# Design of a High-Efficiency Vehicle: Converting a Toyota Hilux to Electric Drive for the Dakar Rally 2028

Presented by: Team 1


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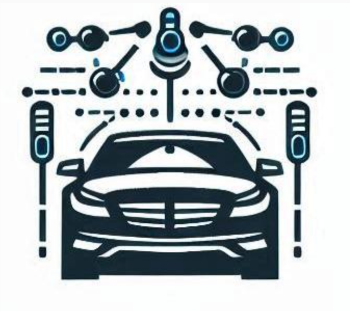
# Global Challenge Context

Design and manufacture of systems for either high speed or high efficiency vehicles

- Structure for manufacturing facility
- Automotive Systems
- Sensors and Control Systems


# Our Solution/Business Case


To compete in the Dakar Rally using a modified Toyota Hilux, powered by Toyota's innovative solid-state battery technology

- Toyota Hilux Conversation
  - Electric drive
  - Twin motor
  - New solid-state battery technology

TOYOTA'S BATTERY TECHNOLOGY ROADMAP

| | TODAY | NEXT-GENERATION | | FURTHER EVOLUTION | | |
|---|---|---|---|---|---|---|
| | 2023 | 2026 | 2026-2027 | 2027-2028 | 2027-2028 | TBD |
| | Battery for bZ4X | Performance | Popularisation | High-Performance | Solid-State 1 | Solid-State 2 |
| | Monopolar | | Bipolar | | N/A | N/A |
| Electrolyte type | Liquid | | | | Solid | |
| Chemistry | Li-Ion | | LiFePO*1 | Li-Ion | | |
| Driving range (WLTP) | 500km | > 800km | > 600km | > 1,000km | > 1,000km | > 1,200km |
| Cost | - | -20% vs bZ4X | -40% vs Bz4x | -10% vs NG performance version | TBD | TBD |
| Fast charge time*2 | ~30 min. | ~20 min. | ~30 min. | ~20 min. | ~10 min. | TBD |

*1 Lithium iron phosphate *2 SoC = 10-80%

NOTE: Established driving range includes aerodynamic and vehicle weight improvements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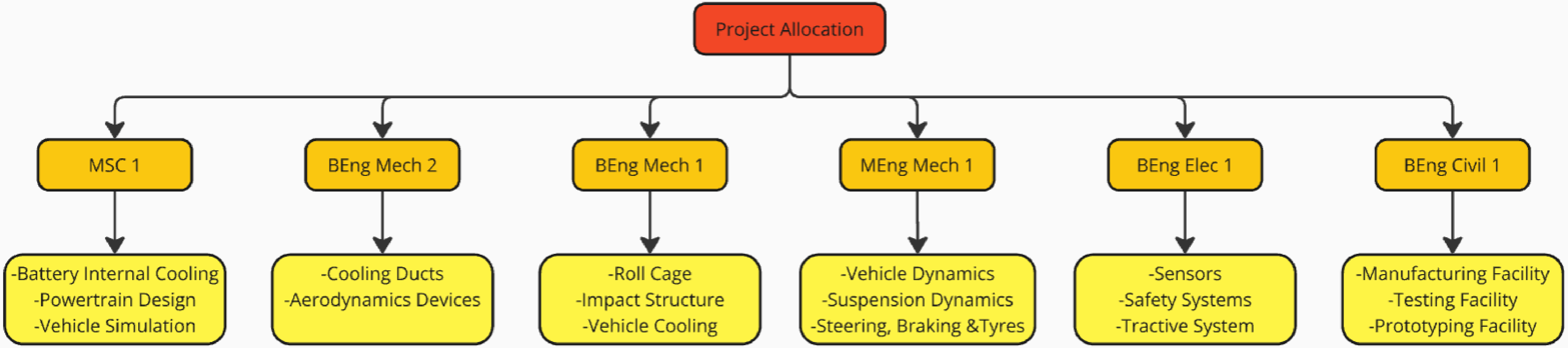
# Group Allocation



# Sustainable Development Goals

Goal 7 - Affordable and Clean Energy

Goal 9 - Industry, Innovation, Infrastructure

Goal 11 - Sustainable cities and communities

Goal 12 - Responsible Consumption and Production

Goal 13 - Climate Action

Goal 15 - Life on Land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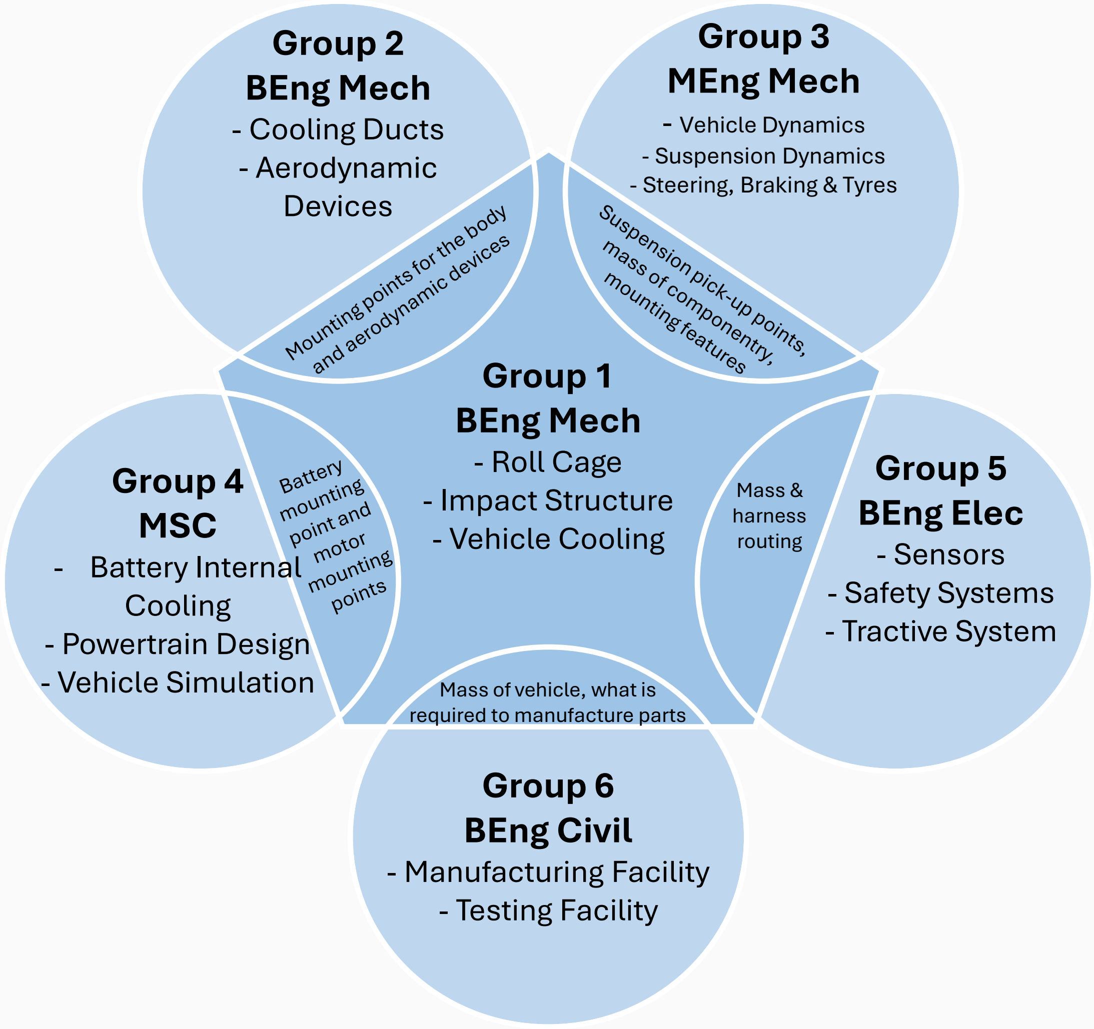
# The Wider Impacts - RISK

- Environmental Impacts – manufacturing and disposing of battery.
- Supply Chain & Material Sourcing – carbon fibre is not very environmentally friendly.
- Safety & Regulations – battery accidents can be more deadly than IC engine accidents.
- Financial/Investment Risks – not enough companies would sponsor or fund the project.

# Team Integration

Methods employed to ensure excellent team integration:

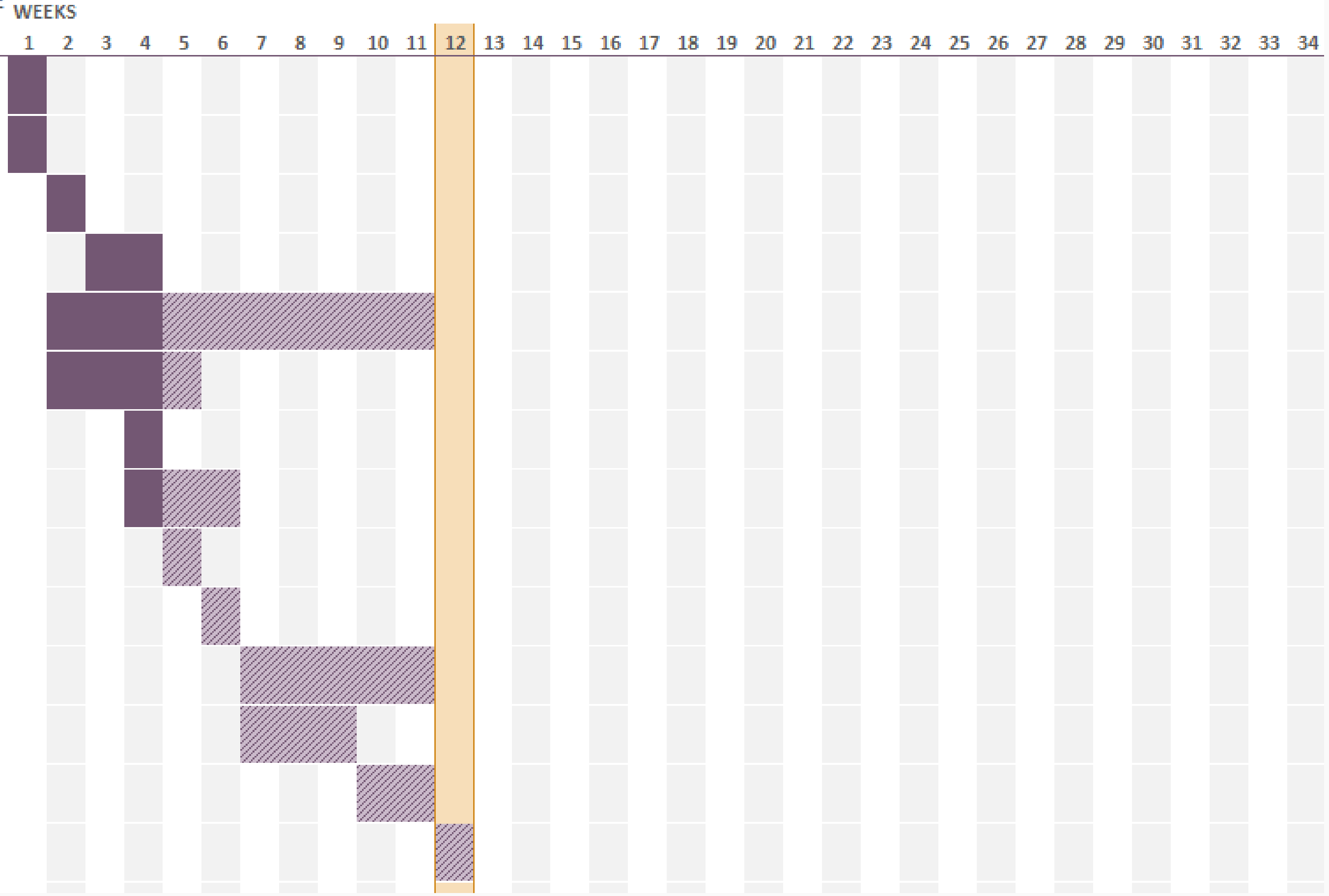
- Regular group leader meetings
- Regular inter-group meetings
- Cloud-based document systems
- Purpose-made integration meetings.
- Integration module as shown in figure X to visualise each team integration.



# Gantt Chart

Project Deadline: 12 | Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Meet Group and Rank Challenges | 1 | 1 | 1 | 1 | 100% |
| Generate Ideas | 1 | 1 | 1 | 1 | 100% |
| Discuss Internal Hurdles | 2 | 1 | 2 | 1 | 100% |
| Produce Group and Team Level SoR | 3 | 2 | 3 | 2 | 100% |
| Consider SDG | 2 | 10 | 2 | 10 | 33% |
| Encorporate Team Integration | 2 | 4 | 2 | 4 | 75% |
| Finalise Concept Design | 4 | 1 | 4 | 1 | 100% |
| Develop Presentation | 4 | 3 | 4 | 3 | 25% |
| Develop Concept Models | 5 | 1 | 5 | 1 | |
| Present Final Idea | 6 | 1 | 6 | 1 | |
| Write Final Report | 7 | 5 | 7 | 5 | |
| Iterate Concept Design Through | 7 | 3 | 7 | 3 | |
| Finalise Design | 10 | 2 | 10 | 2 | |
| Finalise Report and Submit | 12 | 1 | 12 | 1 | |

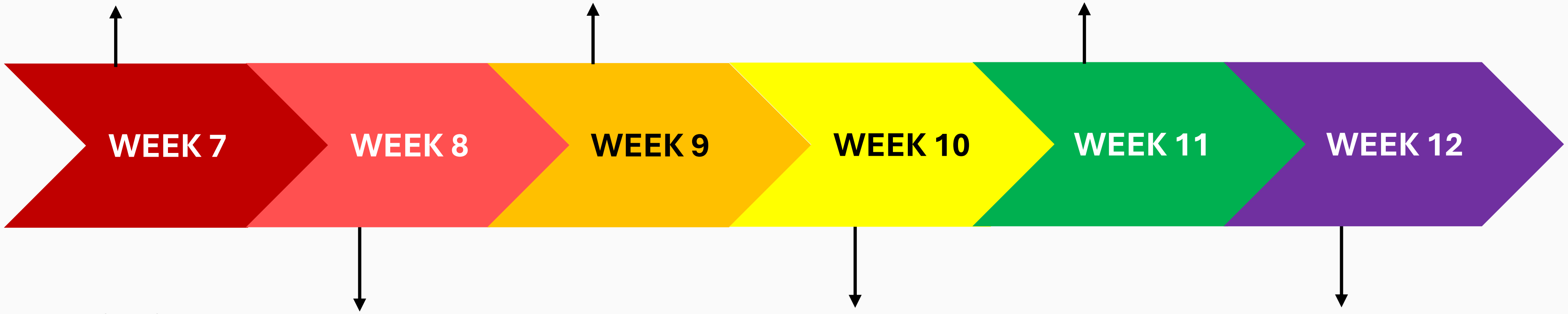


# Future Plans

- Review requirements and specifications
- Research components
- Reflect on presentation

- Start calculations
- Begin final design

- Submit final project report and documentation
- Review project and finalise prototype




- Finalise concepts
- Complete design of each system component
- Begin preparing final report sections and content

- Integrate system designs and review as a group
- Begin to develop prototypes and simulations

- Ready for submission.

# Q&A

# Battery and Powertrain Design

Group- MSc 1

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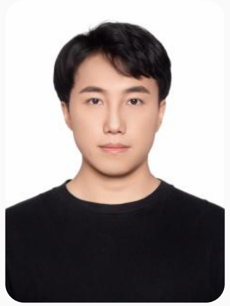
# Introducing the Group

Key:
Group Role-
Belbin Result-

Haokun Wang
Battery Engineer
Coordinator

Shaojie Jia
Powertrain Engineer
Implementor



Yuntao Xu
Battery Engineer
Development

Ao Li
Battery Engineer
Development

Tiannuo Guo
Powertrain Engineer
Researcher

Junzhi Huang
Battery Engineer
Specialist

Mingyang Liu
Battery cooling Engineer
Implementor

Xinyuan Li
Battery Cooling Engineer
Research

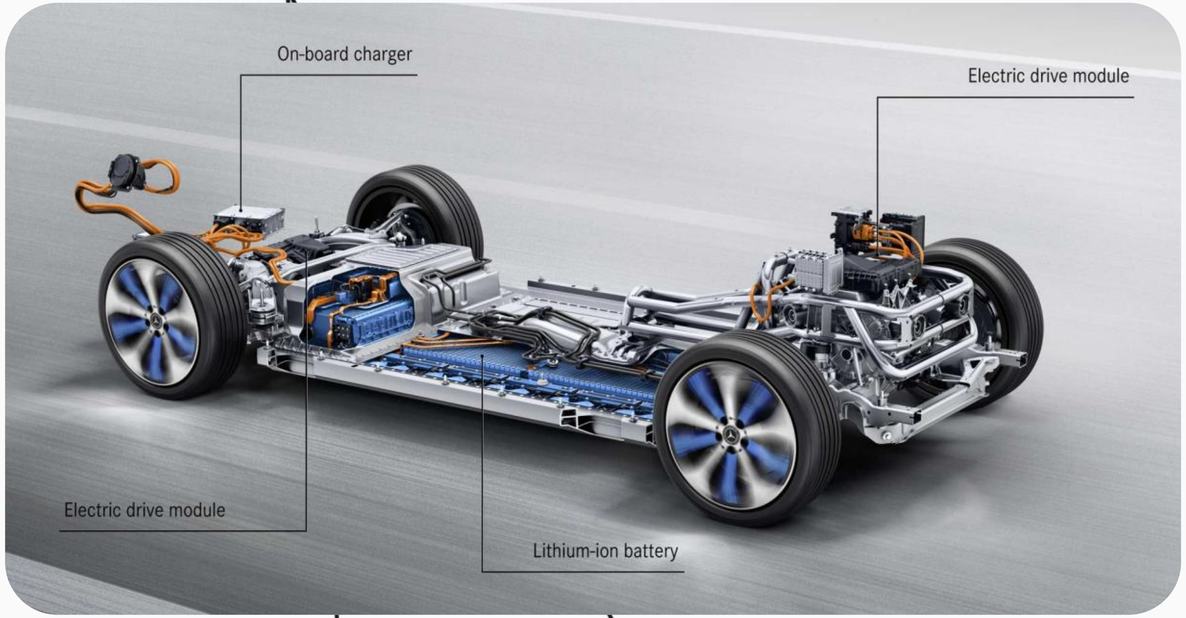
# Group Activities/Goals

**Purpose:**

- Develop a sustainable and durable vehicle.
- Ensure high performance under extreme conditions.
- Achieve a zero-emission target for a cleaner future.

**Aim:**

- Convert the Toyota Hilux into a fully electric vehicle for the Dakar Rally 2028.
- Implement cutting-edge battery and drivetrain technology.
- Promote climate action and innovation in motorsports.



# Team Integration

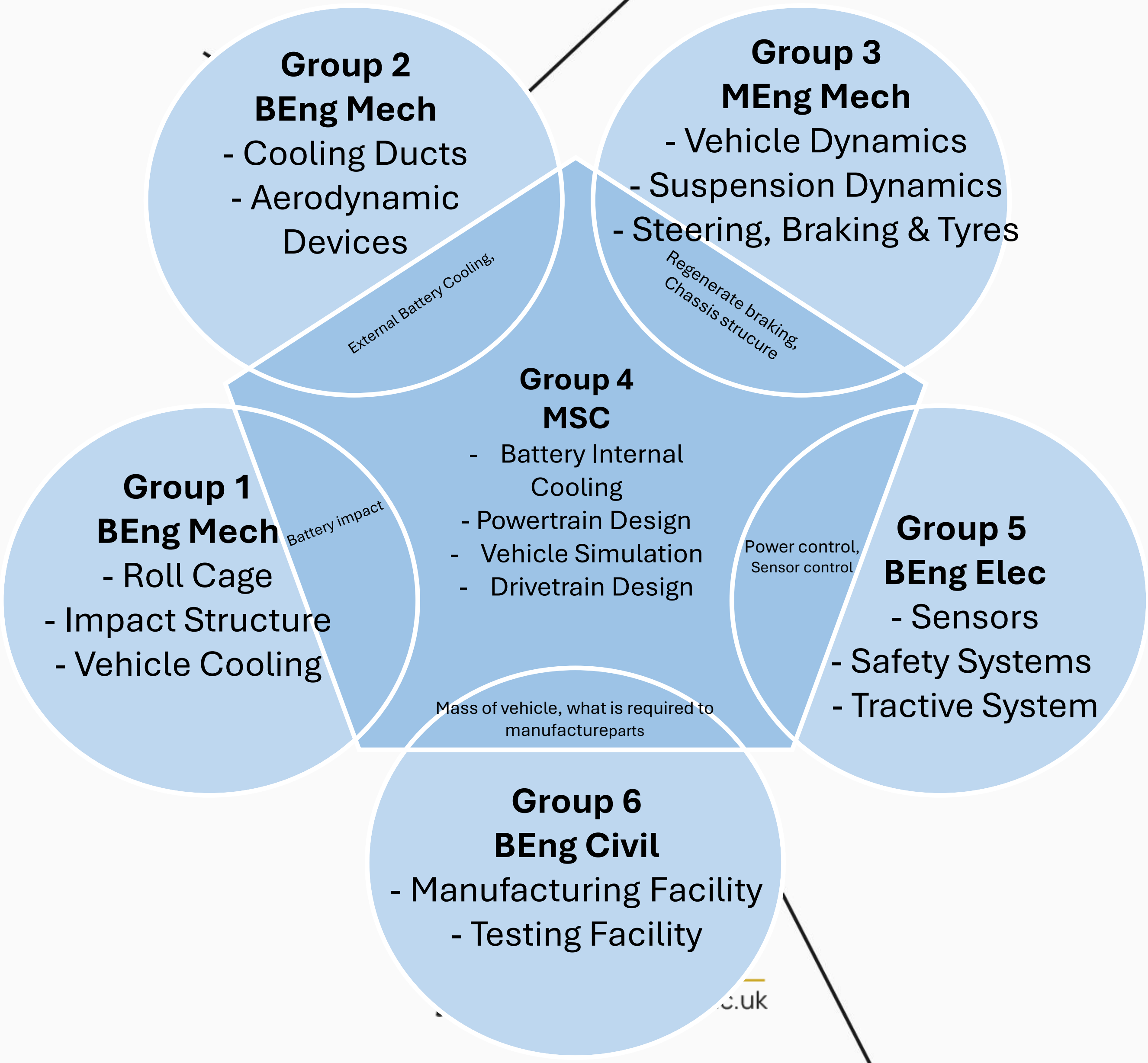
Group 1 – Battery impact

Group 2 – External Battery Cooling

Group 3 – Regenerate braking, Chassis structure

Group 5 – Power control, Sensor control

Group 6 - Manufacture of vehicle, Simulation

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# Motor

Targets Power-Output

- Max.Power-298 kW.
- Max.Torque-500Nm.
- Top Speed-204km/h.

