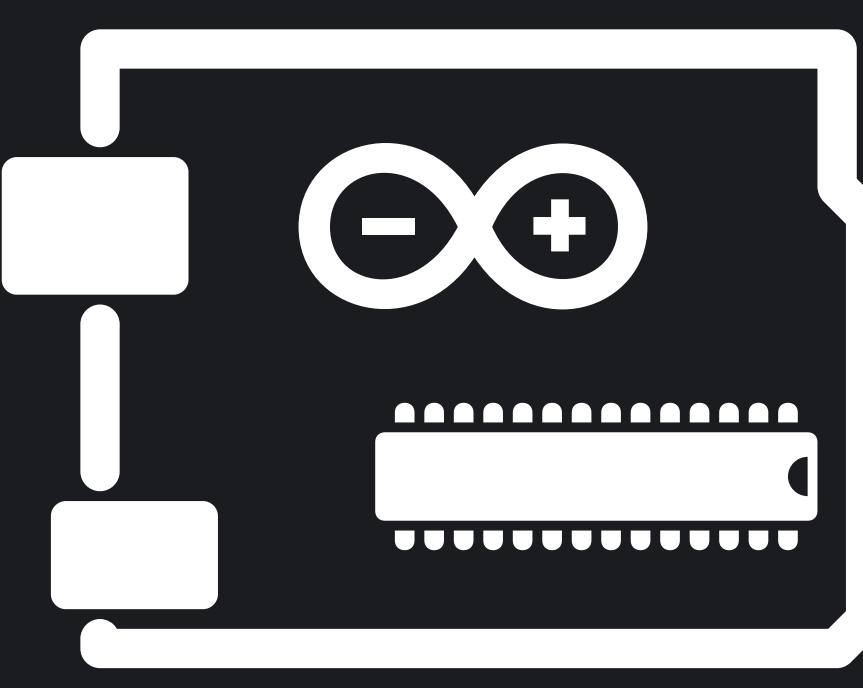


Car Phone

The on-board unit facilitates communication between the control phone and the car, for power efficiency and a reliable connection



Communication



Microcontroller

The car phone has further established serial communication with the arduino completing the connection with the control phone

Ai Training & TensorFlow Lite

The car phone also has inbuilt trailer detection system , it process video input and identifies the trailer and transmits the necessary information to the arduino

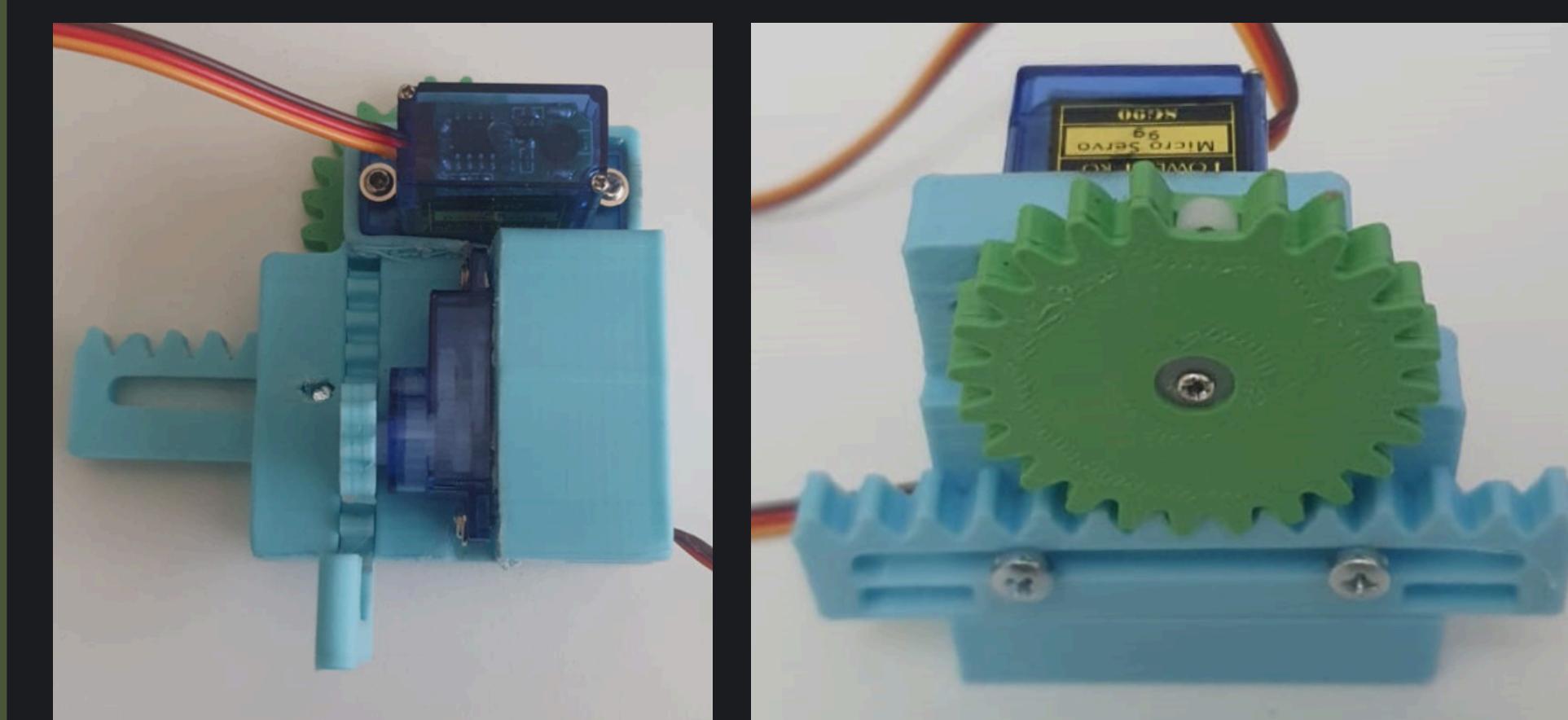
Model Optimization

The model has been optimised with post- training quantization to improve its efficiency and ensure quicker detection

We specially curated a design that moves in both the Y-axis and the X-axis. It utilizes 9g servo motors to control the rack and pinion system present in the towbar mechanism. This system is fully controlled by our AI detection algorithm.

We've advanced from manual control to a seamlessly integrated, fully autonomous system, vastly improving our capacity to swiftly conquer the challenge at hand.

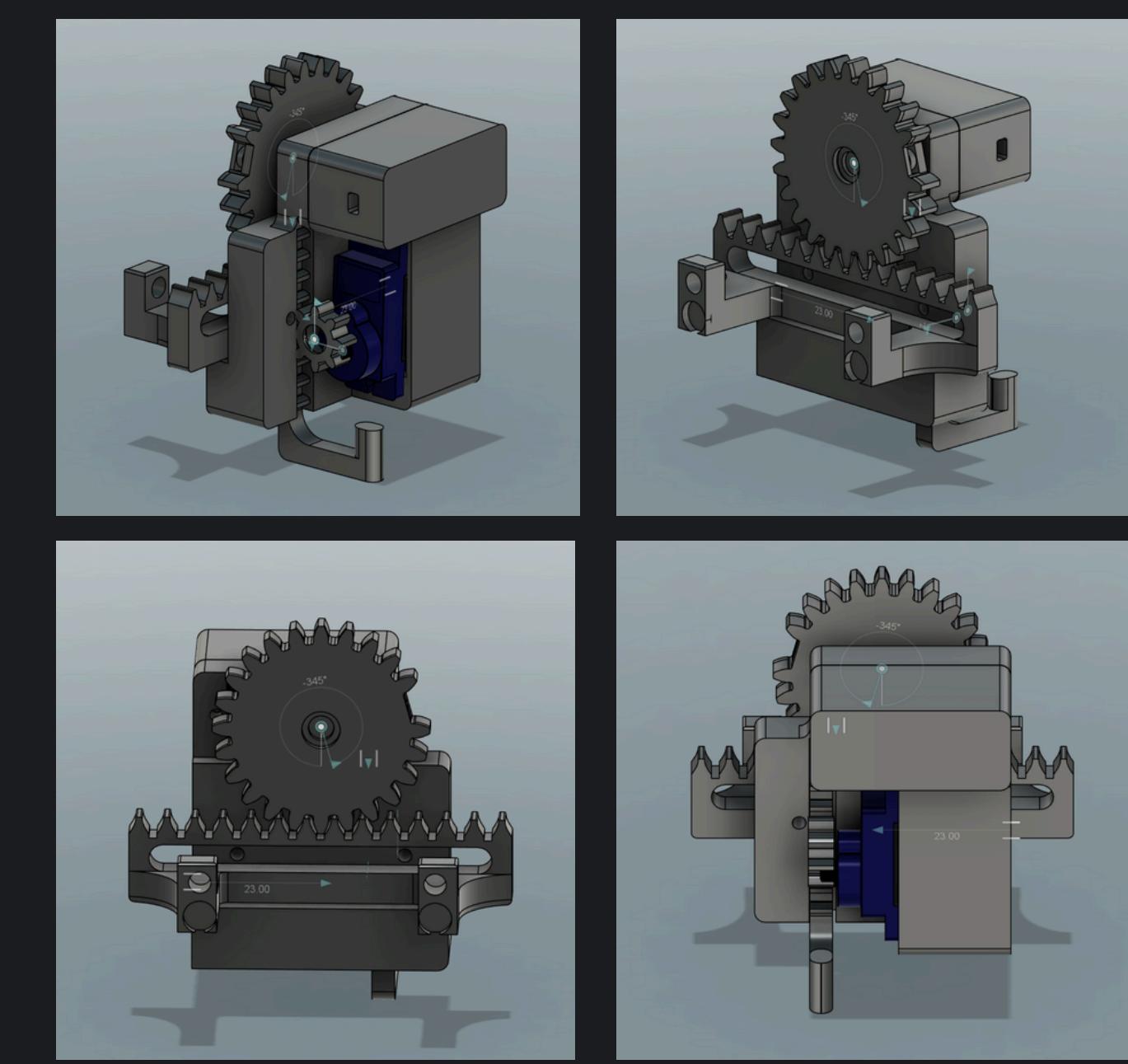
Towbar Design



Challenges Faced

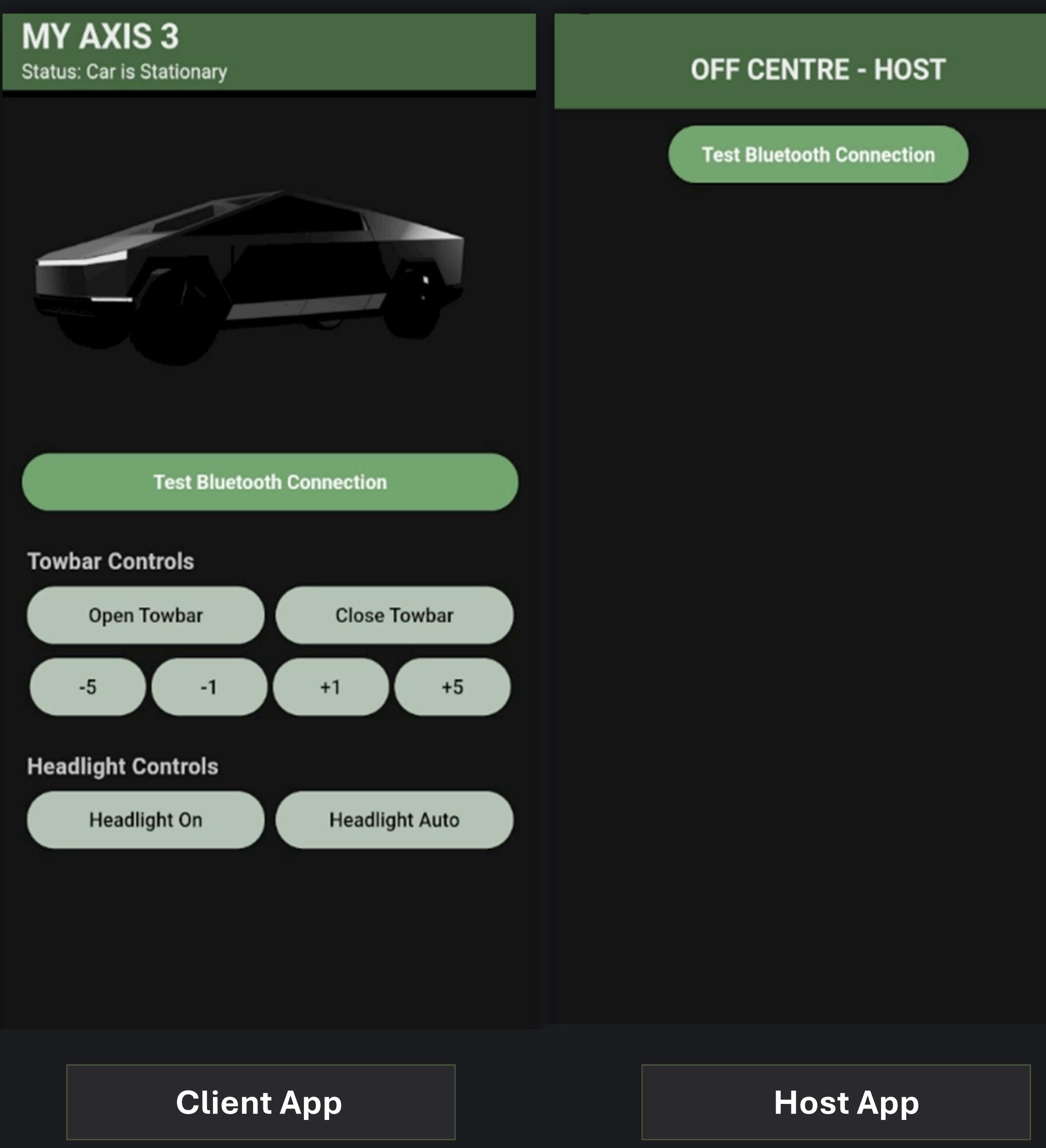
In our previous iteration, the Y and X-axis were manually controlled through our app, resulting in time losses during operation. Additionally, the Y-axis latching mechanism was flimsy, causing the trailer to detach from the towbar.