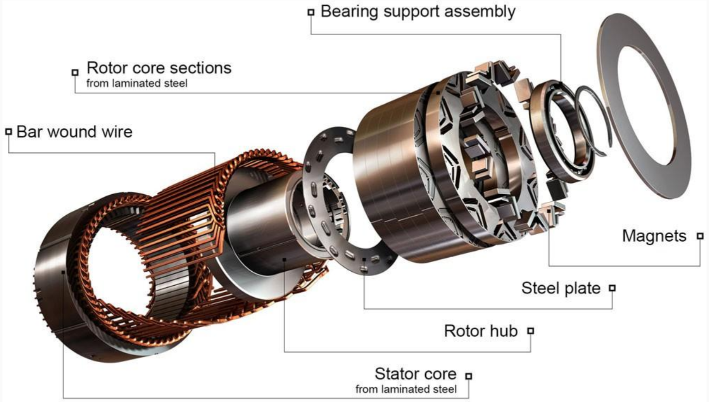
Motor Selection

- AC Permanent Magnet Synchronous Motor (PMSM)(Sankhwar, 2024).
- 400KW+ of peak power and 600Nm of peak torque which provide an excellent power and torque performance (YASA P400R; Cascadia Motion iM 225; Tesla Model S Plaid rear motor).
- Better balance of efficiency combining with dual motor layout.

**TOYOTA GAZOO RACING**

| | | | |
|---|---|---|---|
| **Mark** | TOYOTA | **Weight** | 2000 kg |
| **Model** | HILUX IMT EVO | **Performance tuner** | Toyota Gazoo Racing |
| **Engine** | twin-turbo V6 engine of 3.5 litres | **Assistance** | Toyota Gazoo Racing |
| **Power** | 298 kW of power and appro | **Class** | T1+: Prototype Cross-Country Cars 4x4 |

Power and drive system from the reference vehicle (Dakar.com, 2025).




An layout of the AC PMSM (Lee, Shin and Bak, 2018).

# Drive System & Transmission

All Wheel Drive (AWD) System

- Dual motor layout with computer-controlled torque vectoring.
- Enhance traction force for loosen surface.
- Better energy regenerated efficiency.
- Improves vehicle controllability (Mosin et al., 2023).

Multi-Speed Gearbox (Lacock, du Plessis and Booysen, 2023)

- Provides different torque across speeds.
- Optimize the power output for different terrians.
- More adaptable in long distance and mixed terrian rallys(Lacock, du Plessis and Booysen, 2023).

| Feature | AWD | RWD | FWD |
|---|---|---|---|
| **Traction** | Excellent | Weak on loosen surface | Poor off-road performance |
| **Handling** | Precise steering | Oversteer | Understeer |
| **Terrain adaptability** | All surfaces | Weak on deep sand | Weak on hills,mud,and sand |
| **Braking efficiency** | On all wheels | Limited regeneration | Front wheel only |

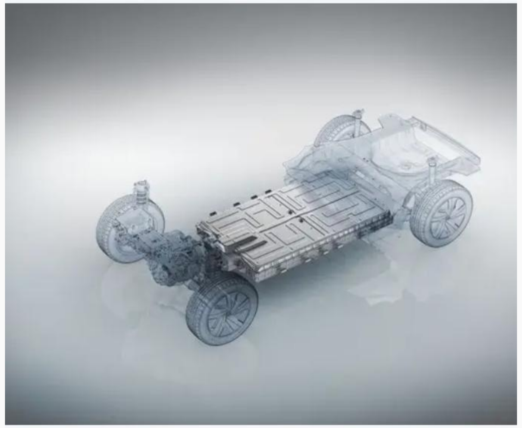
Table 1. Performance of different drive systems.

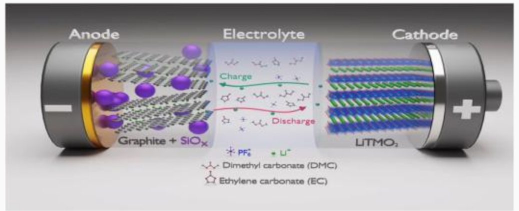
# Battery

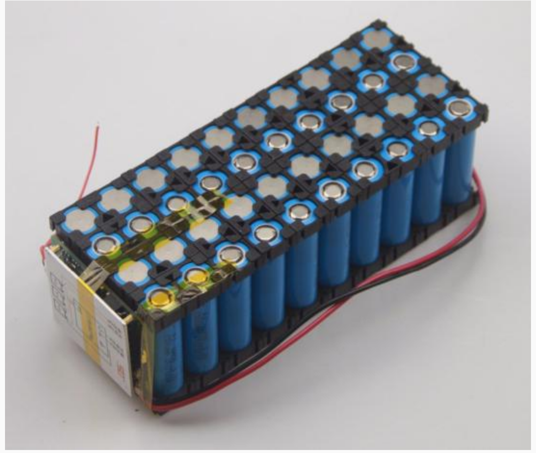
- High Voltage Battery Type: Lithium Iron Phosphate

- Parameters: High theoretical capacity
  Excellent chemical stability
  Superior thermal stability
  Long cycle life

- Requirement:  Single length: 200-900km
- Maximum battery range : 1000 km on a single charge.





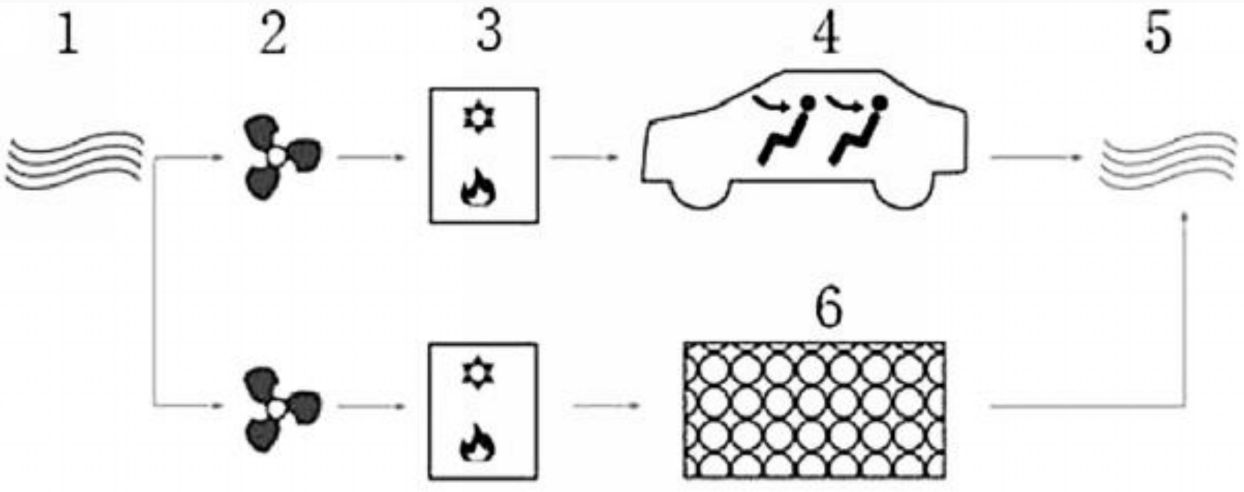
Low Voltage Battery

- Used for Emergency situation
- Emergency calls and GPS
- Data analysis
- Record driving data

# Battery cooling system

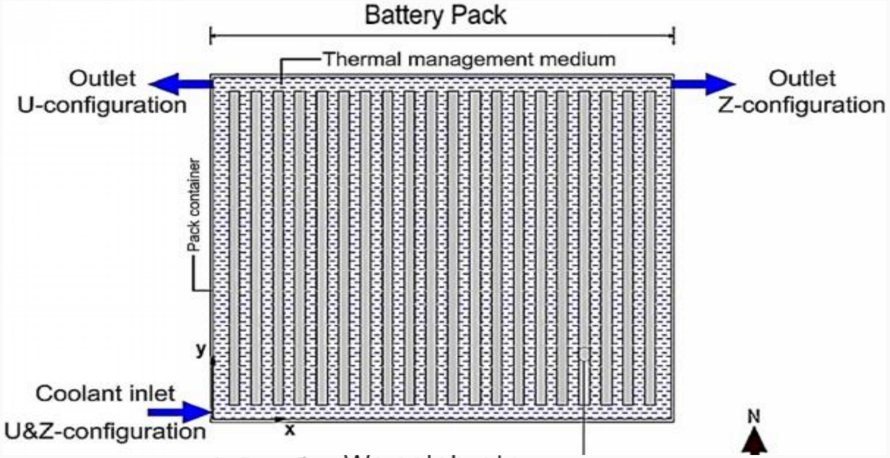
**Air-cooling systems（BTMS）**

- Simple in design, light in weight, low in cost and easy to maintain.
- The low heat capacity of air limits its application under high-speed and high-temperature conditions. It is difficult to achieve uniform air distribution.




**Direct liquid cooled（silicon oil）**

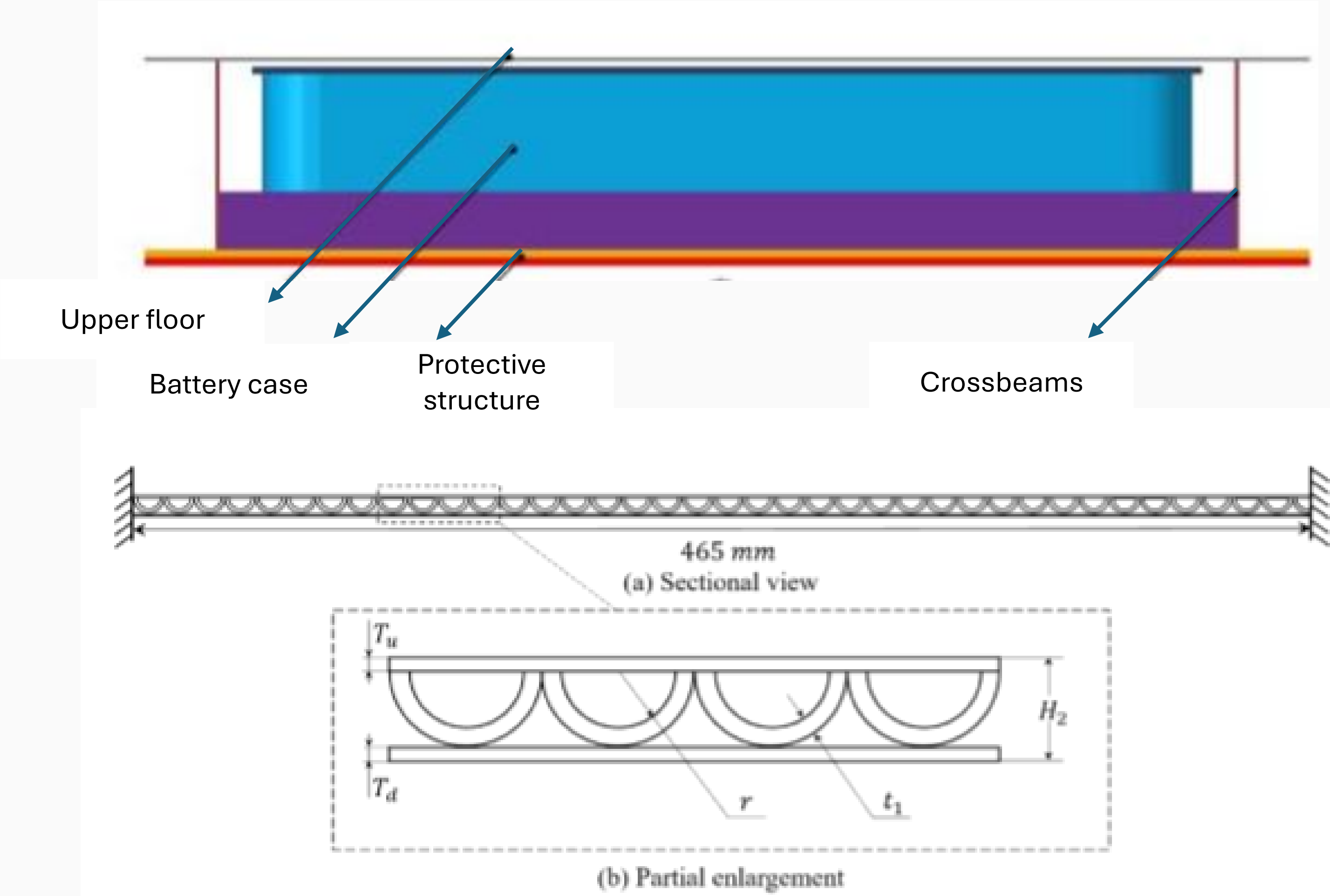
- The heat dissipation efficiency is higher and the heat dissipation performance is better. The structure is more compact.
- There is a risk of leakage and the cooling system is relatively heavy.



# Battery Protection

**Strategy:**
Arched Sandwich Structure + Aluminum

- Lowest deformation
- Highest energy absorption
- Reinforced hexagonal honeycomb sandwich structure
- Recommended material: **7075-T6 aluminum** (high strength & energy absorption capability)



# Battery Swapping Stop

**Type (Ahmad, F. 2020)** :

1.Sideways swapping: vans (most convenient).

2.Rear swapping: battery is placed from backwards (large boot space).

3.**Bottom swapping:** Battery is placed at the bottom of the vehicle.

4.Top swapping: Electric buses.

**Realize the functional sequence (Adegbohun, F. 2019):**

Vehicle positioning, Vehicle lifting (air jacks), Battery removal, replacement and installation (datum pins and nut runners), Vehicle lowering. (About 3-5 minutes)

**Future:**

1. Specific Model Design (Size, Material, et al.)
2. Disassemble and installed method.
3. Lifting and lowering vehicle method.

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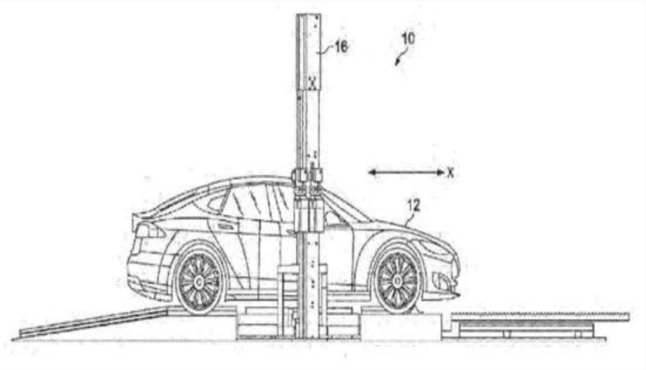

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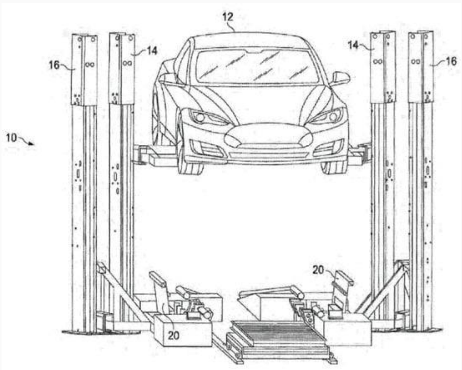

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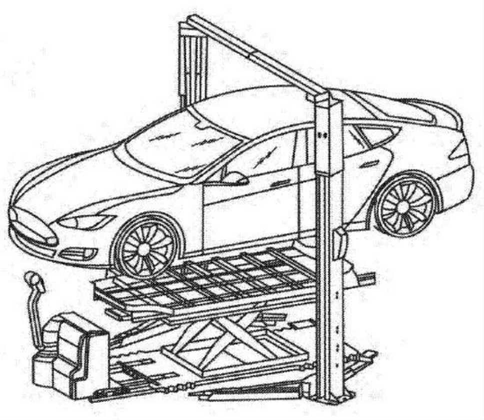

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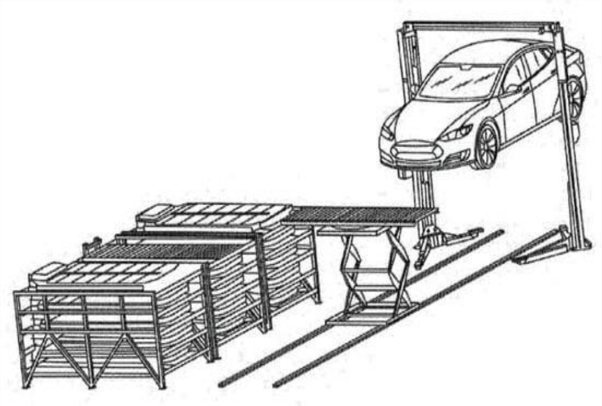


(d)

Battery Swapping Principle

# Sustainability

**Zero Emission**

Electric Vehicles (EV) : Reduce CO2 emissions with clean energy.

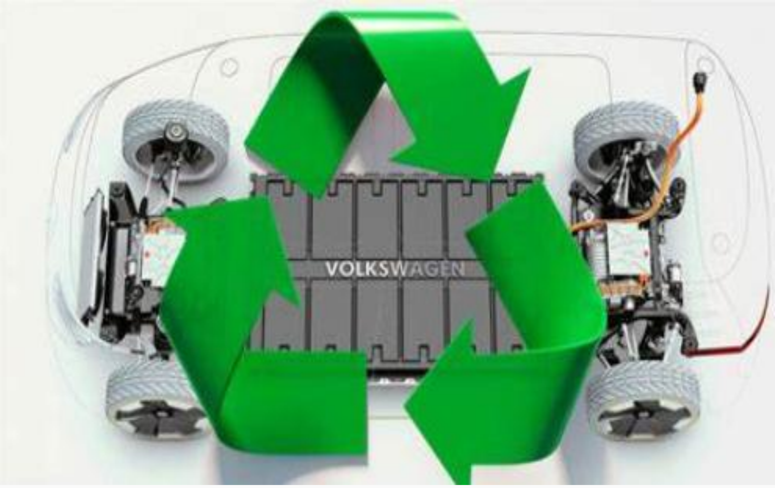
Renewable Energy Charging: Solar and wind-powered charging stations.

Lightweight Materials: Advanced composites reduce energy consumption.

**Recyclable**

Sustainable Materials: Use of recyclable aluminum, carbon fiber composites.

Modular Design: Easy disassembly for parts reuse and upgrades.




**Reusable**

Battery Recycling: Repurpose used EV batteries for energy storage.

3D Printing & Remanufacturing: Utilize recycled materials for component production.

Regenerated Tires: Use of sustainable rubber for longer-lasting tires.

# SWOT Analysis

SWOT

## Strengths

- High Speeds
- Zero Emissions
- Advanced Battery Technology
- Light Weight Design

## Weaknesses

- Battery range limitations
- Complex Supply Chain logistics
- Niche Client Base, could limit Revenue
- Can be Difficult to ensure compliance with all relevant regulations

## Opportunities

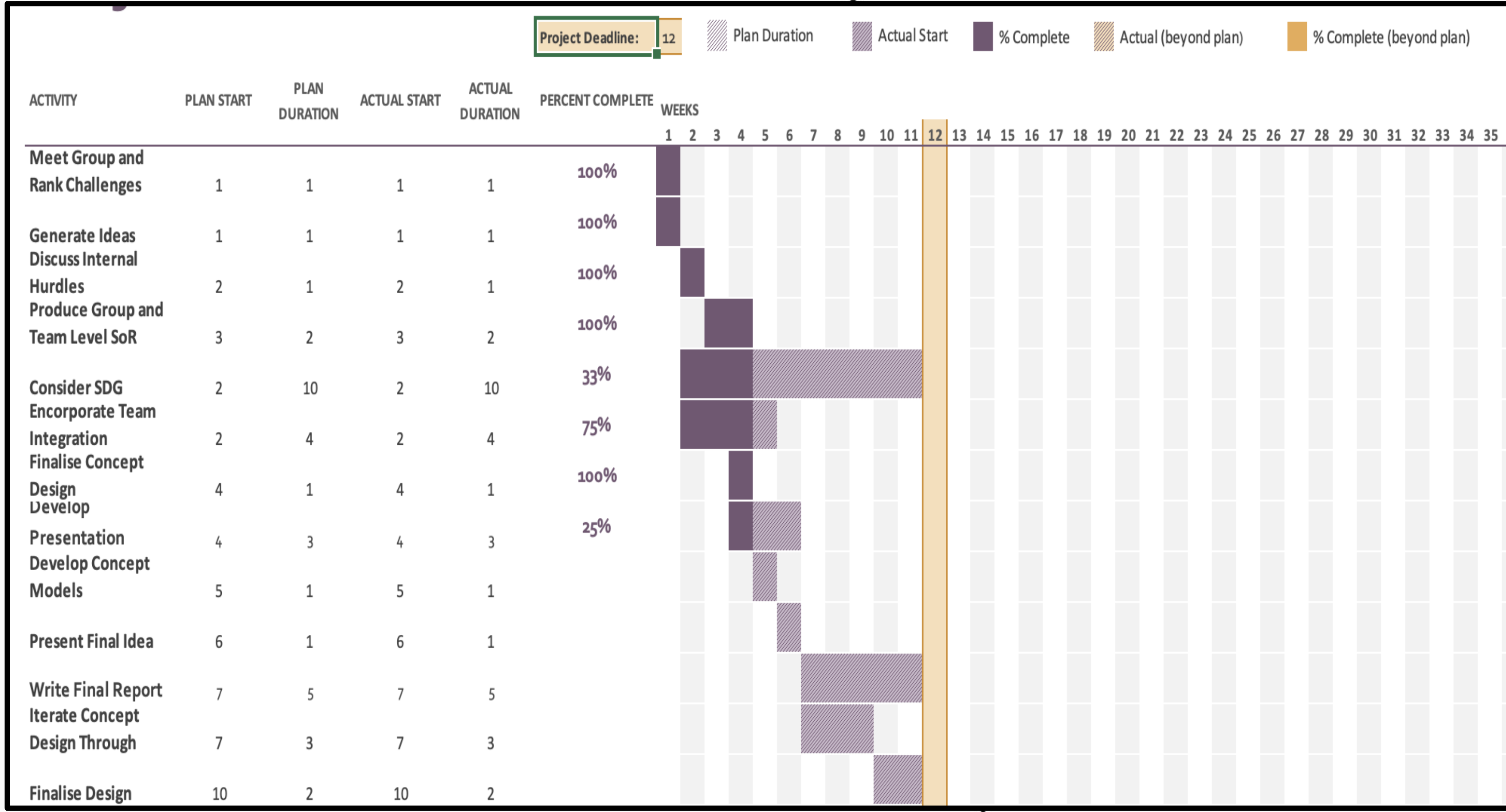
- Increase global interest in motorsports
- Develop Cutting edge technologies
- Opportunities for EV development in Off-road motorsports
- Diversification into other industries such as military, possible government grants

## Threats

- Supply Chain Disruptions
- Economic Uncertainties with Fluctuation within the UK
- Regular change within Emissions regulation which may limit cliental
- Heavy reliance on a few major clients

# Future Plan

- CAD Modelling
- Battery and Motor Calculation
- CFD for Battery Cooling
- FEA of Battery Protection
- IPG Carmaker Simulation

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| Develop Concept Models | 5 | 1 | 5 | 1 | |
| Present Final Idea | 6 | 1 | 6 | 1 | |
| Write Final Report | 7 | 5 | 7 | 5 | |
| Iterate Concept Design Through | 7 | 3 | 7 | 3 | |
| Finalise Design | 10 | 2 | 10 | 2 | |

# References


- Ahmad, F., Saad Alam, M., Saad Alsaidan, I. and Shariff, S.M., 2020. Battery swapping station for electric vehicles: opportunities and challenges. IET Smart Grid, 3(3), pp.280-286.)
- Adegbohun, F., Von Jouanne, A. and Lee, K.Y., 2019. Autonomous battery swapping system and methodologies of electric vehicles. Energies, 12(4), p.667.
- Lacock, S., du Plessis, A.A. and Booysen, M.J. (2023). Electric Vehicle Drivetrain Efficiency and the Multi-Speed Transmission Question. *World Electric Vehicle Journal*, [online] 14(12), p.342.
- Mosin, M., Popov, N., Anibroev, V., Vilberger, M. and Domakhin, E. (2023). Engine power distribution system for four-wheel drive autonomous electric vehicle. *Energy Reports*, [online] 9, pp.115–122.
- Sankhwar, P. (2024). Application of Permanent Magnet Synchronous Motor for Electric Vehicle. *Indian Journal of Design Engineering*, 4(2), pp.1–6.
- Dakar.com. (2025). *Profile of HENK LATEGAN - TOYOTA GAZOO RACING - Dakar*. [online] Available at: https://www.dakar.com/en/competitor/211 [Accessed 20 Feb. 2025].
- Thakur, A.K., Prabakaran, R., Elkadeem, M.R., Sharshir, S.W., Arıcı, M., Wang, C., Zhao, W., Hwang, J.-Y. and Saidur, R. (2020c). A state of art review and future viewpoint on advance cooling techniques for Lithium–ion battery system of electric vehicles. Journal of Energy Storage, [online] 32, p.101771. doi:https://doi.org/10.1016/j.est.2020.101771.