Previous iterations also included a laser pointer to assist in aligning the pin to hitch the trailer. However, as we were standing at a distance from the vehicle, the laser was not visible and therefore did not aid in the hitching process.



Phone App

The user-friendly smartphone app acts as your car's control center. Interactive elements and real-time feedback allow effortless management of features, while customization options personalize the experience. This intuitive app bridges the gap between driver and machine, putting you in the driver's seat with total control.

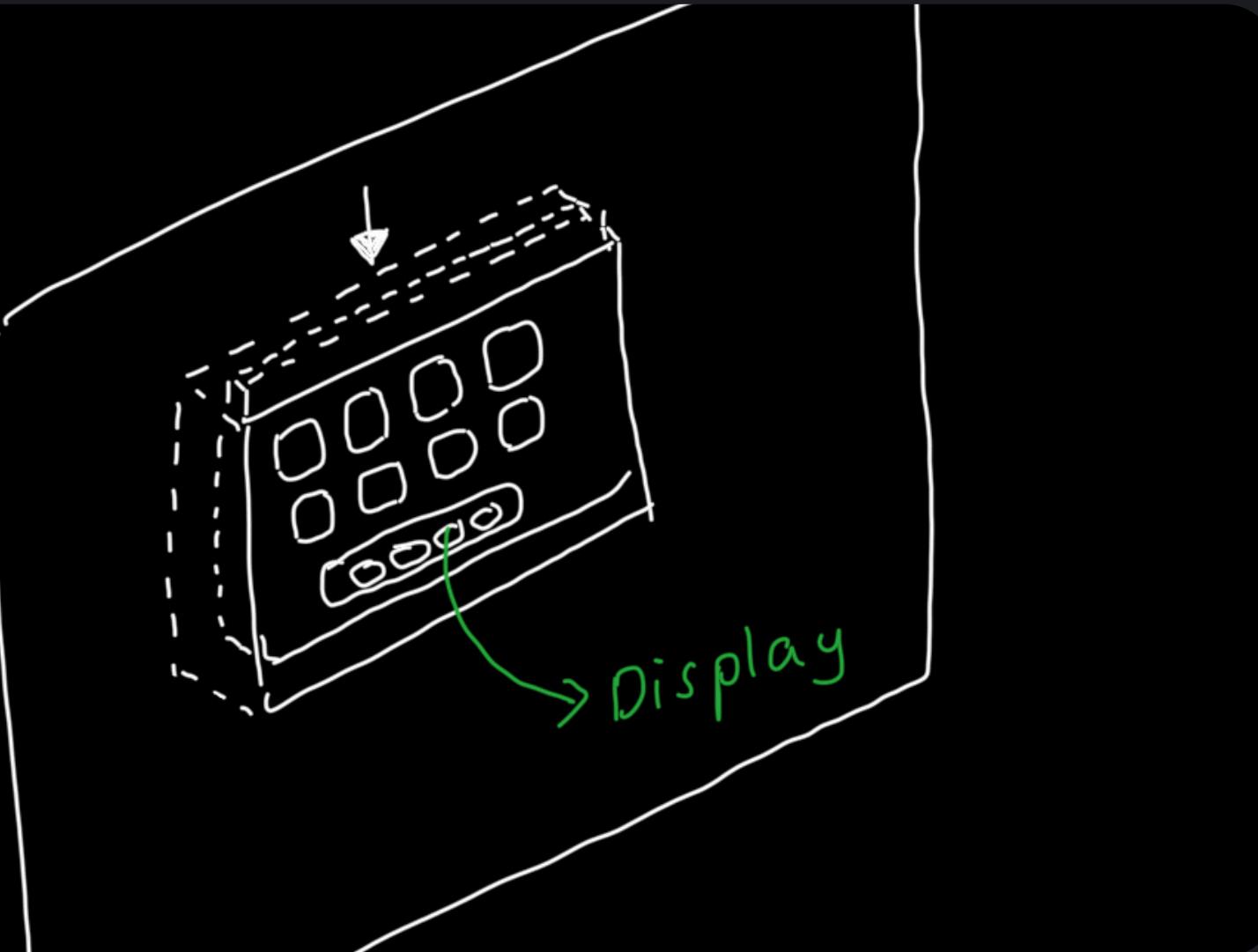


PIT DISPLAY

» Objectives

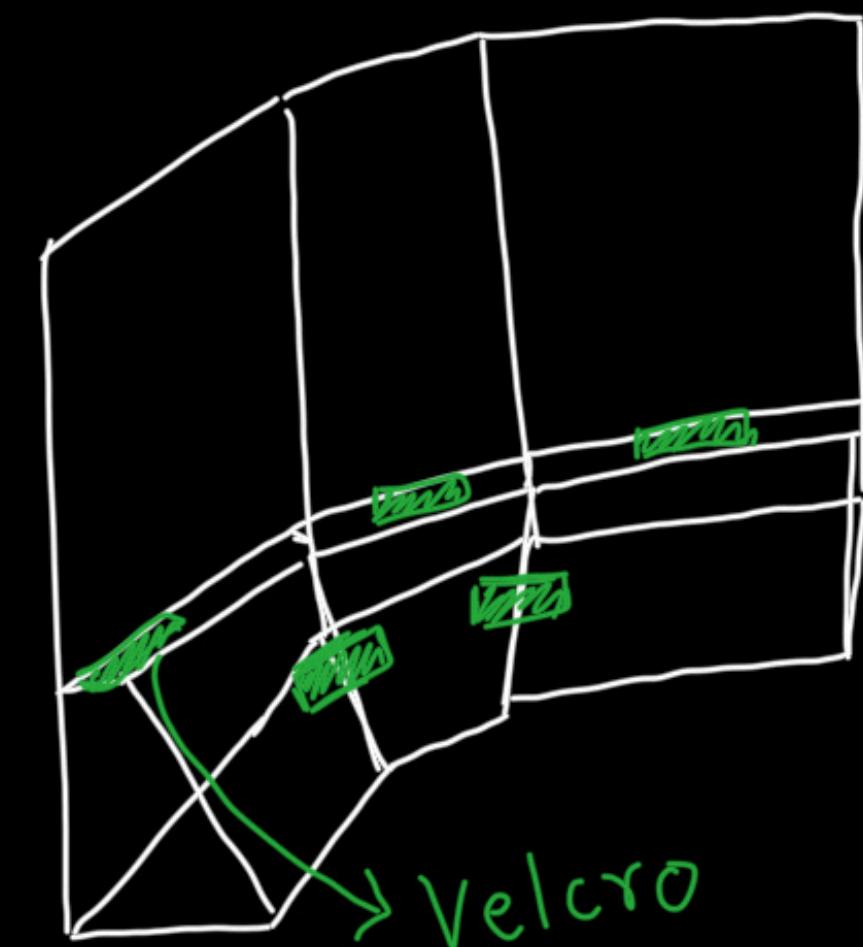
EASY TO READ

To ensure the pit display is easy to read, we strategically optimized the use of space by angling the top and side panels. This design choice positions the information directly in the viewer's line of sight, making it more accessible and improving readability.



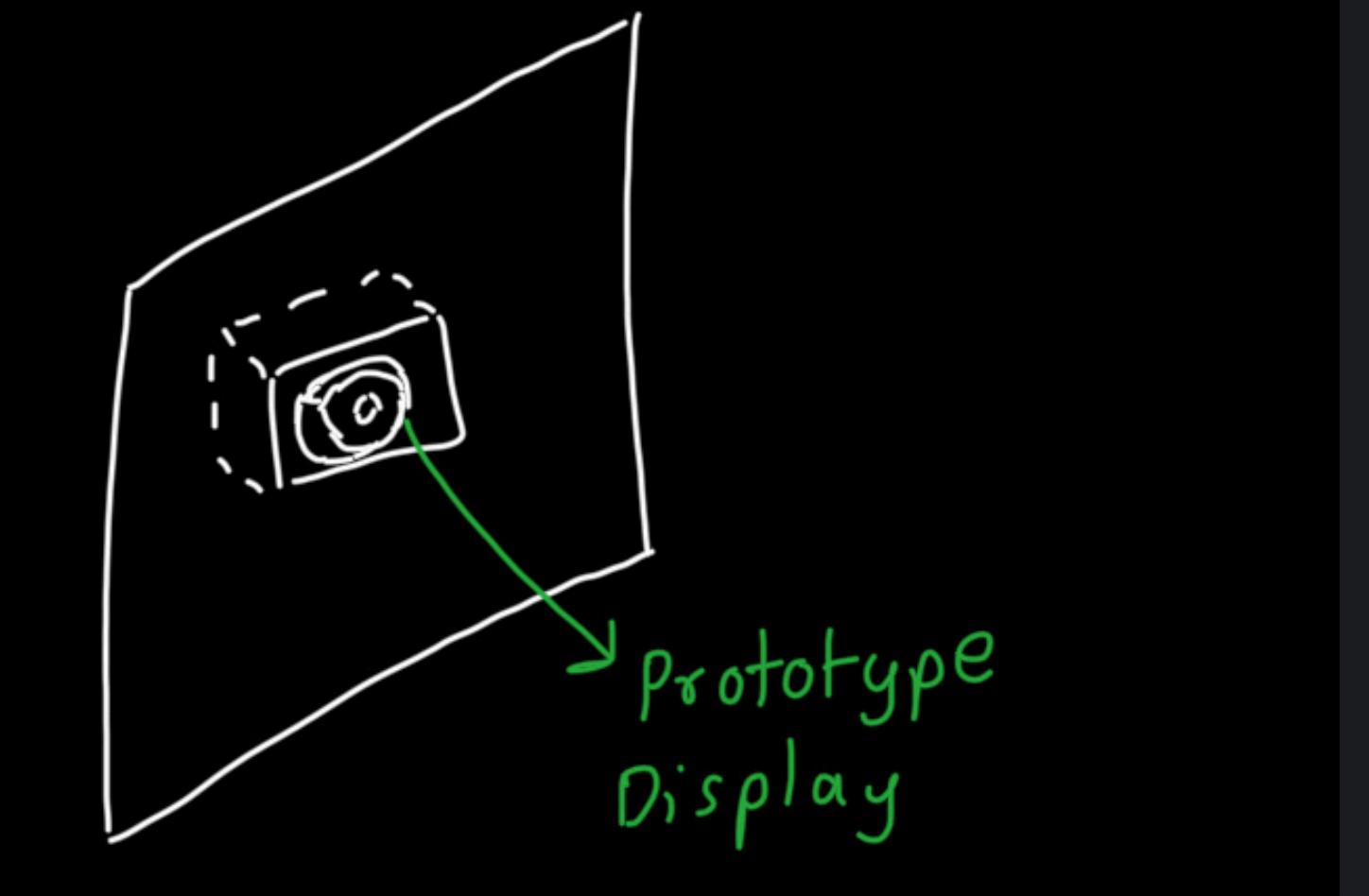
Insertable Displays

We made slots in our pit display so that we can insert a display. This allows us to show demos, such as the car in action, which a stationary medium cant do.