# Q&A

# Roll Cage, Impact Structure and Cooling System Design

Group- BEng Mechanical 1

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# Introducing Group 1

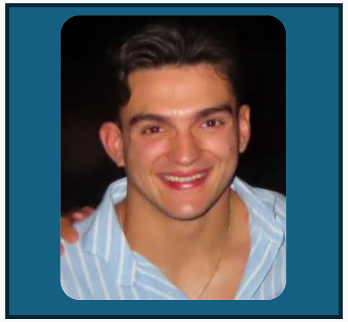
Key:
Name-
Group Role-
Belbin Result-

Edward Crossley
Group Leader
Coordinator

Luis Sobrino
Roll Cage Lead
Resource Investigator

Dhaivat Kothary
Roll Cage Engineer
Team Player

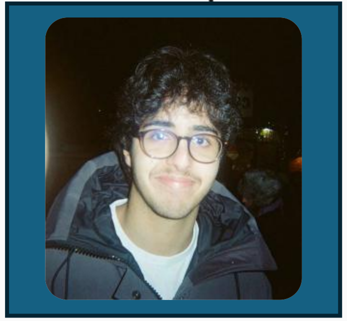
Fynn Jones
Impact Structure Lead
Resource Investigator



Carlos Romero
Impact Structure Engineer
Implementor

Gabriel Brown
Impact Structure Engineer
Specialist

Hadi Lee
Cooling Lead
Implementor



Sadik Berk Syin
Cooling Engineer
Specialist

# Group Activities/Goals

Group tasks:

- Roll Cage Design
  - To comply with all technical regulations.
  - To be able to withstand impact loads.
  - To be below 200 kg.
- Impact Structure Design
  - To comply with all technical regulations.
  - To protect the battery and underside of the vehicle.
  - To be below 80 kg.
- Cooling System Design
  - To comply with all technical regulations.
  - Keep powertrain components at an optimum temperature.
  - To be below 20 kg.

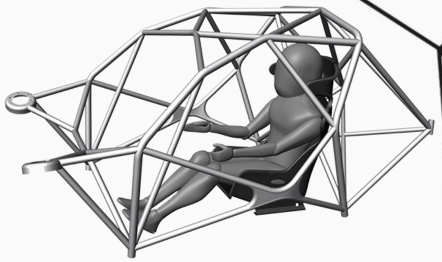
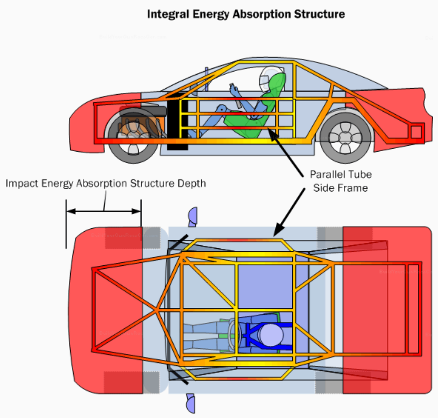


Image courtesy of: https://www.metrosteel.com.au/ten-top-tips-to-building-the-perfect-roll-cage/

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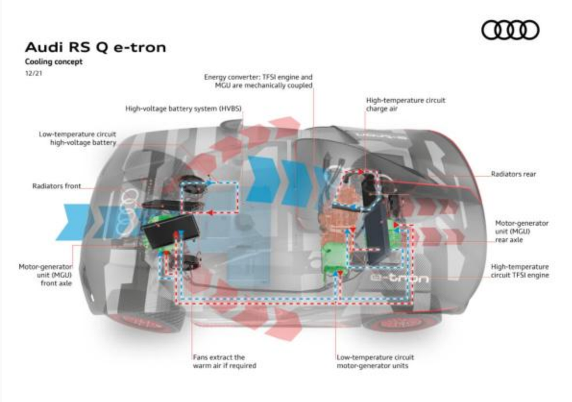


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# SWOT Analysis

## Strengths
- Strong focus on rigidity and strength.
- Easily integrates with other groups.
- It is a good platform to begin with to build structures from.
- Use of advanced simulation tools for analysis through finite element analysis.

## Weaknesses
- Battery range limitations
- Complex Supply Chain logistics
- Niche Client Base, could limit Revenue
- Can be Difficult to  ensure compliance with all relevant regulations

SWOT

## Opportunities
- Increase global interest in motorsports
- Develop Cutting edge technologies
- Opportunities for EV development in Off-road motorsports
- Diversification into other industries such as military, possible government grants

## Threats
- Supply Chain Disruptions
- Economic Uncertainties with Fluctuation within the UK
- Regular change within Emissions regulation which may limit cliental
- Heavy reliance on a few major clients

# SWOT Analysis

| | The Good | The not-so-good |
|---|---|---|
| What we've got | Strong focus on rigidity and safety.<br>Easily integrates with other groups.<br>It is a good platform to begin with to build structures from<br>Use of advanced simulation tools for analysis through finite element analysis. | Limited real-world testing opportunities.<br>Must be rules complaint.<br>Will added mass.<br>Hard to understand cooling loads and weather conditions. |
| What's out there | Adoption of innovative materials.<br>Use of 3D printing technology.<br>Data for material properties.<br>Standard design procedures. | Without physical testing hard to understand exactly how components will react under load.<br>It is hard to simulate different methods of joining. |

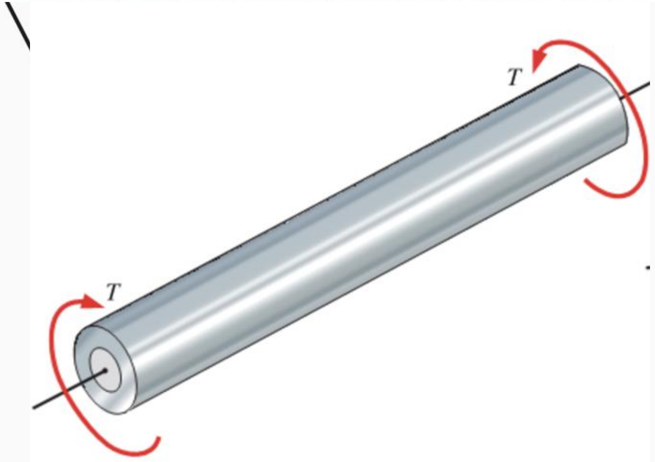
# Material Selection and Tubing

- Following FIA regulations

- **Chosen Material --> AISI/SAE 4130**
  - High Specific Strength (91.25 kN.m/kg)
  - Superior Fracture Toughness (140 MPa.m^0.5)
  - Good weldability, strong joints for tubing

- Roll Cage and Crash Structure Tubing
  - Follows FIA regulations
  - 30 mm outside diameter, 3 mm thickness
  - Torsional stiffness $\frac{E}{2(1+v)} * \frac{\pi}{32} * (OD^4 - ID^4)$

  = 3611.5 Nm/rad per unit length



# Roll Cage Concept Designs

**1.Structural Integrity**

→ Safety drivers

- Reinforced main bar sections

**2. Optimize weight distribution**

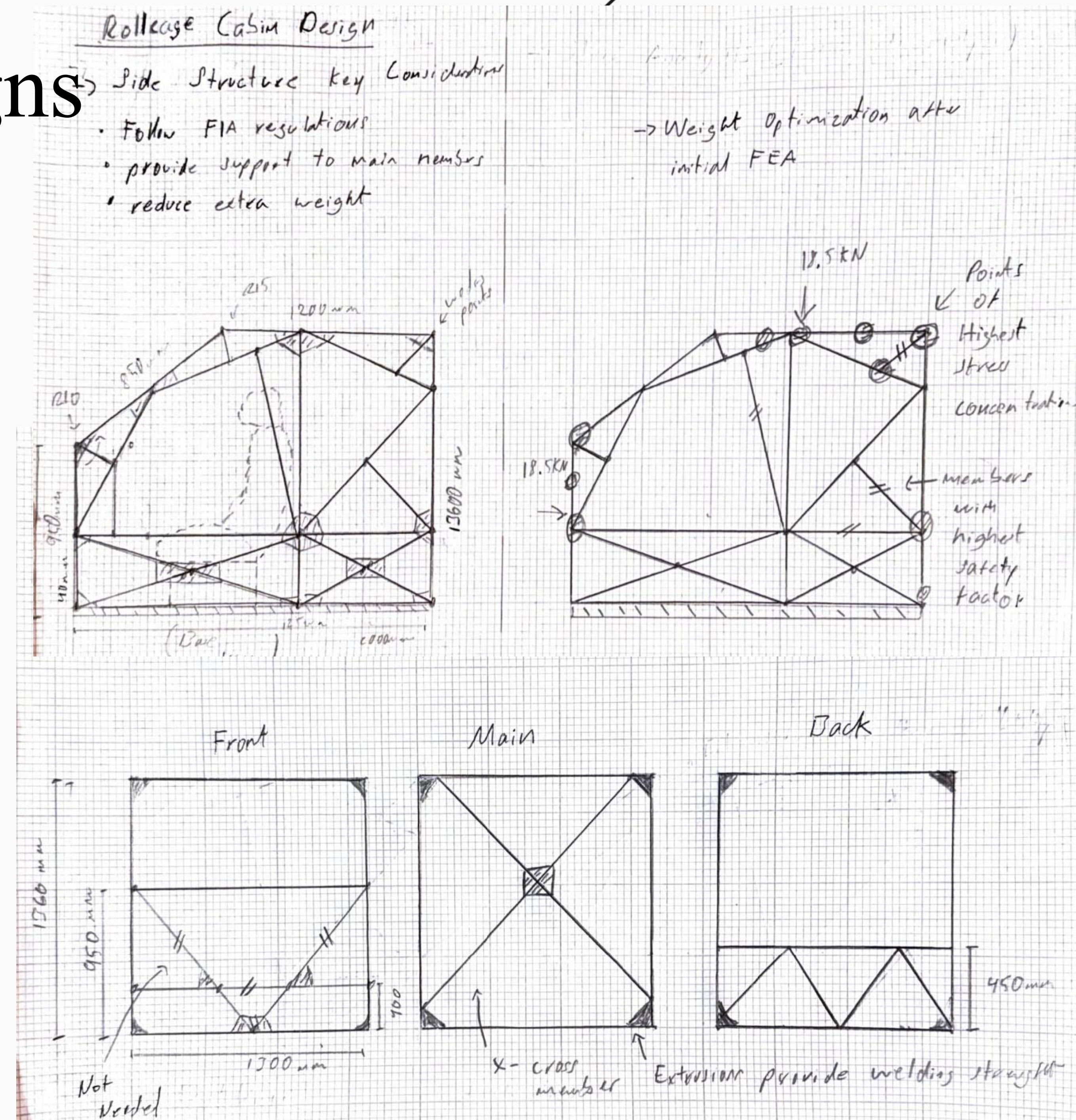
→ Enhance Performance

- Low centre of mass, improved stability

**3. Crash and Impact Absorption**

→ Ensures durability

- Driver and systems safe in multi-directional crashes

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# Design Iterations

- Initial side structure went through multiple design iterations after performing FEA on a point load of 70.5 kN on the top member.
- Final design redistributes loads uniformly along the main and auxiliary members.
- Final design features significant less strain in main bar sections.

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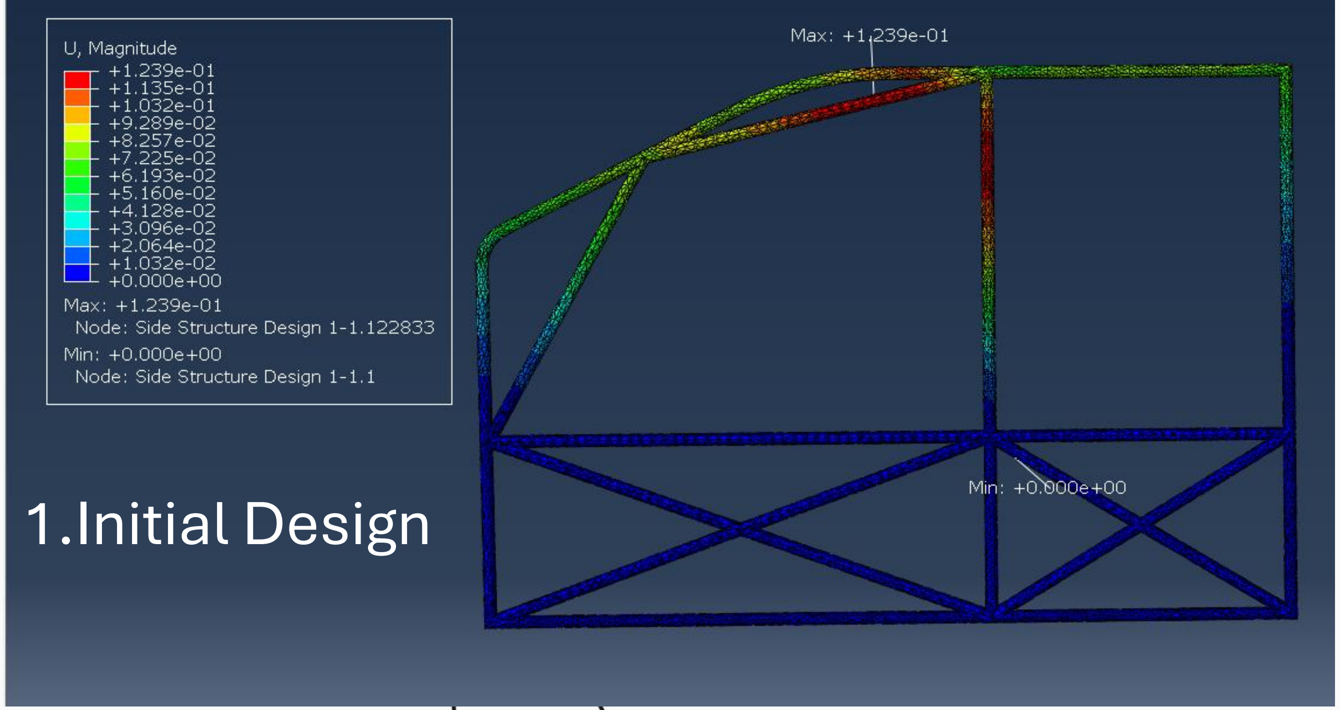
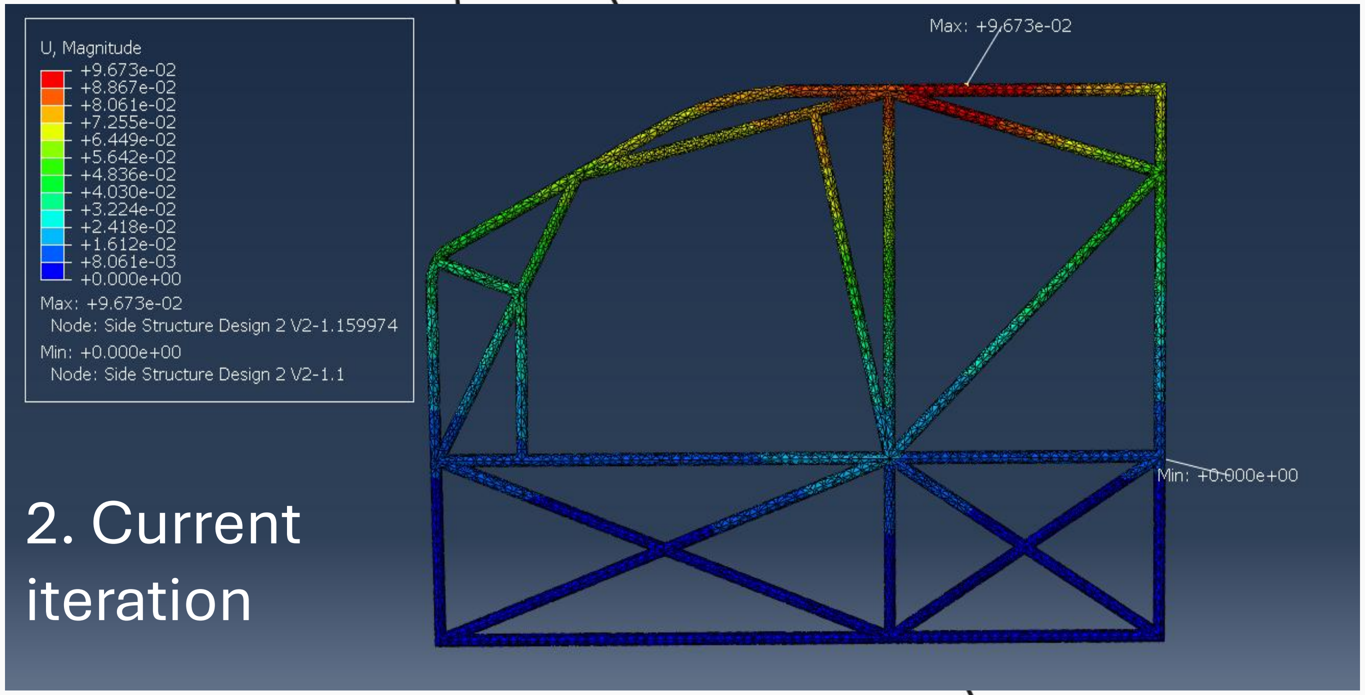


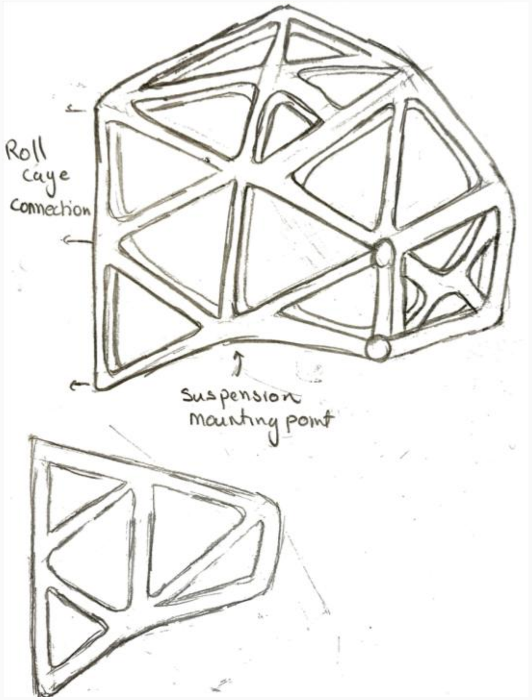
1.Initial Design

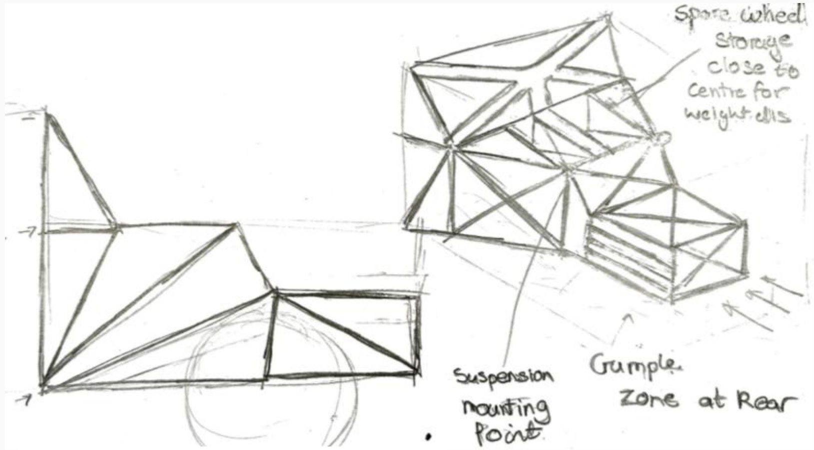


2. Current iteration

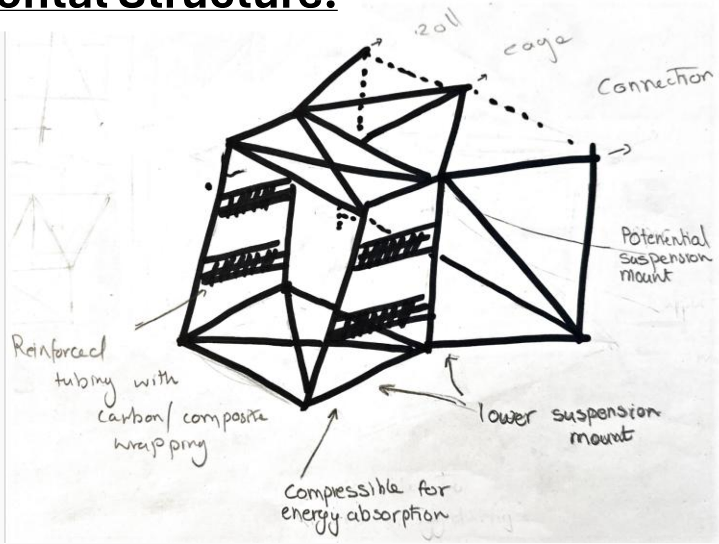
# Concept Sketches For Crash Structure

## Rear Structure:

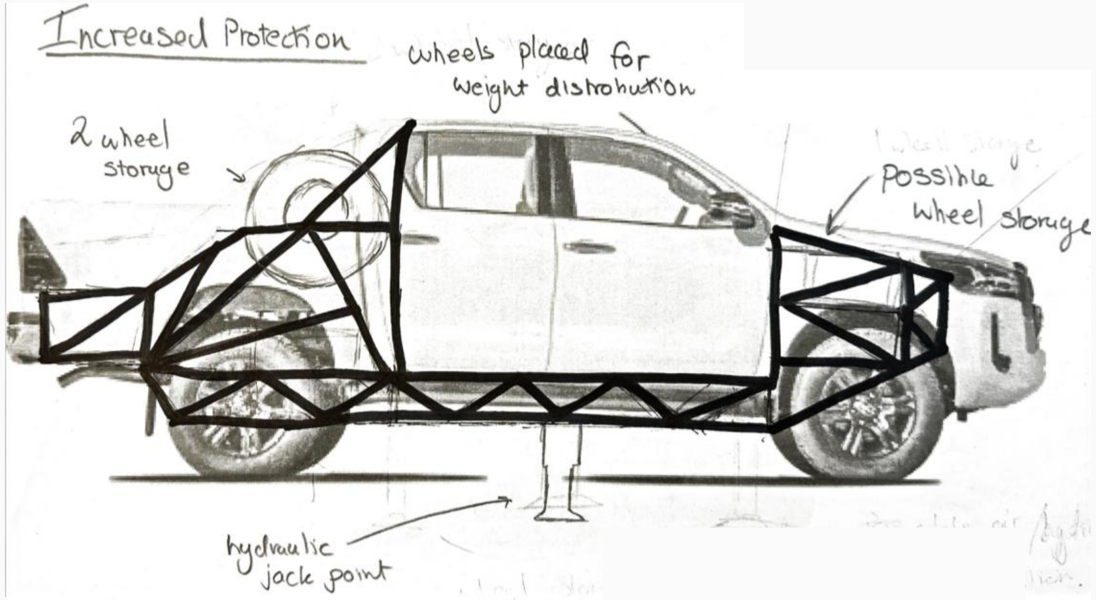


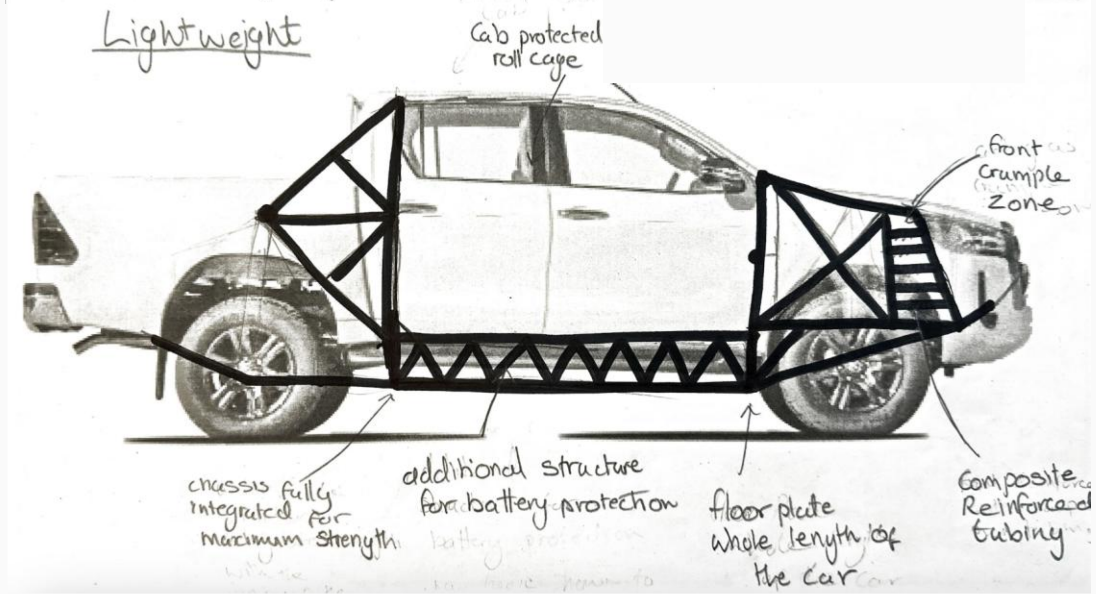




## Frontal Structure:




## Whole Vehicle Concept:

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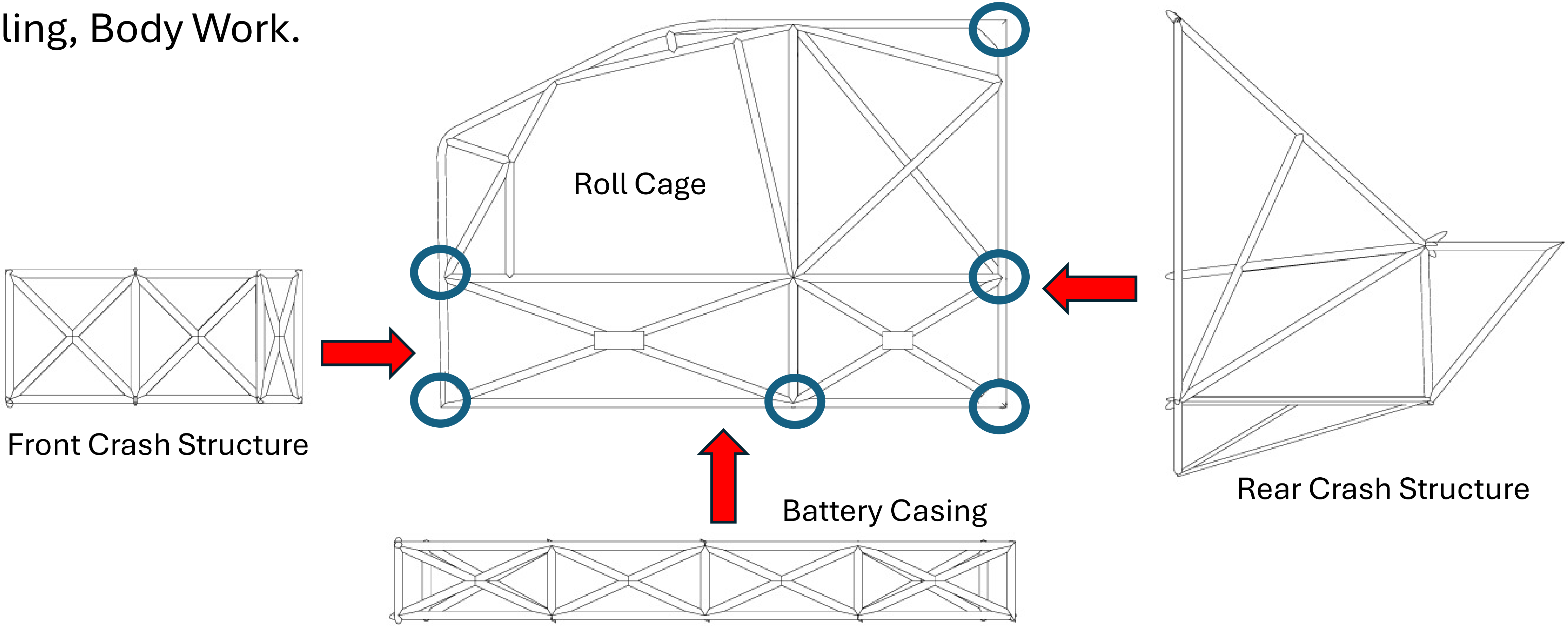
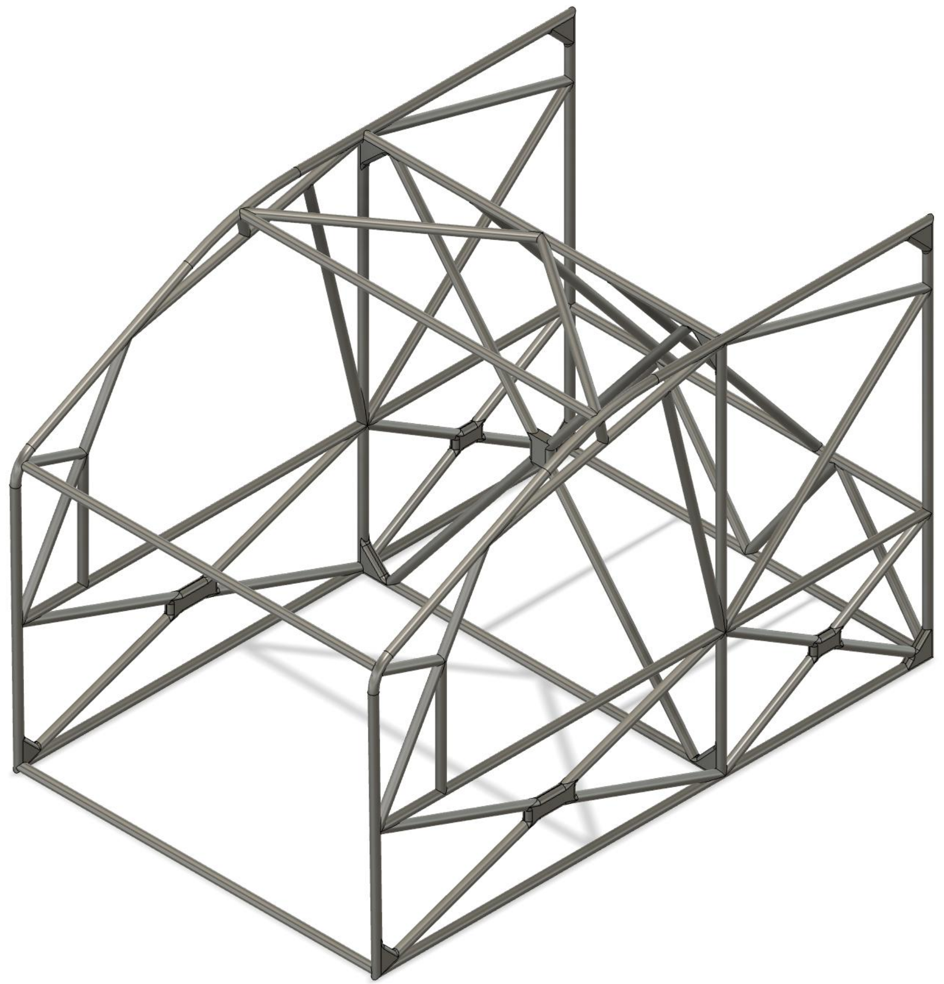
# Roll Cage and Crash Structure Integration

- Welding points established between Crash Structure and Roll Cage.
- Mounting points for Suspension, Cooling, Body Work.

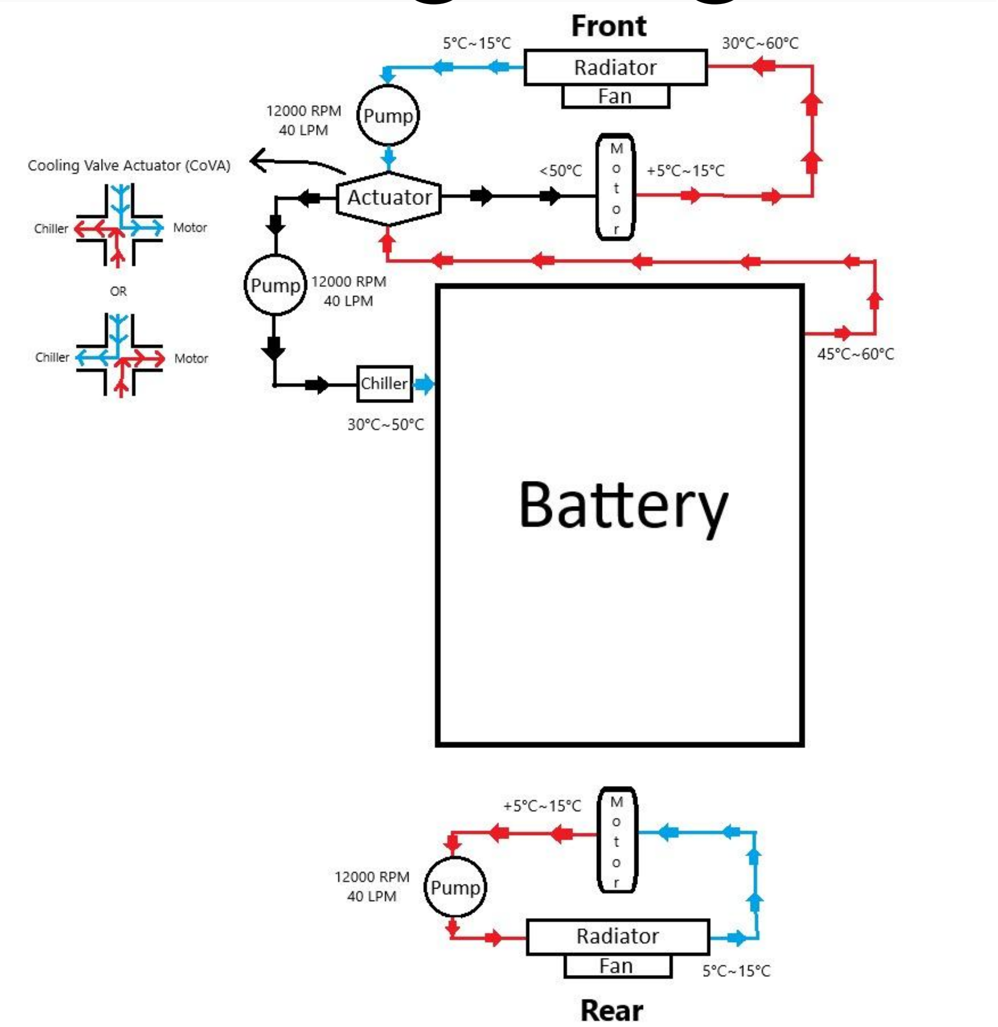


# Future Plans Crash Structure and Roll Cage

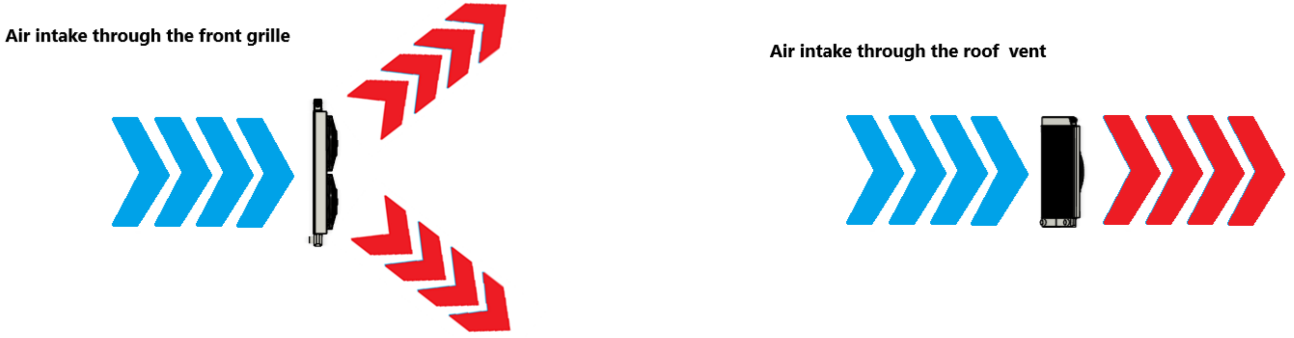
- Further FEA simulations to validate design safety compliance.
- Integrate accumulator and drivetrain into structure.
- Further enhance performance by weight reduction and structure optimisation.
- Establish mounting points for suspension, cooling systems, fire extinguisher mounting and other auxiliary systems.
- Utilization of generative design in key aspects of crash structure.



# Cooling Diagram




## Top View




## Side View

| Component | Ideal Operating Temperature | Allowable Temperature Range | Coolant Inlet Temperature |
|---|---|---|---|
| EMRAX 348 Motor | Below **120°C** (internal components) | **-40°C to +60°C** (ambient) | **≤ 50°C** (recommended) |
| Toyota Solid-State Battery | **20°C to 60°C** | **-30°C to +170°C** (varies by design) | **30°C to 50°C** (if liquid cooling is added) |

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# Cooling Calculations

Temperature Decrease in the Radiators

$$Q = \dot{m} C_p \Delta T$$

$\dot{m} = 0.718\ kg/s$
$C_p = 3.359\ kJ/kg.K$
$\Delta T = T_{in} - T_{out}$

For the Front Radiator: $\Delta T = \frac{Q}{\dot{m} C_p} = \frac{34000}{0.718 \times 3359} = 14.098°C$

For the Rear Radiator: $\Delta T = \frac{Q}{\dot{m} C_p} = \frac{14000}{0.718 \times 3359} = 5.805°C$

Battery Pack Heat Loss:

$$Q_{battery} = (1 - \eta) * P_{battery}$$

$$(1 - 0.95) * 400\ kW = 20kW$$

Motor Heat Loss:

$$Q_{motor} = (1 - \eta) * P_{motor}$$

$$(1 - 0.93) * 400\ kW = 28kW$$

**Battery: 20kW**
**Front Motor: 14kW**
**Rear Motor: 14kW**

Front Radiator Cools: 20 + 14 = 34kW
Rear Radiator Cools: 14kW

Radiator Sizing

$$Q = U \times A \times \Delta T_{\log mean}$$

$$A = \frac{Q}{U \times \Delta T_{\log mean}}$$

For Front Radiator : $A = \frac{34000}{400 \times 30} = 2.83\ m^2$

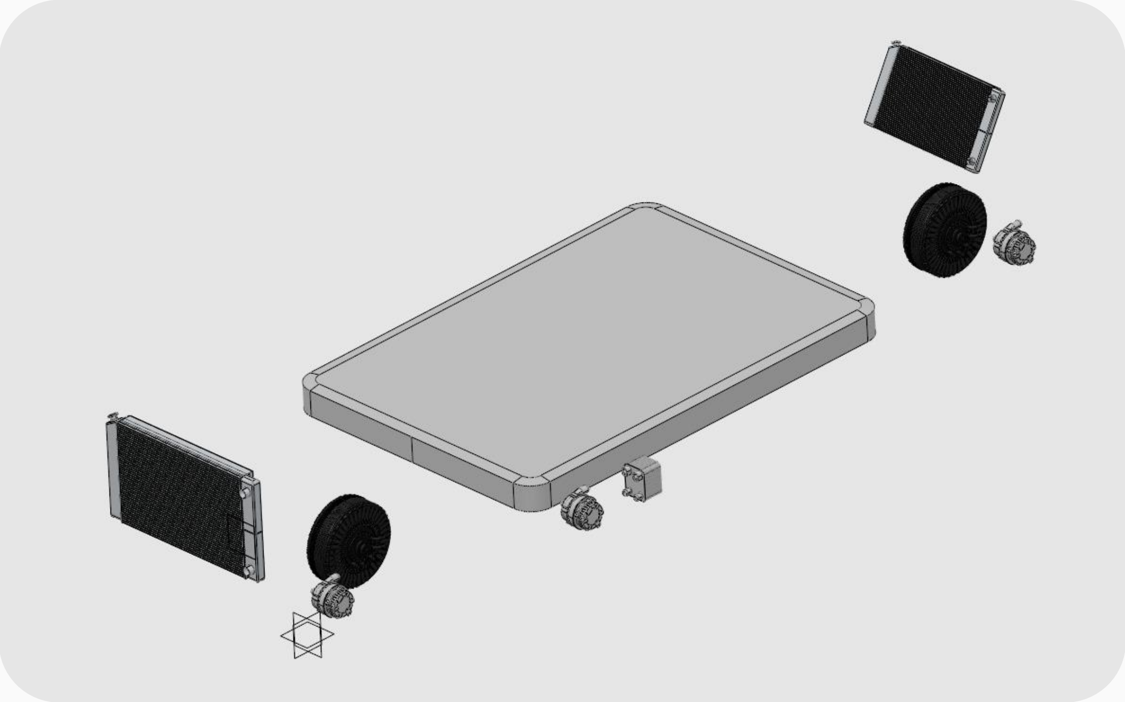
For Rear Radiator: $A = \frac{14000}{400 \times 35} = 1\ m^2$

Front Radiator: 60 x 50 x 5 cm (Battery + Front Motor, 34kW)

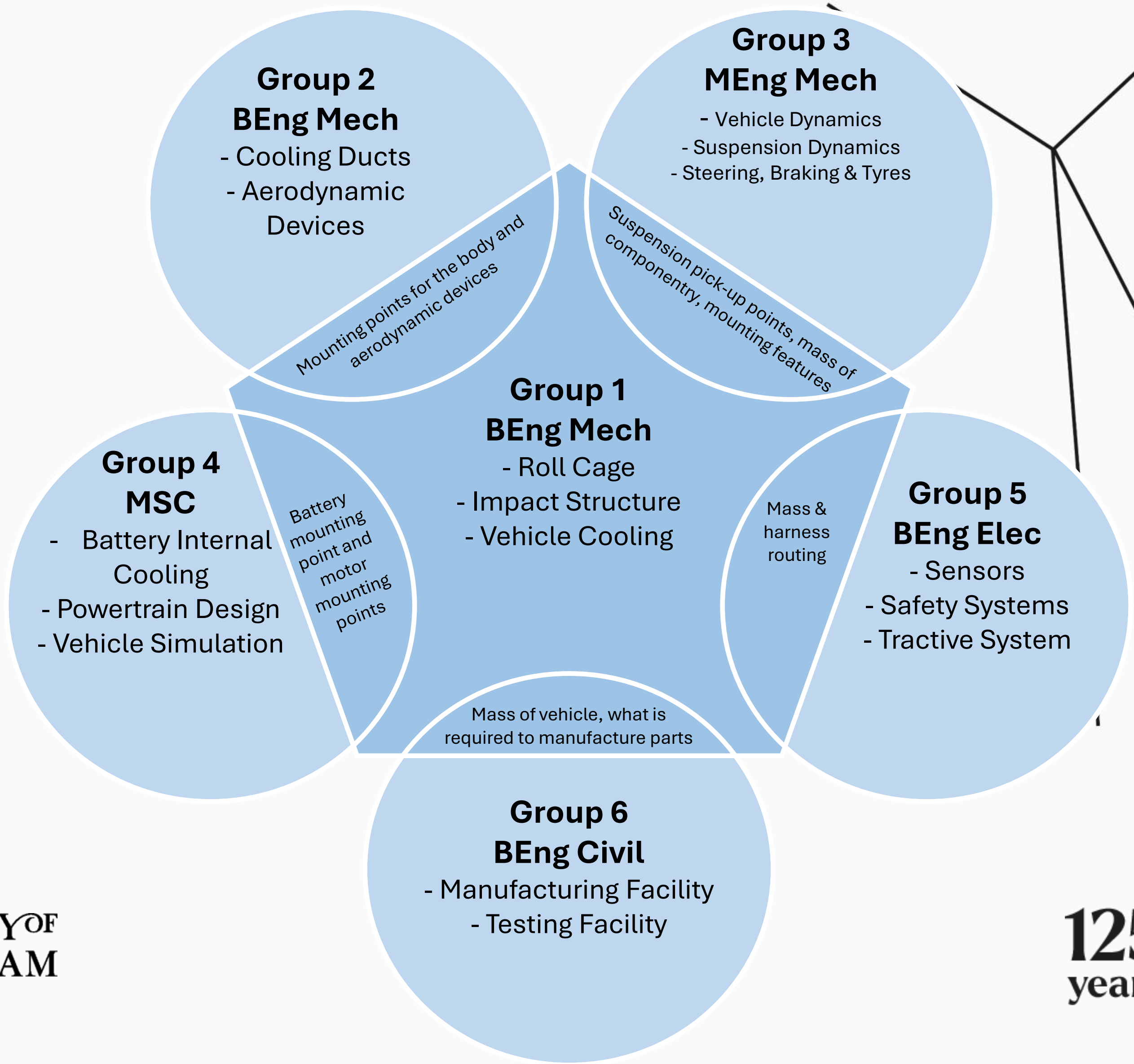
Rear Radiator: 40 x 35 x 5 cm (Rear Motor, 14kW)