Velcro System

We use velcro pads in order to keep the pit display holding together. It also is quick to assemble at the event, and take down while transporting.



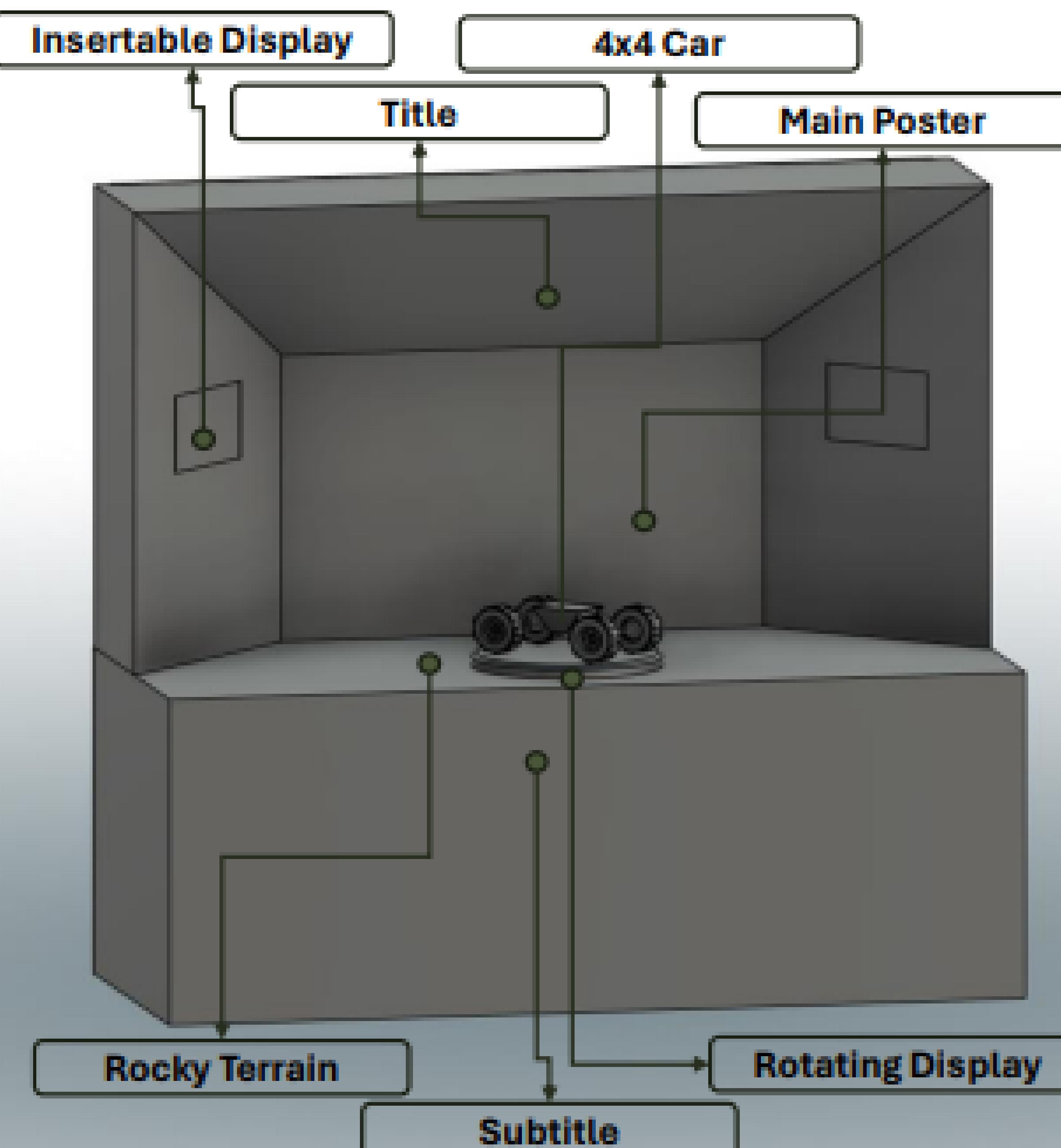
Prototype Displays

We made an indent in the pit display which has an acrylic sheet covering it upcycled from document covers. This is used to show our prototypes.

VISUALLY INTERESTING

We used various cues, such as rocky terrains, and gravel paths to showcase the versatility of our project. Our vehicle would be placed at the center of our Pit Display on a rotating table to showcase all the details and effort that went into designing it.

Pit Display Mockup



QUICK TO ASSEMBLE

Taking into consideration the intricacies of our Pit Display, we also had to make sure it was quick to assemble. We have also added an insertable display that makes it easy to attach any additional information.

» Transportability

Last year, our journey from Dubai to Abu Dhabi lasted for approximately 2 hours. To minimize damage, we have split our Pit Display into various parts to assemble once we reach our destination.

To elevate our pit display and have it represent our team's vision, we decided to build the pit display from the ground up. An added advantage of engineering a pit display from scratch is control over its structure.

After various iterations, we ended up on a design that is 176cm wide and can collapse to a size that is 70cm wide. This allows us to transport the entire pit display with relative ease.