# Future Plan

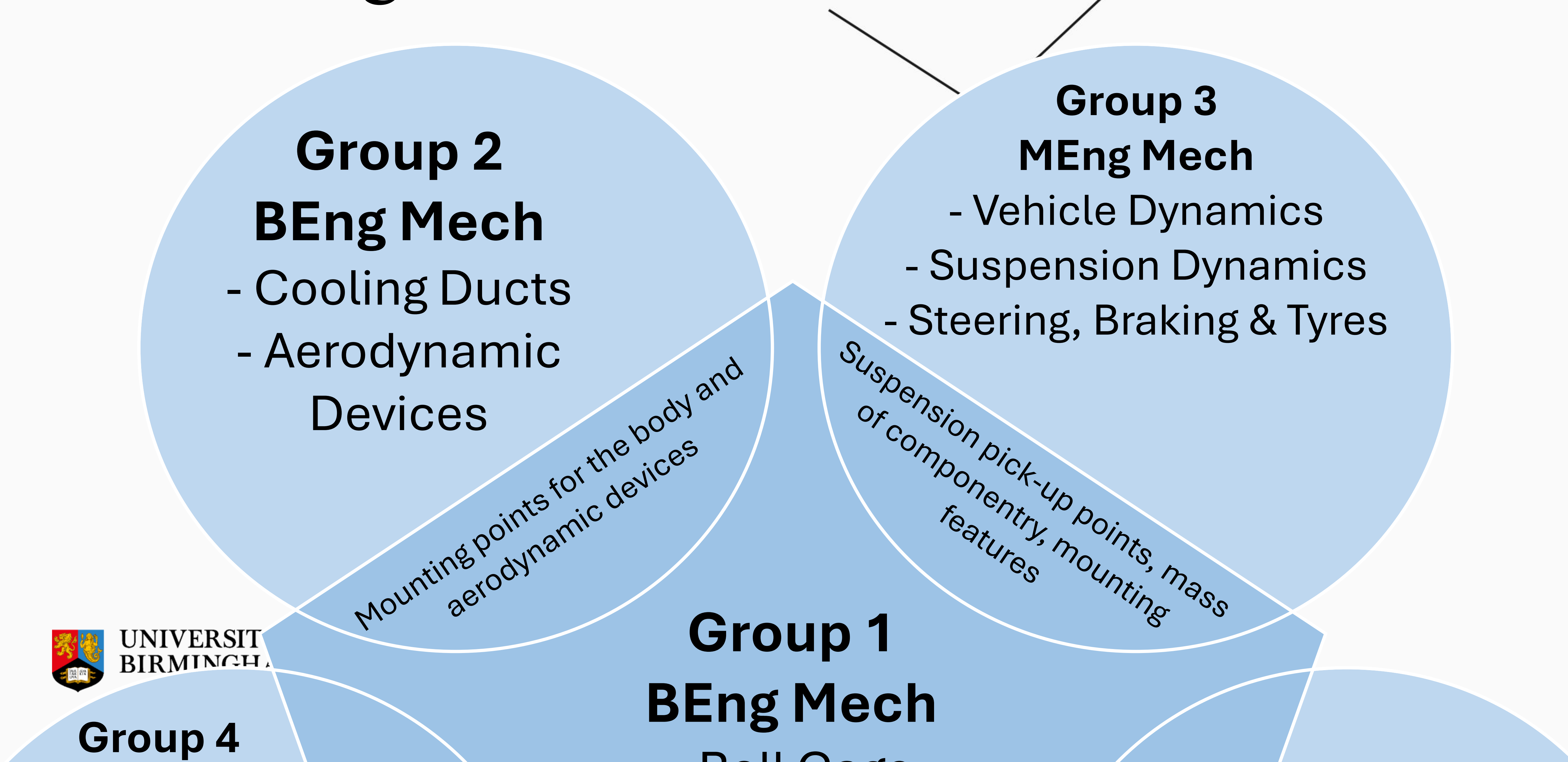
- Improvement on the CAD
- Further calculations on dynamic cooling behaviour, effects of vehicle speed on cooling
- Optimise fan speed and energy usage to balance cooling and efficiency.



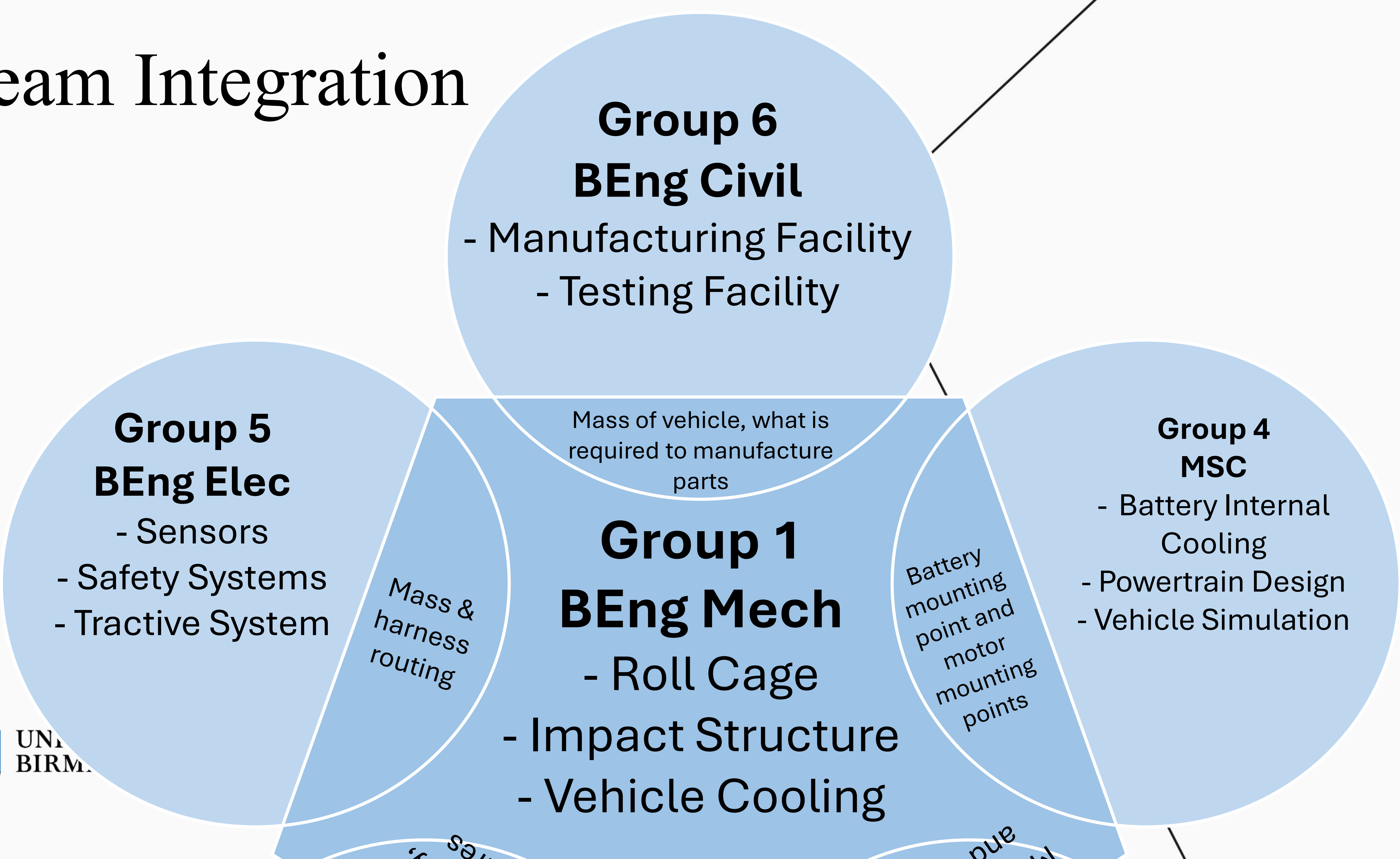
# Team Integration



# Team Integration



# Team Integration

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# Sustainability

SUSTAINABLE DEVELOPMENT GOALS

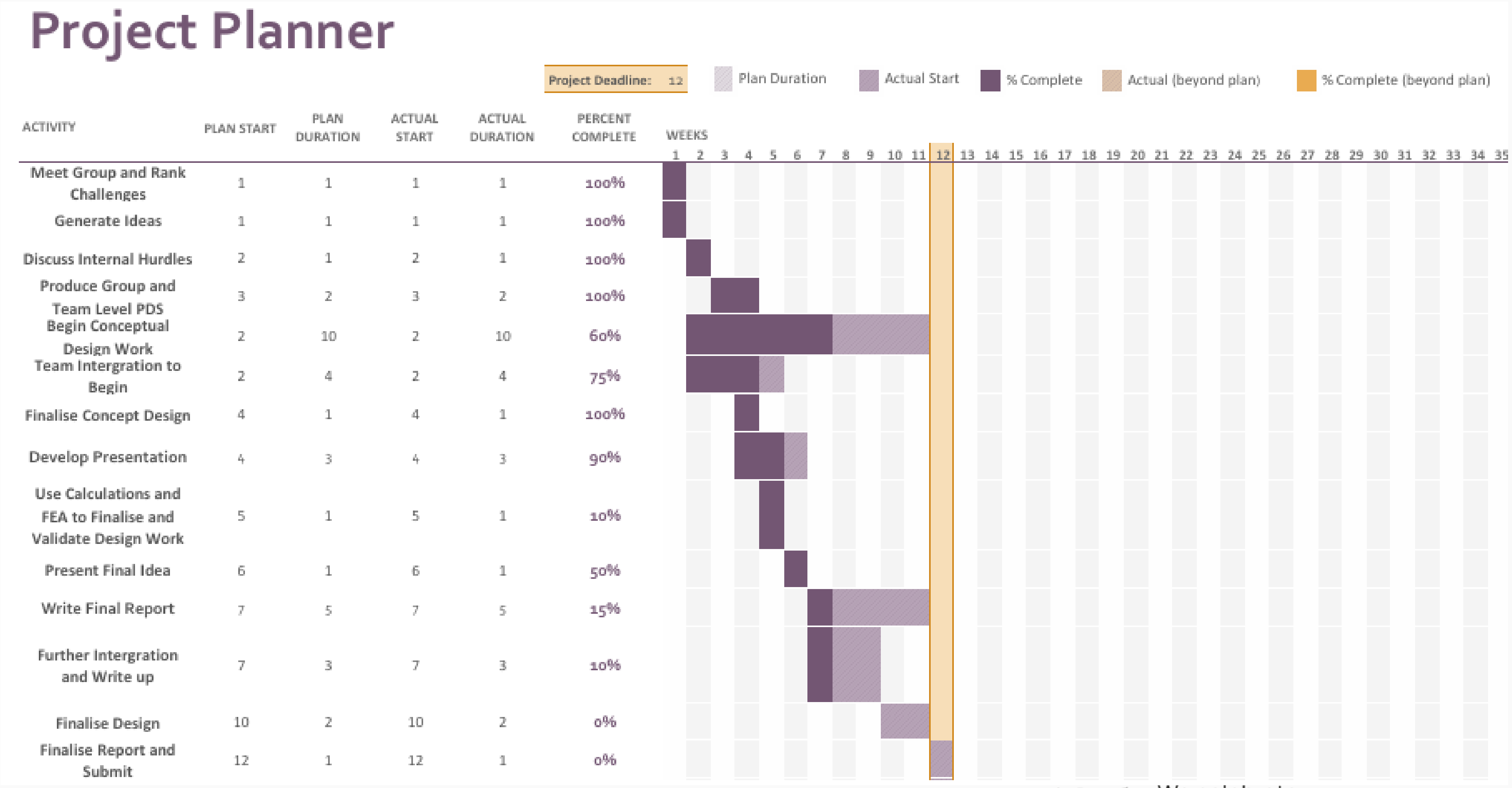
- Efficiency through material usage.
- Sustainable clean methods of cleaning components and finishing them.
- Using sustainable materials and recycled componentry.

7 AFFORDABLE AND CLEAN ENERGY

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

# Future Plans- Gantt Chart




| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Meet Group and Rank Challenges | 1 | 1 | 1 | 1 | 100% |
| Generate Ideas | 1 | 1 | 1 | 1 | 100% |
| Discuss Internal Hurdles | 2 | 1 | 2 | 1 | 100% |
| Produce Group and Team Level PDS | 3 | 2 | 3 | 2 | 100% |
| Begin Conceptual Design Work | 2 | 10 | 2 | 10 | 60% |
| Team Intergration to Begin | 2 | 4 | 2 | 4 | 75% |
| Finalise Concept Design | 4 | 1 | 4 | 1 | 100% |
| Develop Presentation | 4 | 3 | 4 | 3 | 90% |
| Use Calculations and FEA to Finalise and Validate Design Work | 5 | 1 | 5 | 1 | 10% |
| Present Final Idea | 6 | 1 | 6 | 1 | 50% |
| Write Final Report | 7 | 5 | 7 | 5 | 15% |
| Further Intergration and Write up | 7 | 3 | 7 | 3 | 10% |
| Finalise Design | 10 | 2 | 10 | 2 | 0% |
| Finalise Report and Submit | 12 | 1 | 12 | 1 | 0% |

# Future Plans

**WEEK 7**

- Review requirements and specifications
- Begin importing into the report
- Reflect on presentation

**WEEK 8**

- Finalise Design Work
- Begin preparing final report sections and content

**WEEK 9**

- Validation, FEA
- Design Freeze

**WEEK 10**

- Integrate system designs and review as a group

**WEEK 11**

- All information submitted into the report
- Review project and finalise report

**WEEK 12**

- Ready for submission.

# Q&A

# Optimizing Aerodynamics, Cooling, and Compatibility for the Dakar 2028 EV Hilux

BEng Mech 2

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# The Group

Haokun Wang
Battery Development

Shaojie Jia
Powertrain Development

Yuntao Xu
Battery Development

Ao Li
Battery Development

Tiannuo Guo
Research

Junzhi Huang
Battery Development

Mingyang Liu
Battery cooling system

Xinyuan Li
Research

# The Group

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Battery Development

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Battery Development

Ao Li
Battery Development

Tiannuo Guo
Research

Junzhi Huang
Battery Development

Mingyang Liu
Battery cooling system

Xinyuan Li
Research

# Group Activities/Goals

1. Cooling Ducts: for optimal temperature management

- Efficient air intake design for brake and radiator cooling
- Optimized duct placement for airflow improvement

2. Aerodynamics: for efficiency and stability

- CFD simulations to reduce drag and improve handling

3. Rally Modification: to meet Dakar’s extreme conditions

- Enhancing durability and resilience under extreme conditions

# Basic Calculations

1. Drag Force Calculation

$$F_D = \frac{1}{2} . \rho . v^2 . C_D . A = 320\ N$$

2. Lift Force Calculation

$$F_L = \frac{1}{2} . \rho . v^2 . C_L . A = 45\ N$$

3. Lift to Drag Ratio

$$Ratio = \frac{F_L}{F_D} = 0.14$$

4. Cooling for Brakes

$$Q = m\ c\ \Delta T = 1225\ kJ$$

**Parameters**

$F_D$: Drag Force (3.20 N)

$\rho$: Density of Air (1.293 kg/$m^3$)

$v$: average Car velocity (30m/s)

$C_D$: Drag Coefficient (0.367)

A: Frontal Area (1.5 $m^2$)

$F_L$: Lift Force (-0.45 N)

$C_L$: Lift Coefficient (-0.051)

$Q$: Heat Required for cooling ( kJ)

$m$: mass of the brakes (10 kg)

$c$: Heat Capacity for Steel (490 J/kg °C)

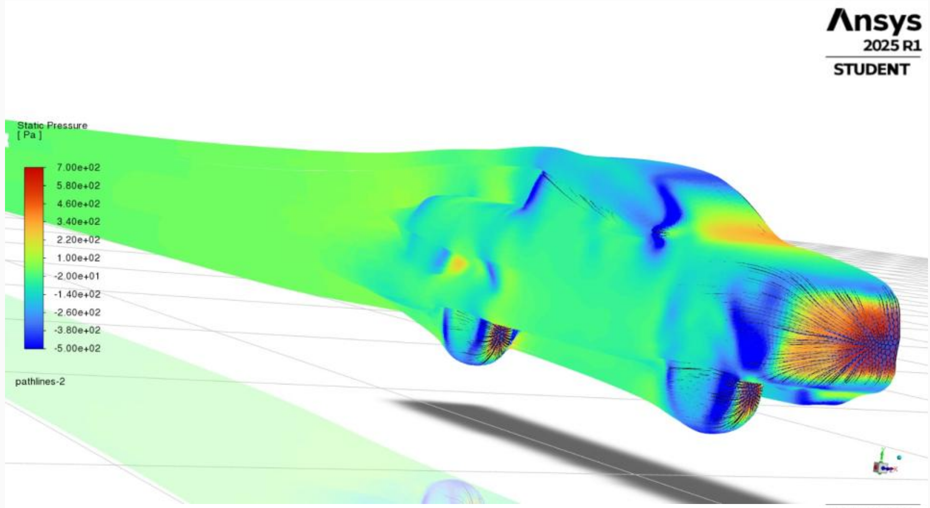
$\Delta T$: Change in Temperature (250 °C)

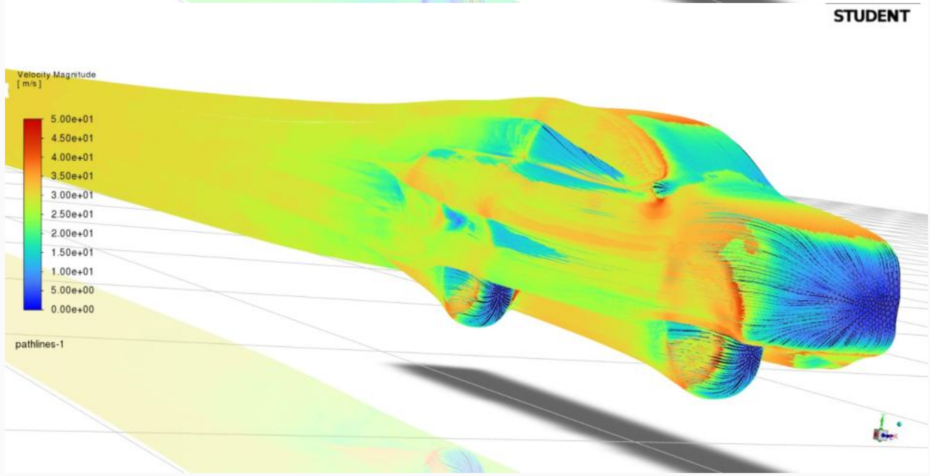
# Purpose and Methodology of CFD Analysis

- **Objective**: Assess aerodynamic performance of the base car at an **air speed of 30 m/s** (Dakar Rally Average Stage Speed)
- **Significance**:
  - **Efficiency**
  - **Stability**
  - **Performance**
- **Simulation Approach**:
  - Scaled model for simulation
  - **Reduced processing time & Ensure Accuracy**.
- **Focus Areas**:
  - **Airflow distribution**
  - Identify **high resistance zones**.

# CFD Results and Future Development

- **Key Findings:**
  - **Aerodynamic Performance Metrics**: Analysis of **coefficient of lift and drag**. (Cl=-0.05, Cd=0.367)
  - **Pressure Distribution**: Identification of **high-pressure zones** at the front of the car.
  - **Flow Behavior**: Observation of **stall streams** at the rear, affecting aerodynamic efficiency.
- **Proposed Optimizations:**
  - **Front-end Refinement**: Reduce high-pressure zones through improved geometry.
  - **Rear-end Design Enhancement**: Modify shape to minimize stall streams and improve airflow.
  - **Performance Balancing**: Maintain a **negative lift coefficient** for improved downforce while simultaneously reducing drag.



# Cooling Intake

**Aims**

O1: Provide cooling for brakes and radiators

O2: Optimise Air Flow

**Tools**

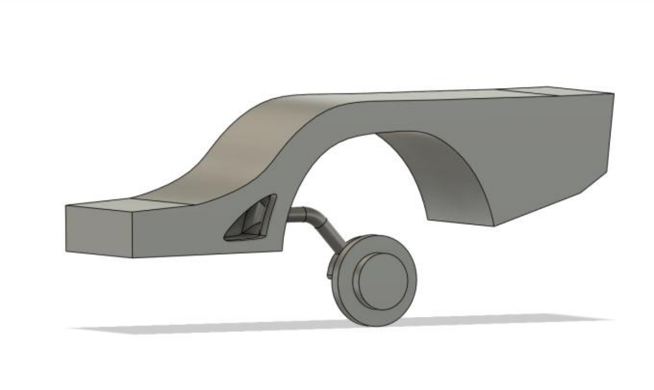
- Fusion 360
- Ansys Fluent

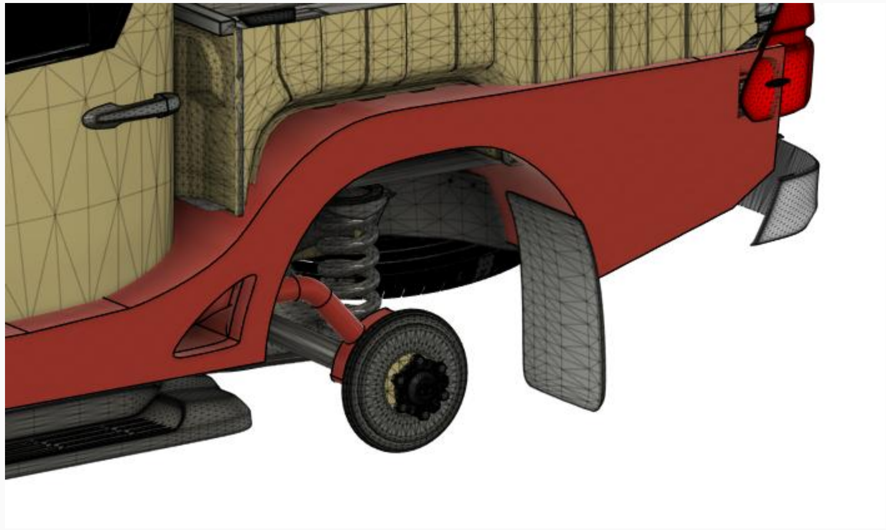
**Improvements**

- Side vents
- Roof air vent

**Things to consider**

- CFD for the air flow





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# Aerodynamics

**Aims**

O1: Reduce Induced Drag

- Increases stability and efficiency

O2: Increase Downforce

- Increases grip on lose surfaces



**Tools**

- Fusion 360
- Ansys Fluent

**Improvements**

- Front winglets (O2)
- Rear Spoiler (O2)
- Thinned Out front Bumper (O1)
- Streamlined Rear End (O1)

# Aerodynamics

**Improvements**

- Front winglets (O2)
- Thinned Out Front Bumper (O1)


**Improvements**

- Rear Spoiler (O2)
- Streamlined Rear End (O1)

# Enhancing Rally Compatibility

## Objective:

Improve durability and off-road resilience by protecting critical components from rough terrain, debris, and impacts.

## Key Modifications:

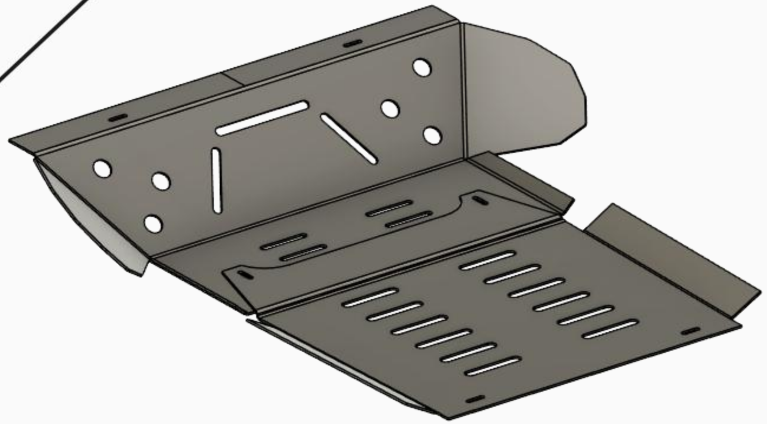
- **Engine Bash Plate:** Shields the engine from rocks, debris, and ground impact.
- **Transmission Bash Plate:** Protects the gearbox from damage due to rough terrain, preventing mechanical failures.

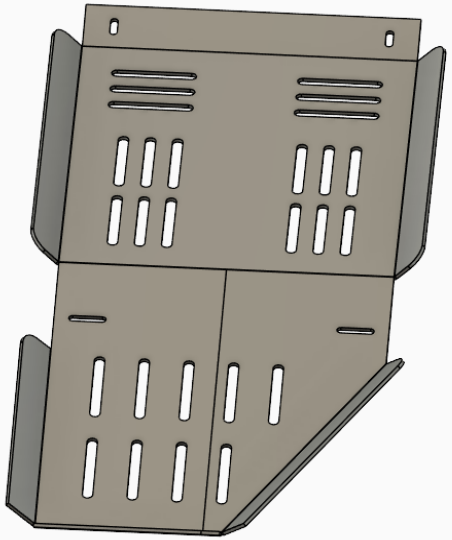
## Design Features:

Constructed using **lightweight** Aluminum 7075-t6 alloy sheets, powder coated for maximum durability and corrosion resistance

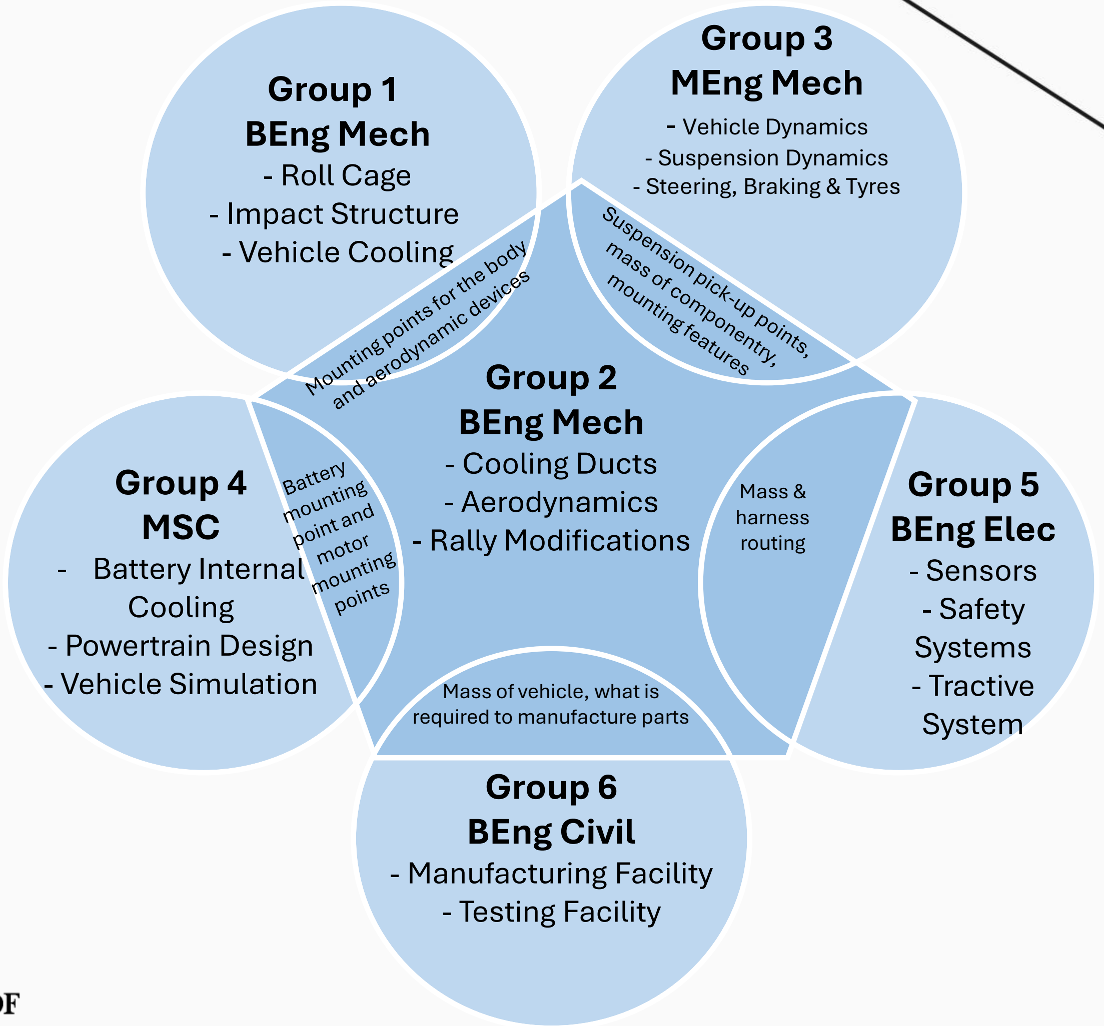
**Optimized airflow and heat dissipation** to maintain cooling efficiency.

**Streamlined geometry** to reduce aerodynamic drag while maintaining clearance for off-road conditions.





# Team Integration

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# Sustainability



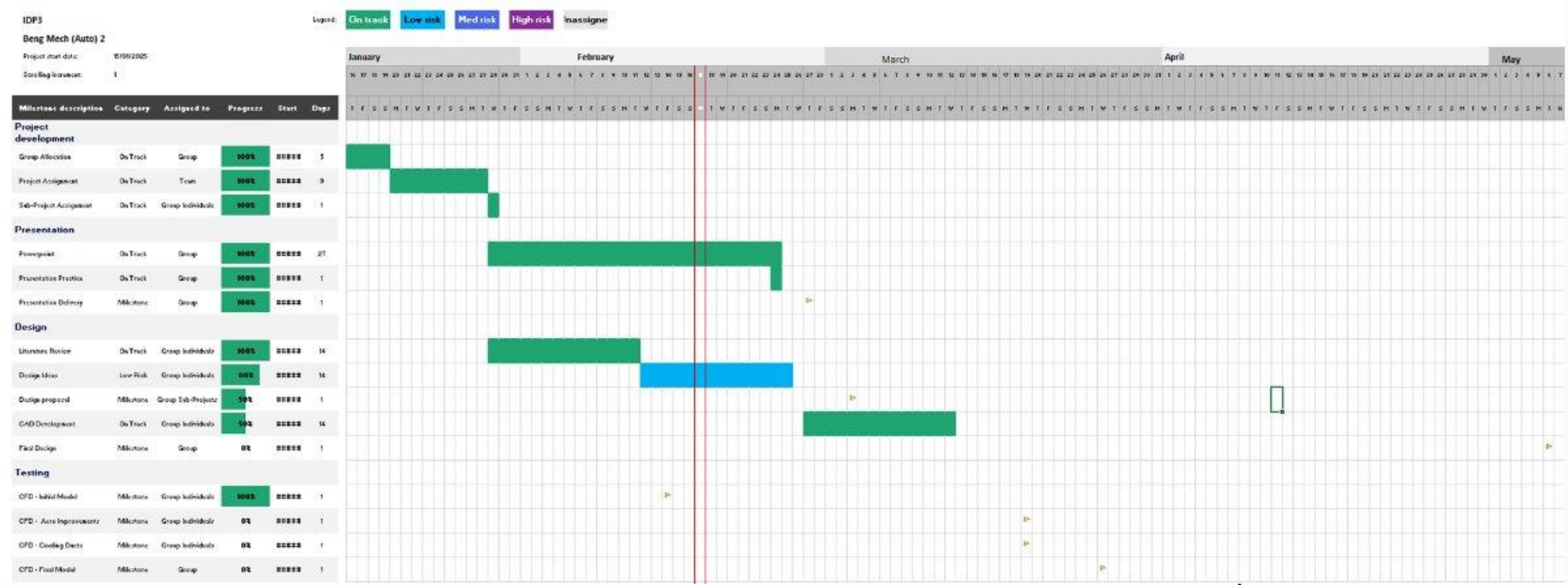

**For Sustainable Development Goals:**

- Innovation on Aerodynamic design and Lightweight part design – SDG 9
- Improve fuel efficiency – SDG 11
- Reduce carbon emission – SDG 13

**How to achieve:**

- Low drag aerodynamic design
- Material consideration – cost and performance
- Lifecycle consideration of design - durability

# Gantt Chart



IDP3
Beng Mech (Auto) 2
Legend:
On track
Low risk
Med risk
High risk
Unassigned
January
February
March
April
May
Milestone description
Category
Assigned to
Progress
Start
Days
Project development
Group Allocation
Project Assignment
Sub-Project Assignment
Presentation
Powerpoint
Presentation Practice
Presentation Delivery
Design
Literature Review
Design Ideas
Design proposal
CAD Development
Final Design
Testing
CFD - Initial Model
CFD - Aero Improvements
CFD - Cooling Ducts
CFD - Final Model
On Track
Low Risk
Milestone
Group
Team
Group Individuals
Group Sub-Projects
100%
50%
0%
#####

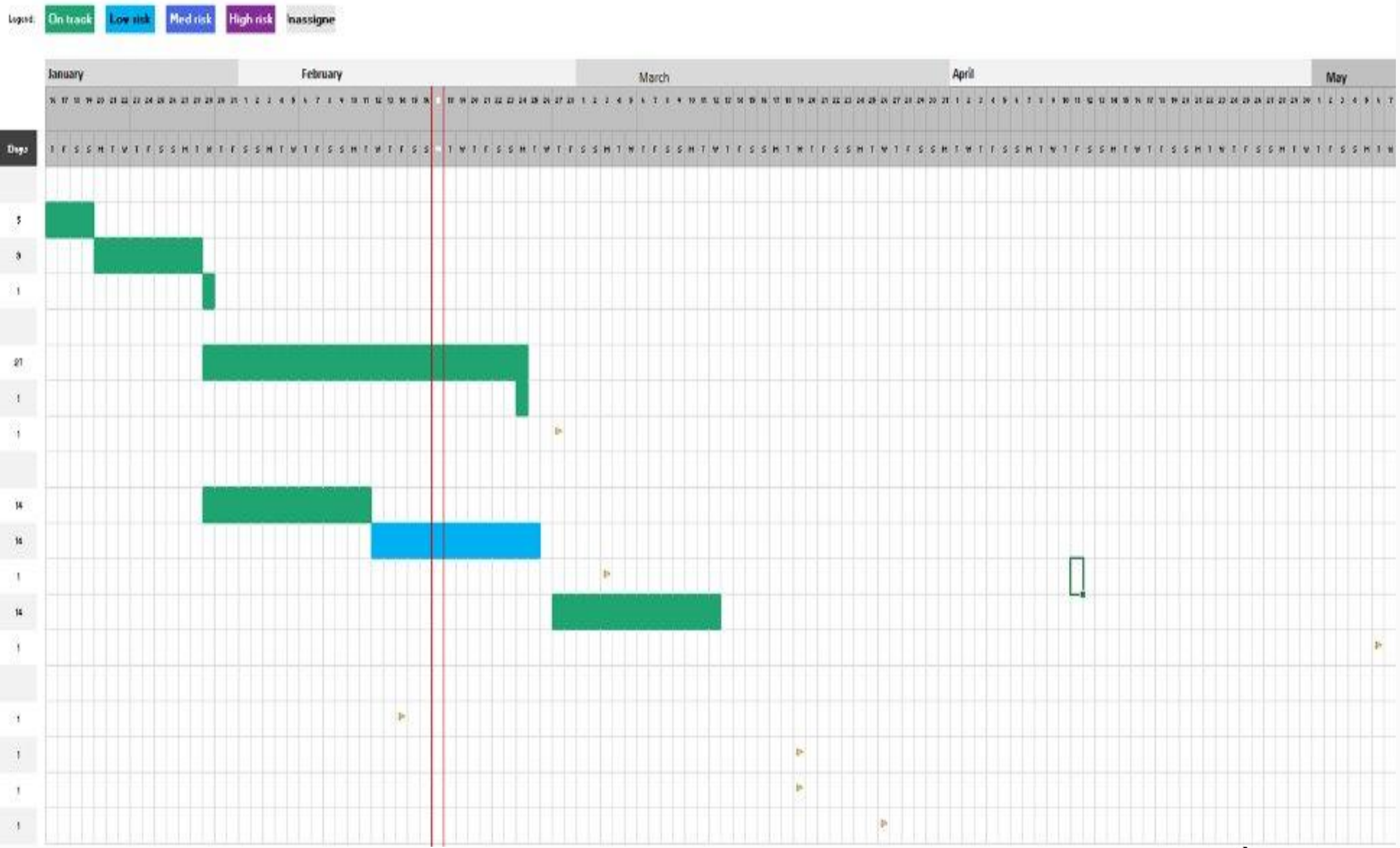
IDP3

Beng Mech (Auto) 2

Project start date: 15/01/2025

Scrolling increment: 1

| Milestone description | Category | Assigned to | Progress | Start | Days |
|---|---|---|---|---|---|
| **Project development** | | | | | |
| Group Allocation | On Track | Group | 100% | ##### | 5 |
| Project Assignment | On Track | Team | 100% | ##### | 9 |
| Sub-Project Assignment | On Track | Group Individuals | 100% | ##### | 1 |
| **Presentation** | | | | | |
| Powerpoint | On Track | Group | 100% | ##### | 27 |
| Presentation Practice | On Track | Group | 100% | ##### | 1 |
| Presentation Delivery | Milestone | Group | 100% | ##### | 1 |
| **Design** | | | | | |
| Literature Review | On Track | Group Individuals | 100% | ##### | 14 |
| Design Ideas | Low Risk | Group Individuals | 80% | ##### | 14 |
| Design proposal | Milestone | Group Sub-Projects | 50% | ##### | 1 |
| CAD Development | On Track | Group Individuals | 50% | ##### | 14 |
| Final Design | Milestone | Group | 0% | ##### | 1 |
| **Testing** | | | | | |
| CFD - Initial Model | Milestone | Group Individuals | 100% | ##### | 1 |
| CFD - Aero Improvements | Milestone | Group Individuals | 0% | ##### | 1 |
| CFD - Cooling Ducts | Milestone | Group Individuals | 0% | ##### | 1 |
| CFD - Final Model | Milestone | Group | 0% | ##### | 1 |



# Swot Analysis

**Strength**

- Optimized aerodynamics reduce drag and improve efficiency
- Durable modifications enhance resilience for extreme rally conditions

**Weaknesses**

- Added aerodynamic components may increase vehicle weight
- Cooling system complexity requires precise airflow management

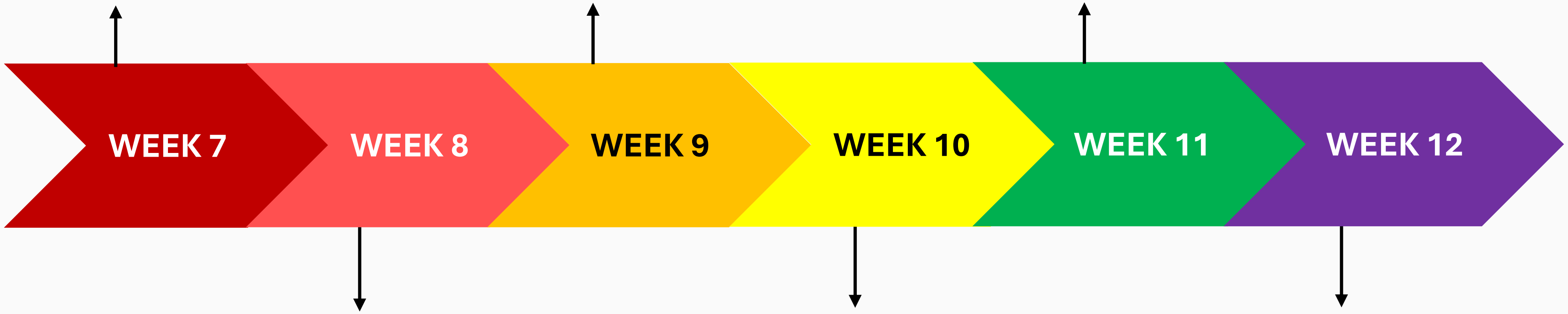
**Opportunities**

- Advancement in cooling technologies can enhance efficiency

**Threats**

- Harsh rally conditions may push components beyond tested limits

# Future Plans




- Define Requirements
- Research components

- Finalise concepts
- Work on the report’s content

- Work on calculations
- Improve design
- Test Compatibility

- Integrate system designs
- develop simulations

- Finalise Report
- Get Feedback from supervisor

- Ready for submission.

# Q&A

# Vehicle Dynamics, Suspension, Steering, Braking, and Tyres

Meng Mech 1

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# The Group

Key:
Name-
Group Role-
Belbin Result-

Diljit Singh
Vehicle Dynamics
Coordinator

Saeed Ahmed
Suspension

Keranveer Mann
Steering & Braking`

Aqib Mahmood
Steering & Braking

Grant Rogan
Suspension

Ayodeji Joseph
Vehicle Dynamics

Sayhan Ali
Vehicle Dynamics

Vinay Mahal
Vehicle Dynamics

# Group Activities/Goals

Tasked with designing:

- Suspension
- Steering, Braking, & Tyres
- Vehicle Dynamics

Looking at how the vehicle rides and handles.

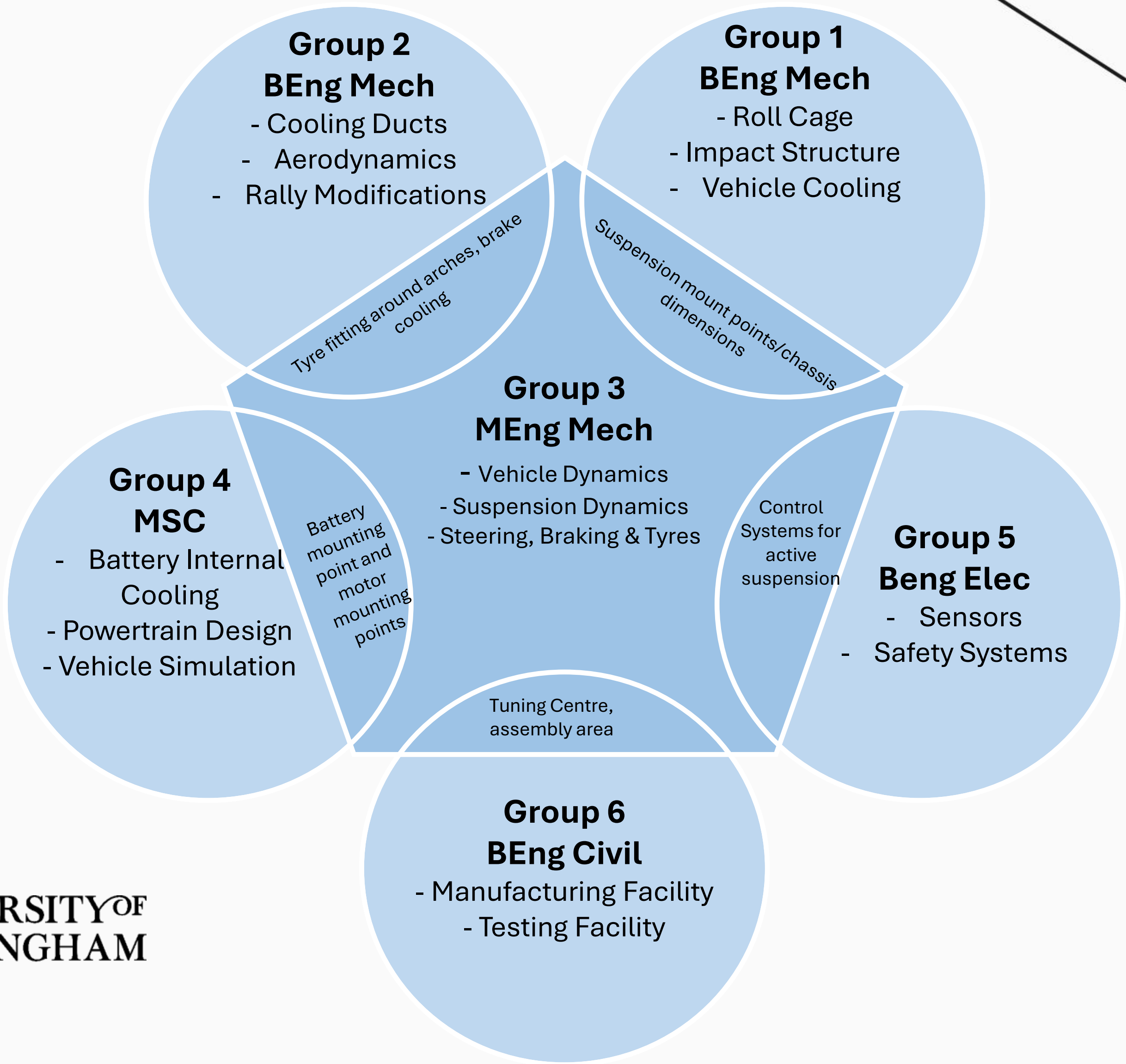
Goals:

- Research on types of components we need.
- Model the components to fit the chosen vehicle.
- Test and simulate rally conditions.
- Make a prototype.