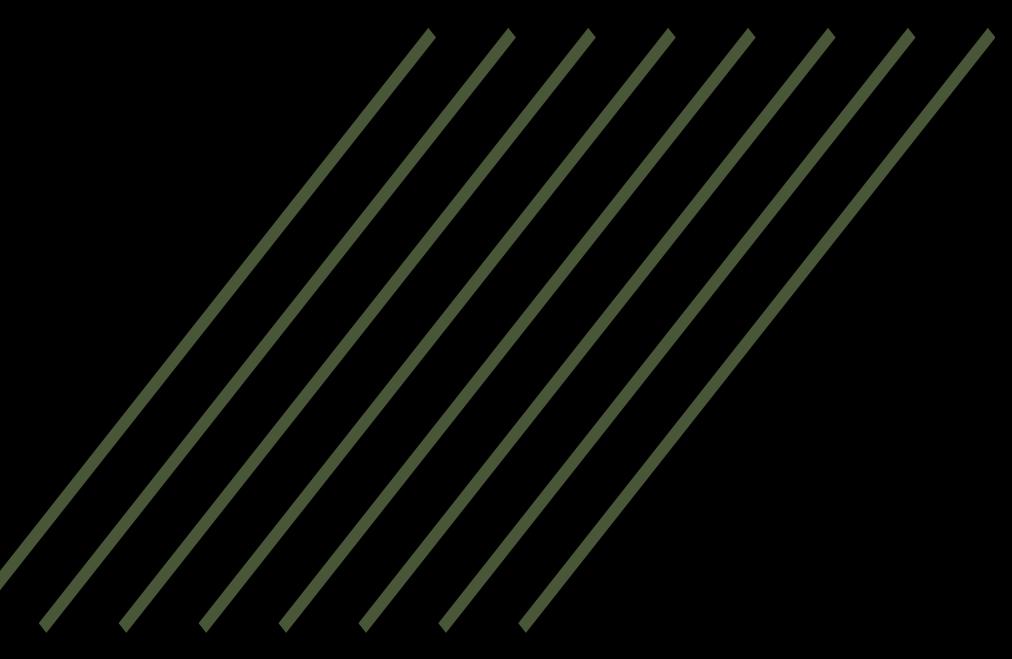


Collapsed



Assembled

SUSTAINABILITY



» Our Core Principles

As people of earth, it's our responsibility to conserve it, and it's our promise to try our best to recycle all materials used for the competition, such as failed plastic prints, cardboard materials, etc.

Our school has a coveted environment club, and sustainability is one of our biggest key principles of our school.

Therefore, we have tied up with them to ensure that the materials used will be recycled in an effective manner.

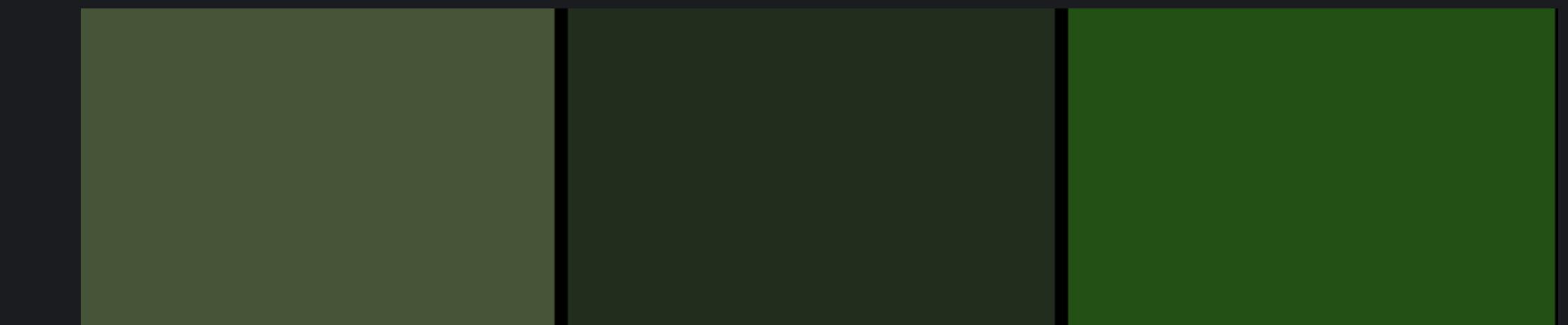


» Economic Sustainability

We tried our best to not buy many parts, rather we reused many electronics parts. Furthermore, we tried to take a step back and think before we bought something, ensuring that it was something useful and meaningful to the project.



» Our Shift To Sustainability



Significance of Green

The verdant hue of our logo is a testament to our unwavering commitment to sustainability. Green, the color of life, renewal, and nature, reflects our dedication to environmental stewardship. It symbolizes our efforts to foster a harmonious balance between human innovation and the natural world.

RESOURCE EFFICIENCY



Our team tried to use the least amount of resources and materials. Rather than going all out with the pit display, we used materials that were widely available with us.

UPCYCLING RESOURCES



Our team upcycled materials, transforming old cardboard into pit display structures. By upcycling resources, we reduce waste and demonstrate innovative ways to support eco-friendly practices.

RECYCLABLE MATERIALS



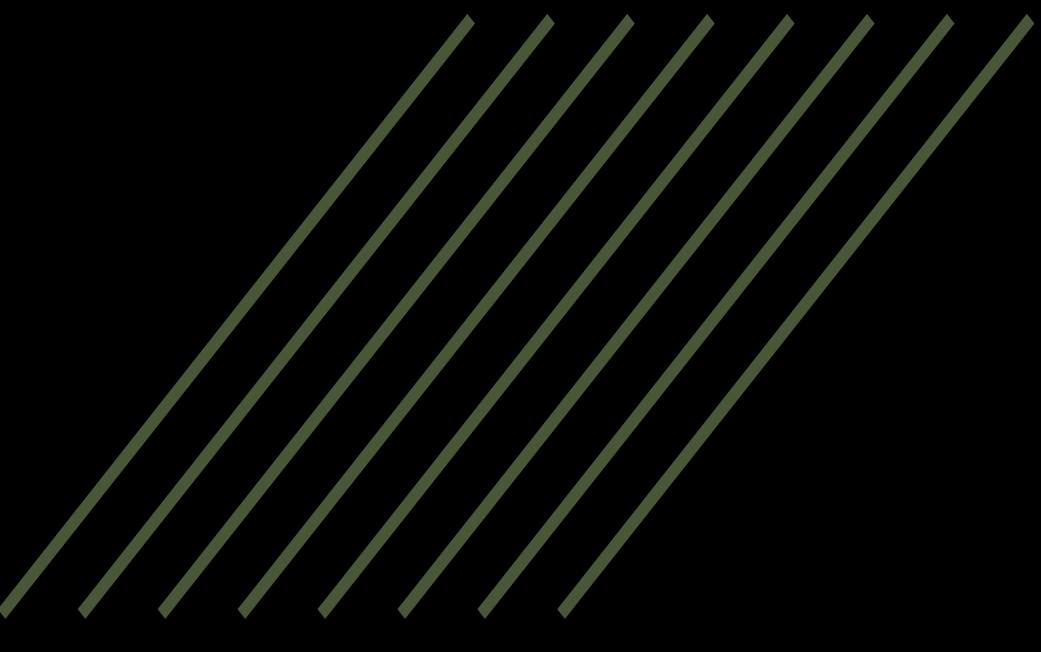
Other than upcycling, we also used materials that are easier to recycle, for instance we used cardboard for many things. Furthermore, we selected 3d printing filaments that are corn based, which is easier to recycle.