# Swot Analysis

| | The Good | The not-so-good |
|---|---|---|
| **What we've got** | Strong focus on performance optimisation for off-road conditions.<br>Electric powertrain allows for a low centre of gravity.<br>Use of advanced simulation tools for analysis. | Limited real world testing opportunities.<br>High loads on suspension due to significant weight on suspension.<br>Integration with other groups can be complex. |
| **What's out there** | Adoption of innovative materials.<br>Use of regenerative braking for efficiency.<br>Testing and feedback loops can improve design before the final one. | Reliability concerns for off-road conditions.<br>Stability and rollover risk due to rugged terrain.<br>Unpredictable conditions may expose unforeseen weaknesses. |

# Team Integration

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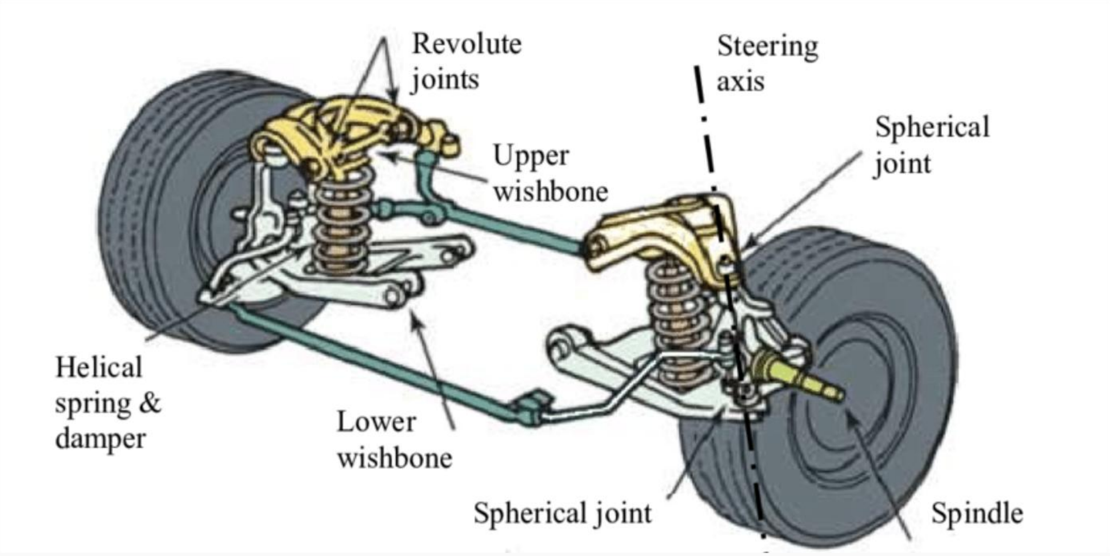
# Suspension

| Design Factors | Considerations |
|---|---|
| Loads (Static and Dynamic) | Weight, vehicle dynamics, number of impacts |
| Terrain | Surface type; sand, gravel, dirt |
| Geometry | Track width, wheel base, ground clearance |
| Temperature | Ambient/surface temperature, energy dissipation |

- Double wishbone suspension with hydraulic dampers and spring coilovers.
- Will be bought in from companies such as:
  - KONI
  - Reiger
  - KW
  - ICON

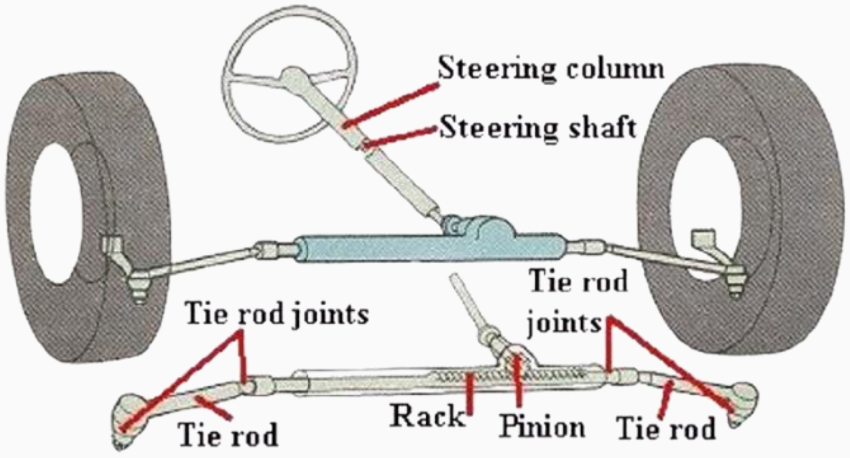


# Steering, Braking & Tyres

Steering: (Sadev Racing, Mamba Racing, Sheppard Motorsports)
- Rack and Pinion – quick ratio and power assisted
- Reinforced design for heavy duty application
- Customisation for driver including comfort

Brakes: (Brembo, AP Racing, Alcon Brakes)
- High performance disk brakes - ventilated
- Air cooled design for body work
- Durable and balanced
- (Consider Handbrake)

Tyres: (BFGoodrich, Michelin, Pirelli)
- (Low pressure) Off-road tyres (rally stage)
- Wide with tread
- Puncture resistant
- (Wheels)





# Vehicle Dynamics


Top Speed: 160-180 km/h
Acceleration (0-100 km/h): 4-6 seconds

Distribution of Mass - Even weight distribution, low centre of gravity, load & weight transfer

Cornering & Stability – Track Width, Torque Vectoring, Steering Ratio, Ackermann Geometry, Anti-Roll Bar

Suspension & Ride Comfort - Camber angle, caster, angle, ride height, damper

# Sustainability

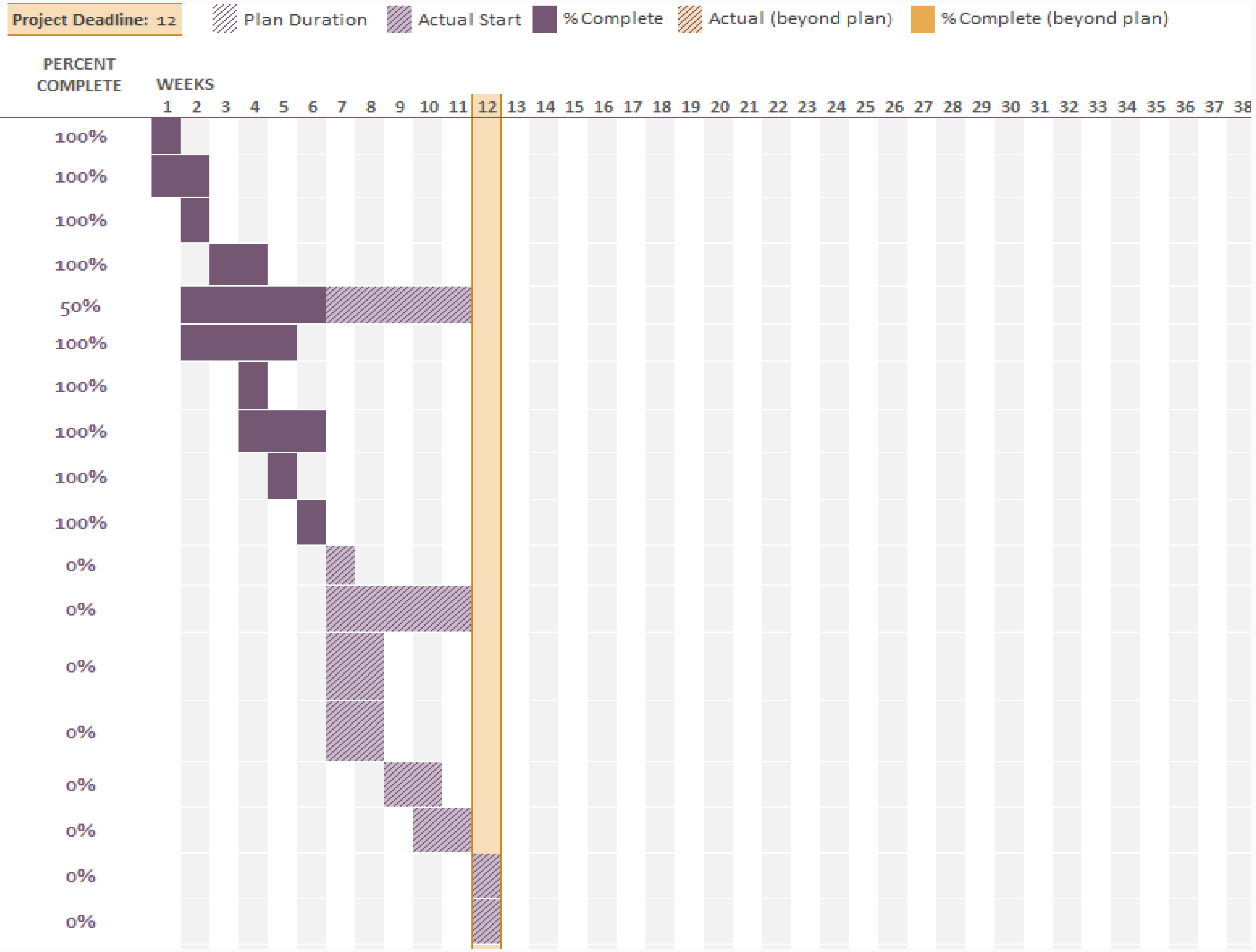
- Material selection (tyres, brake pads)
- Recyclable tyres
- Efficient brake cooling system
- Regenerative components by capturing kinetic energy of the system.

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

# Future Plan – Gantt Chart

| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Meet Group and Rank Challenges | 1 | 1 | 1 | 1 | 100% |
| Generate Ideas + Initial Research | 1 | 2 | 1 | 2 | 100% |
| Discuss Internal Hurdles | 2 | 1 | 2 | 1 | 100% |
| Produce Group and Team Level SoR | 3 | 2 | 3 | 2 | 100% |
| Consider SDG | 2 | 10 | 2 | 10 | 50% |
| Encorporate Team Integration | 2 | 4 | 2 | 4 | 100% |
| Finalise Concept Design | 4 | 1 | 4 | 1 | 100% |
| Develop Presentation | 4 | 3 | 4 | 3 | 100% |
| Develop Concept Models | 5 | 1 | 5 | 1 | 100% |
| Present Final Idea | 6 | 1 | 6 | 1 | 100% |
| Reflection on presentation | 7 | 1 | 7 | 1 | 0% |
| Write Final Report | 7 | 5 | 7 | 5 | 0% |
| Detailed Calculations | 7 | 2 | 7 | 2 | 0% |
| Iterate Concept Design Through Suspension Modelling Simulations | 7 | 2 | 7 | 2 | 0% |
| Finalise Design | 9 | 2 | 9 | 2 | 0% |
| Manufacture Prototype | 10 | 2 | 10 | 2 | 0% |
| Machine Testing and Evaluating Protoype | 12 | 1 | 12 | 1 | 0% |
| Finalise Report and Submit | 12 | 1 | 12 | 1 | 0% |

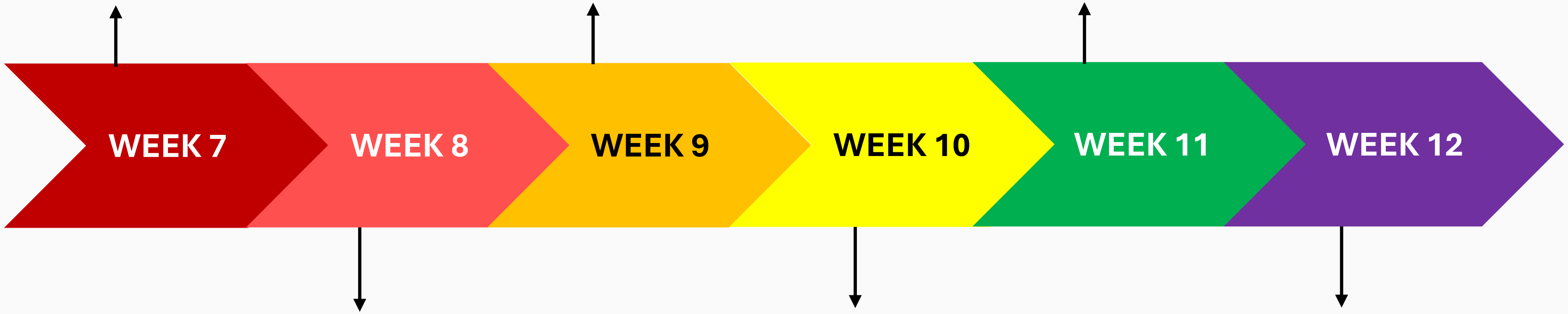


# Future Plans

- Review feedback from the presentation
- Continue developing concepts and research

- Continue with final designs
- Start simulations

- Finalise prototype
- Think about how we should test
- Finalise report




- Start calculations
- Start developing final designs

- Start developing prototype

- Ready for submission.

# Q&A

# Adaptive Terrain Response System (ATRS) for Dakar Electric Rally Truck

BEng Elec 1

# The Group

Junlin Zhou
Management, general design

Jiahan Xu
Research, simulink implementation

Xi Jin
Design, simulink implementation

Zhejia Zhang
Communication, software design

Zihan Lin
Research, software design

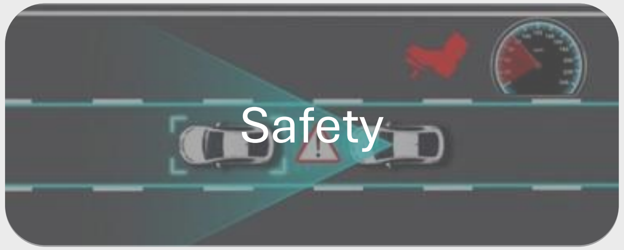
Junjie Wang
Research, detailed design

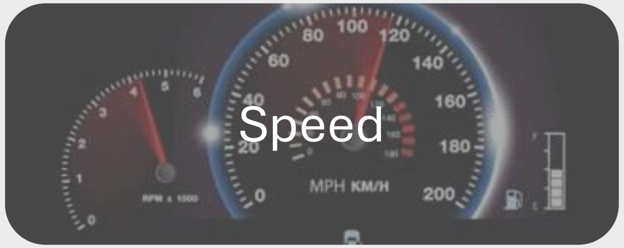
Dexin You
Research, simulink implementation

Yi Wang
Research, detailed design

# Goals & Requirements

## Team Level Challenges





## Group Goals & Requirements

| | | |
|---|---|---|
| Robust hazard detection | Predictive, adaptive control | Dynamic stability management |
| High-speed responses | Optimized suspension control | Agile dynamic adjustments |
| Energy-efficient design | Long-term durability | Eco-friendly operation |

# Related Background

## Dakar Rally Challenges

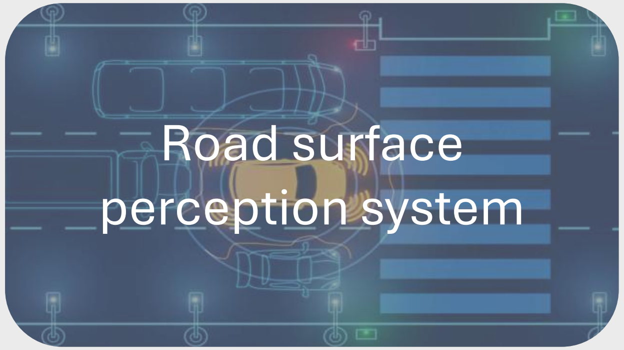
- Extreme terrain & environment
- Vehicle durability & performance
- Driver & control complexity

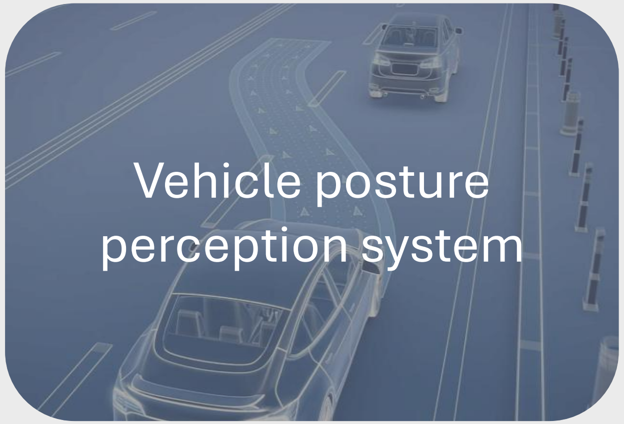
## Advanced Technology about Electric Vehicles

| | | |
|---|---|---|
| Control system | BYD DiSus Intelligent Body Control System | NIO SkyRide Intelligent Chassis System |
| Intelligent driving system | Tesla Full Self-Driving (FSD) | BYD God Eye Intelligent Driving System |
| Xpeng XNGP (Xpeng Navigation Guided Pilot) | NIO Aquila Super Sensing System | Li Auto AD Pro/Max Intelligent Driving System |

# System Overview

## Perception Layer




## Decision Layer



## Execution Layer


# Perception Layer

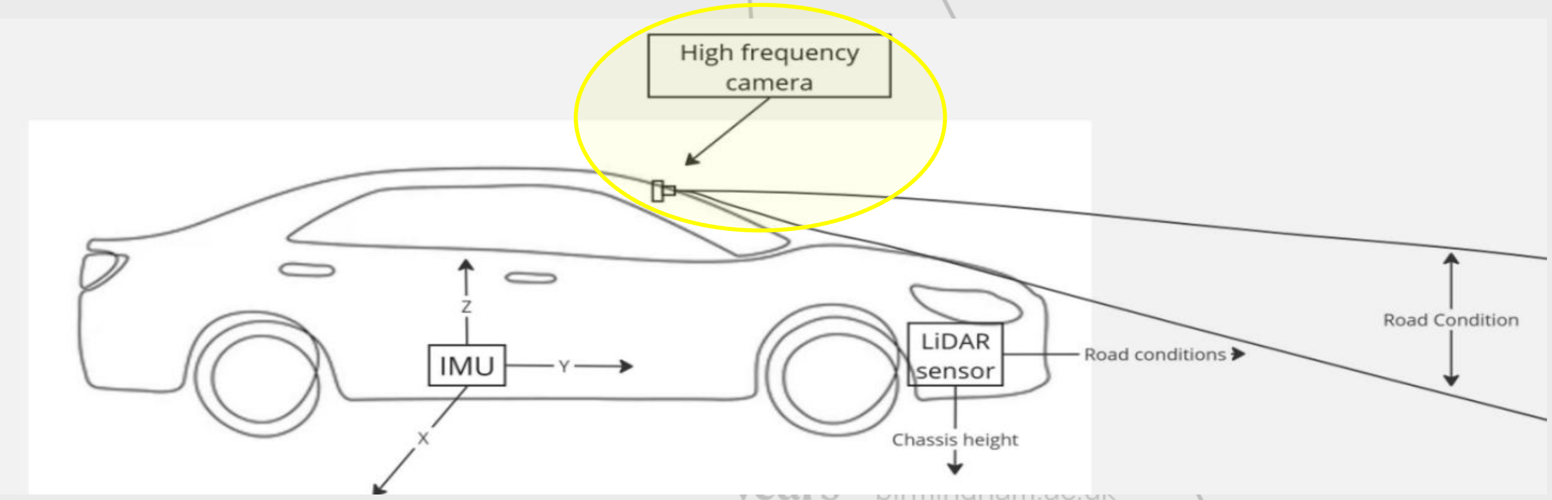
## Subsystem 1: Road Surface Perception System

### Camera

- Front-Facing Camera: Detects road conditions, vehicles, pedestrians, and information to enhance driving safety.
- Stereo Camera: Enables high-precision distance measurement for 3D recognition.

### Requirements

- Environmental Adaptability
- Real-time Processing
- Vibration Resistance



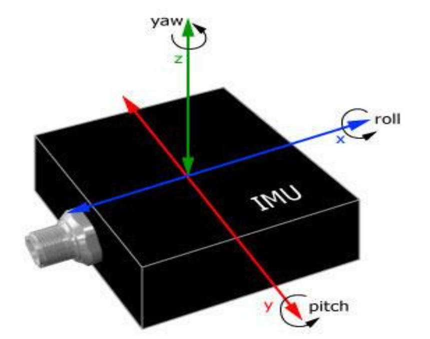
# Perception Layer

## Subsystem 2: Vehicle Posture Perception System

### IMU

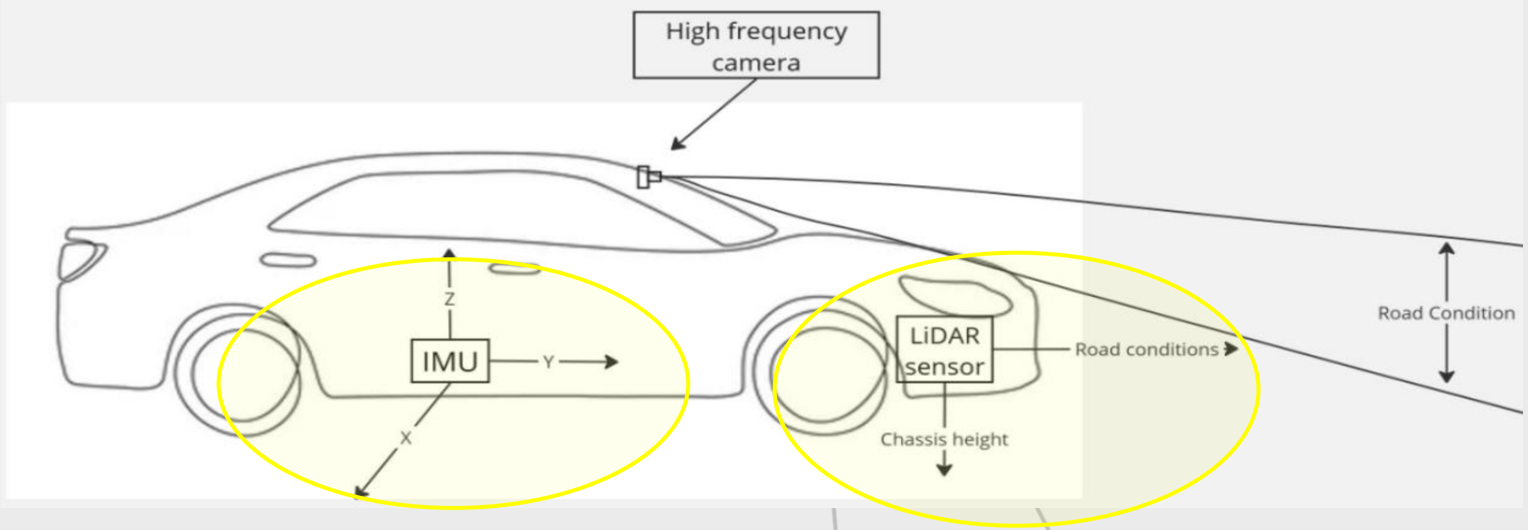
Pitch, Roll, Yaw

- Accelerometer
- Gyroscope



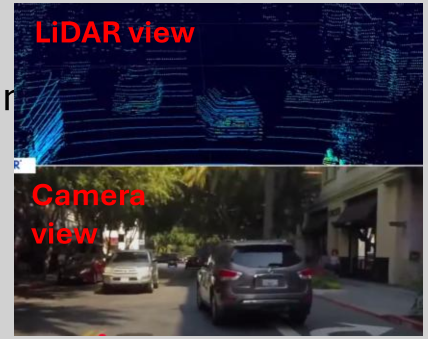

### Requirements

- Minimized drift
- High shock and vibration resistance




### Chassis Height Sensor: LiDAR

- Use laser or infrared for high-accuracy vehicle ground clearar measurement.
- Ensures strong adaptability to various surfaces.