» Repairing Our Car

Sustainability also extends to finances, and it was another one of our goals to keep the costs relatively low. For this reason, we decided to repair our broken cars instead of buying new ones, and for this matter YiS had provided us parts from other broken cars. Together we were able to take parts from various cars, and get a final product that was flawless.

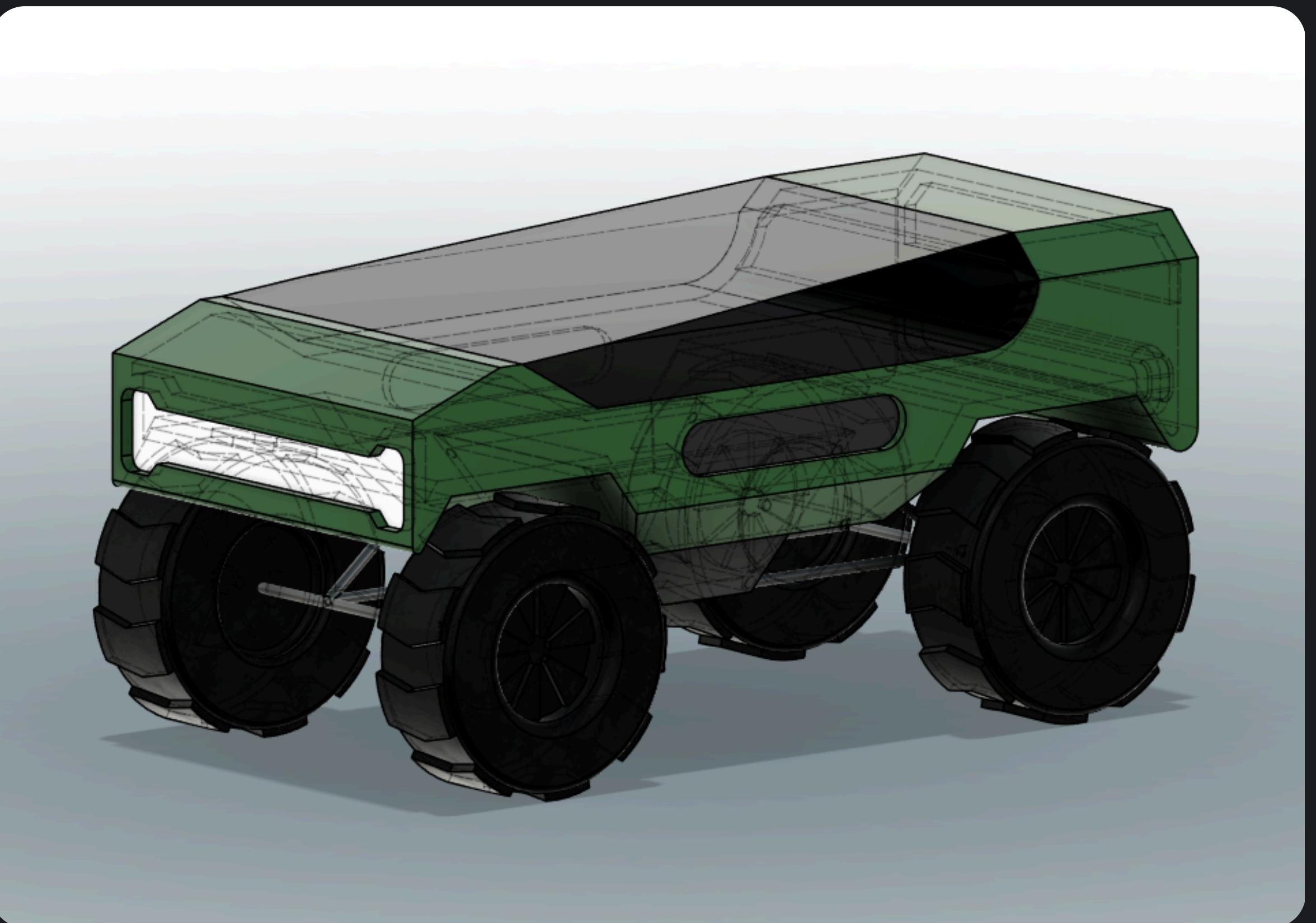


PROJECT MANAGEMENT



» Objectives

Our aim is to engineer the pinnacle of innovation in the realm of 4x4 vehicles, boasting unprecedented features that push the boundaries of conventional design. We aspire to excel in every facet, dedicating relentless effort towards this endeavor. Such ambition is inherent in our identity as Off Centre.



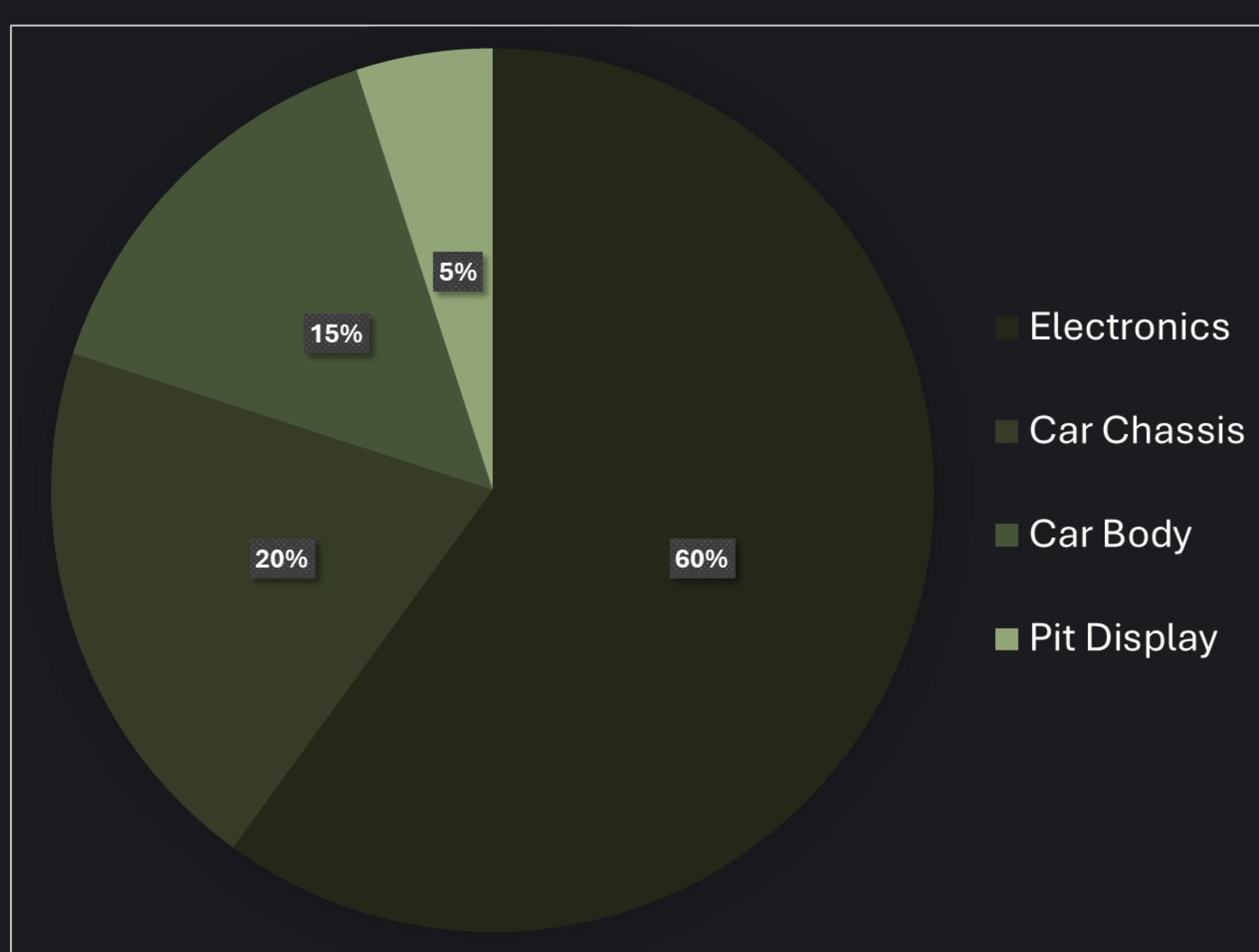
» Project Planning Method



After winning the Innovation Award last year, we wanted to up our game. However, as many upgrades as we wanted to have, it was also important to place fail-safes for them. To introduce new features, we'd have to look at aspects of its feasibility, the budgeting to provide it with, and whether the effort put into it is worth the final product.

» Budgeting

Our priority was given to the electronics on board and the car chassis to ensure the smooth operation of our vehicle. The pit display comes in at the least amount.



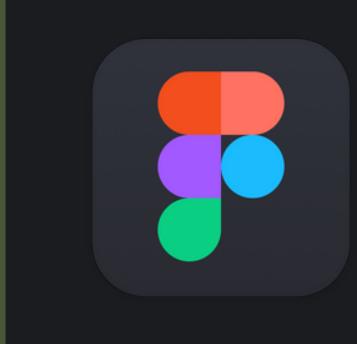
» Tools Used



Miro
Miro is a mind mapping software which allows our team to collaborate on ideas.



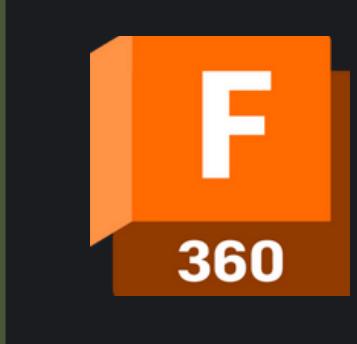
Trello
Trello is an online to do list so that we can keep track of all our pending tasks.



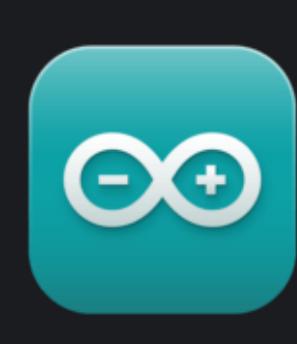
Figma
Figma is a designing software for both documents and for app.



Visual Studio Code
There are many coding software but we chose VS Code for its real time collaborative features.



Autodesk Fusion 360
Fusion 360 is a CAD software which has collaborative features. We use it for its flexible workflow.



Arduino IDE
Arduino is the brains of our car, and for this we used the Arduino IDE which has many libraries.

» Quality Control

At Off Centre, we believe that quality control is of utmost importance when engineering a vehicle. Flawed components or software errors could lead to disastrous consequences. By detecting faults and flaws early on, we ensure that we do not lose our competitive edge out on the track.

Fail Safes

Due to the nature of the competition, it is unavoidable that some parts may fail. Planning in accordance with this we have placed a few fail-safes

Stress Testing

We have stress-tested each crucial aspect of our vehicle ensuring that it can handle the worst of situations.

Usability

We made sure that the applications, and controls are good, by testing it with all our team members, ensuring that it is comfortable.

Repairability

We have made sure that our most vulnerable parts are easy to access in case things were to go wrong.



OFF CENTRE