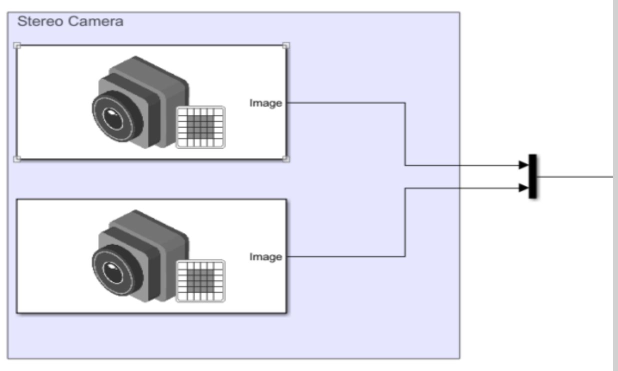

### Requirements

- Environmental Adaptability
- Real-time Processing
- Vibration Resistance

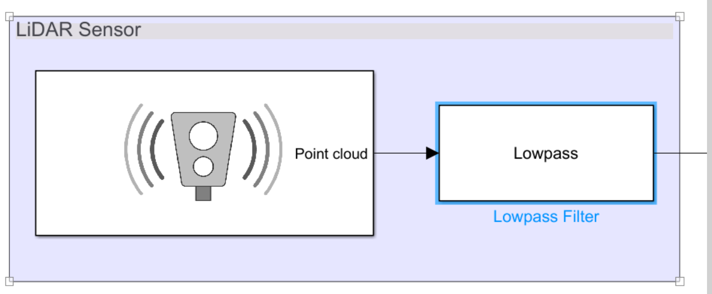
# Perception Layer

## Solution in Simulink

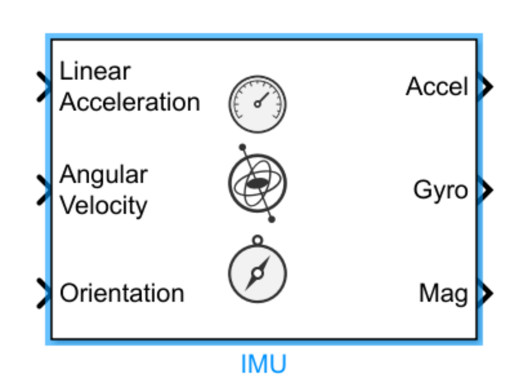
### Stereo Camera



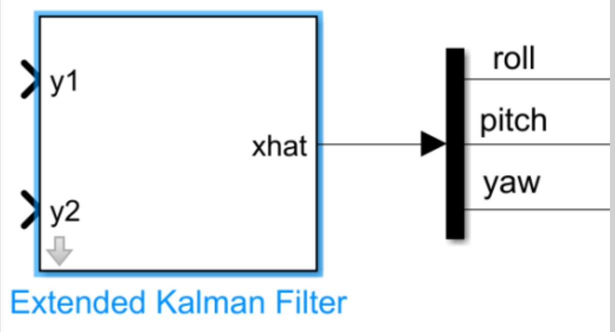

### LiDAR Sensor




### IMU




EKF for IMU Drift Correction:




**Overall Solution:**

**Multi-Sensor Fusion**

- Integrate LiDAR, Cameras, and IMU to enhance perception in low visibility and extreme conditions.

**Enhanced Visual Perception**

- Employ stereo vision and high-frame-rate cameras.
- Utilize internal Kalman filtering (EKF) for real-time drift correction.

**Vibration and Noise Reduction**

- Implement mechanical damping (rubber mounts).
- Apply low-pass filters eliminate noise caused by road shocks.

# Decision Layer

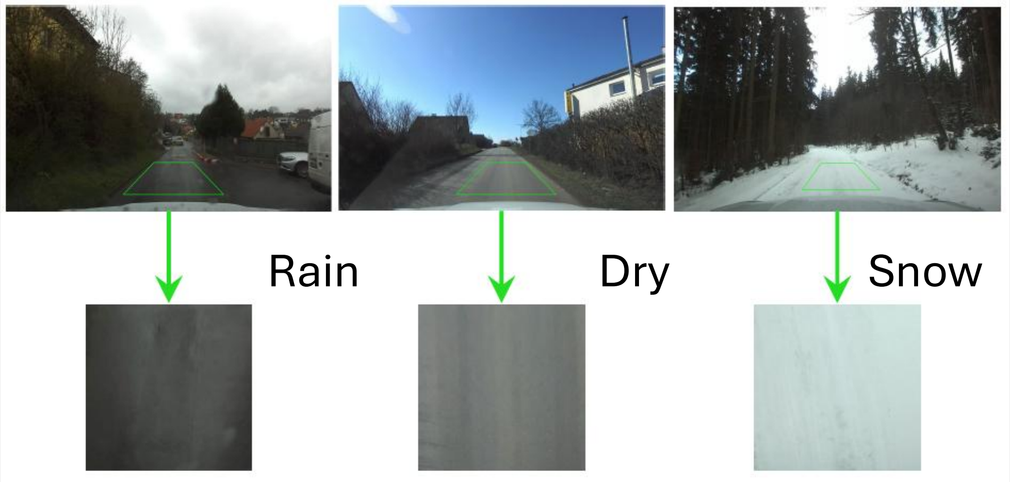
## Model 1: Road Surface Analysis Based on Camera

### Attention region mask

- Semantic segmentation model applied
- Attention mask for road region

### Surface classification

- Reshape the attention region
- Surface classification based on light weighted convolutional network

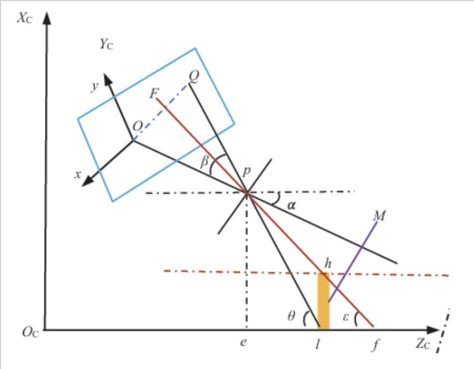


# Decision Layer

## Model 1: Road Surface Roughness Based on Camera

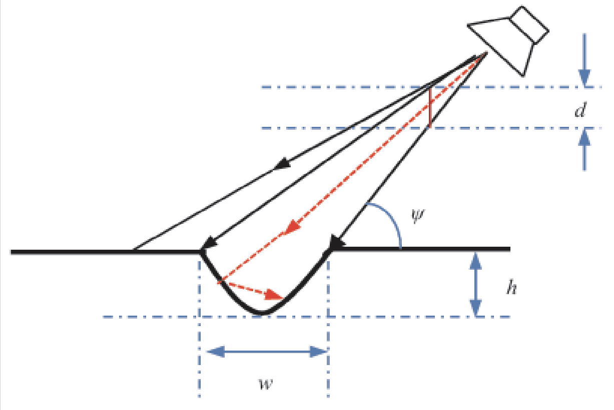
### Camera detection

- Barrier detection based on greyness threshold calculated in attention region.
- Coordinates transformation from camera to world




### Lidar detection

- Barrier detection based on reflection beams
- Coordinates transformation from polar scan to world




### Sensor fusion

- IoU (Intersect over Union) evaluation between Lidar scan and camera.
- GNN matching for data fail passing the IoU evaluation.

# Decision Layer

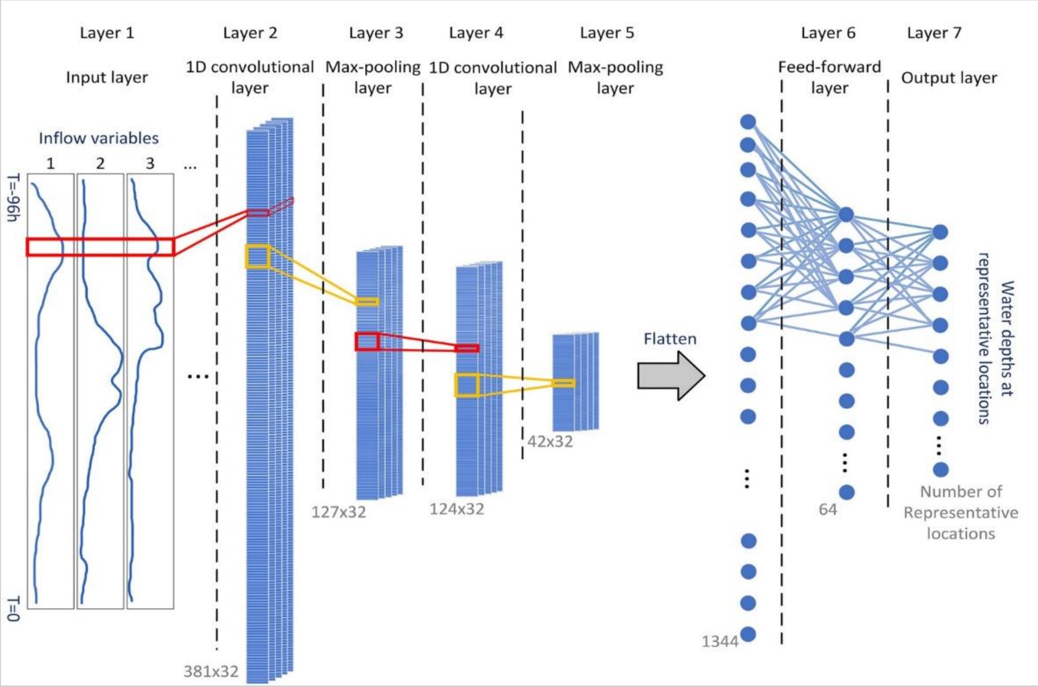
## Model 2 : Road Surface Analysis Based on IMU

### Introduction of Model 2

1D-CNN (1D Convolutional Neural Network) is a deep learning model designed for time-series data analysis. It extracts features from time-series suspension sensor data to detect road conditions (smooth, bumpy, potholes, slippery) and optimize suspension in real-time. It enhances race car tuning and ride performance using both real-time and historical data.

### Architecture

- Input
- Conv1D Layers
- Pooling Layer
- Dense Layers
- Output



# Execution Layer

## Input 1: Driving Mode

### Definition

- Macro-level, global setting
- Overall driving strategy for a specific terrain

### Characteristics

- Remain relatively stable
- Manually select / Change by decision layer / Stage preset

**Desert mode**

Prevent sinking in sand

**Rock mode**

Maximize grip on rocky terrain

**Mud mode**

Enhance traction in slippery conditions

**High-speed mode**

Improve stability at high speeds

**Crawl mode**

Improve stability on steep inclines

# Execution Layer

## Input 2: Future Terrain Perception

### Definition

- Short-term, dynamic adaptation
- Change within the selected driving mode

### Characteristics

- Higher frequency of changes
- Change by decision layer / Stage preset
- Short-duration adjustments to refine the driving mode settings

**Risk of Side Tilting**
Reduce body roll

**Large Gradient & Undulations**
Absorb impact

**Continuous Sand Dunes**
Maintain stability

**Rocky Incline**
Improve traction

**Extensive Loose Gravel**
Enhance stability

**Marshy Terrain**
Prevent slippage

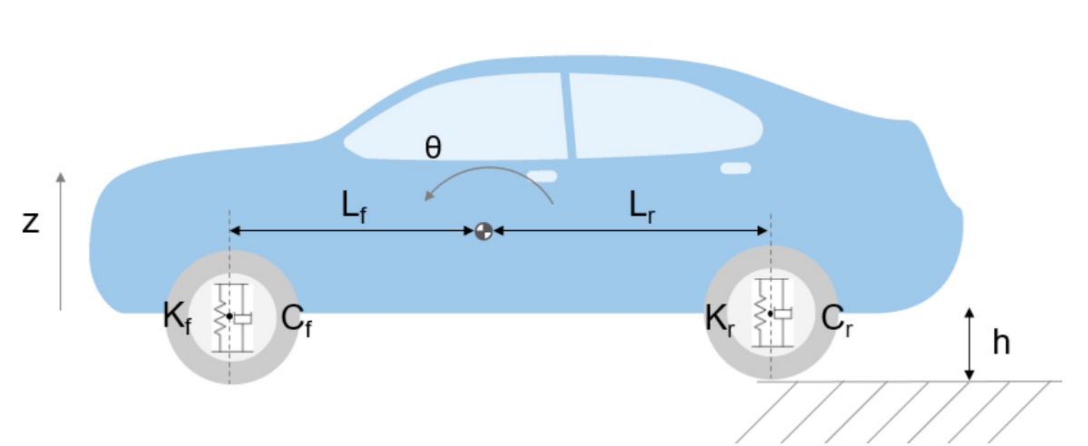
# Execution Layer

## Solution in Simulink

### Suspension parameter matrix

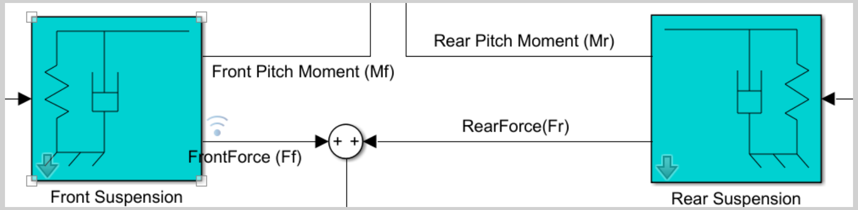
$$P = \begin{bmatrix} K_{mode} & C_{mode} & h_{mode} \\ K_{Prediction} & C_{Prediction} & h_{Prediction} \end{bmatrix}$$

- $K$ for suspension stiffness, $C$ for damping, $h$ for ground clearance

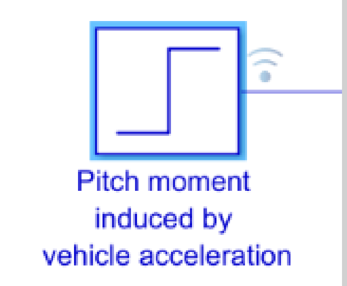



### Adjustable parameters of the simulation

1. Front & Rear suspension



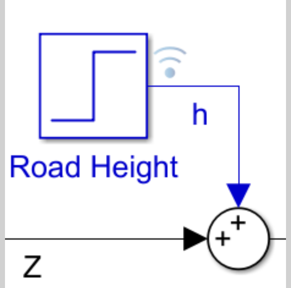

2. Pitch moment




3. Road height

Decomposed into:

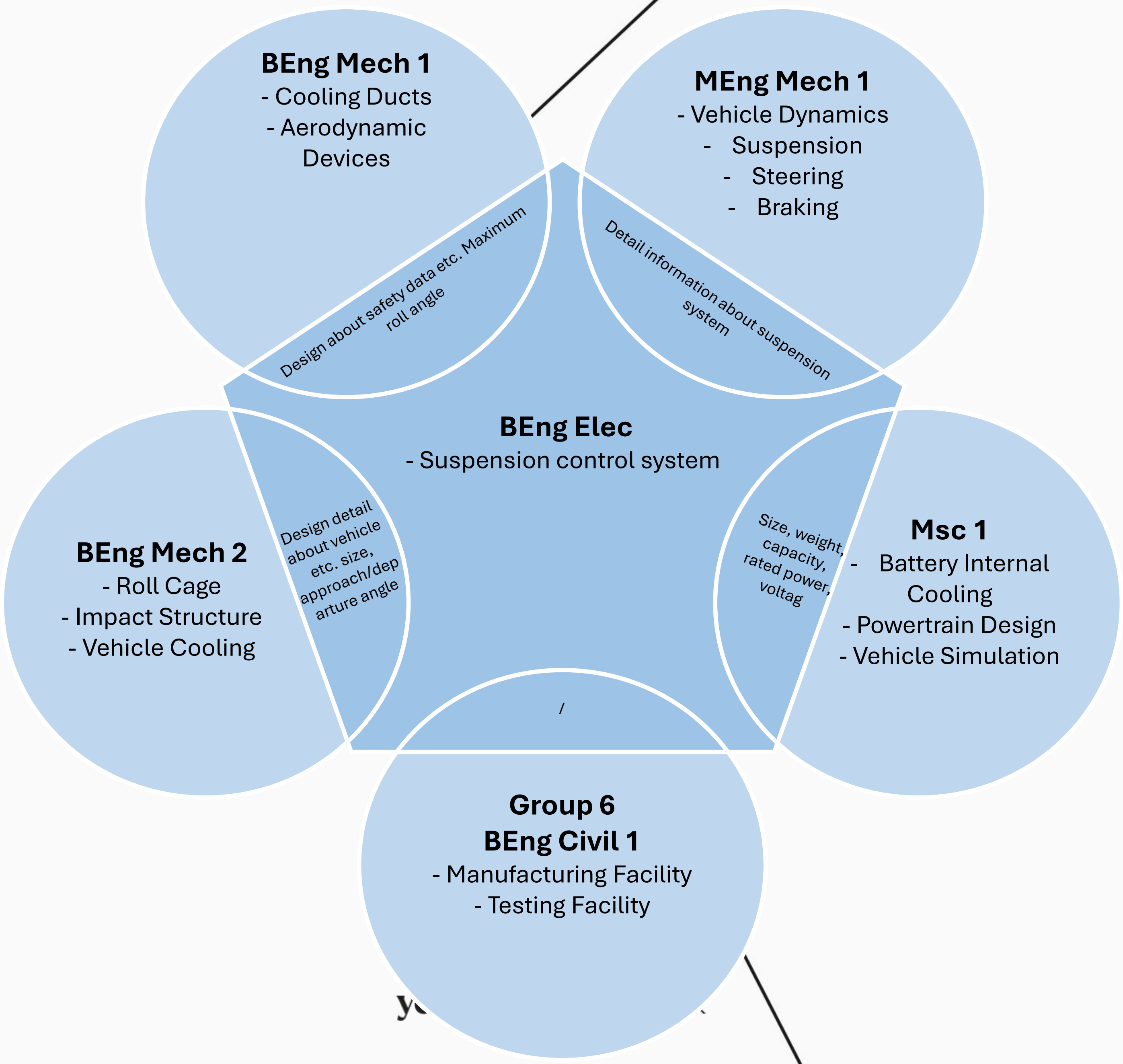
- Initial suspension height
- Suspension travel
- Adjustable range



# Team Integration

Require: Design detail of the electrical truck

Feedback/outcome: reasonable control system during operation

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# Sustainability

## SDG 7: Affordable and Clean Energy

High-Efficiency Energy Utilization

Emission Reduction and Eco-Friendliness

## SDG 9: Industry, Innovation and Infrastructure

Advanced Vehicle Technology Innovation

Infrastructure and Ecosystem Development

## SDG 13: Climate Action

Reducing the Carbon Footprint of Racing

Promoting Sustainable Values

# SWOT Analysis

### Weaknesses

High System Complexity,
R&D and Cost Challenges,
Extreme Condition Durability

### Threats

Intensifying Competition,
Hardware Dependency

SWOT

### Strengths

Intelligent Suspension Control, Enhanced Safety,
Integration with Advanced Chassis Tech

### Opportunities

Growing EV Off-Road Market,
Emerging Smart Chassis Trends,
Dakar Rally Electrification,
Sustainability Alignment

# Future Plan

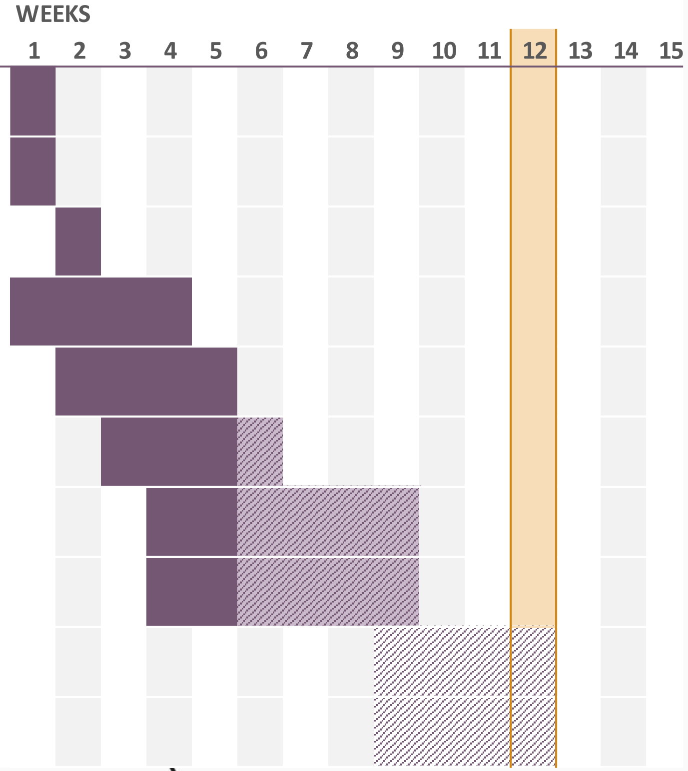
Things haven't finish:

- Model building based on Python & Simulink
- Model integration and optimization
- Report

**Project Deadline:** 12

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Meet Group and Rank Challenges | 1 | 1 | 1 | 1 | 100% |
| Generate Ideas | 1 | 1 | 1 | 1 | 100% |
| Discuss Internal Hurdles | 2 | 1 | 2 | 1 | 100% |
| Background Research | 1 | 4 | 1 | 4 | 100% |
| Requirements Exploration | 2 | 4 | 2 | 4 | 100% |
| Concept Design | 3 | 4 | 3 | 4 | 75% |
| Model Building based on Python | 4 | 6 | 4 | 6 | 40% |
| Model Building based on Simulink | 4 | 6 | 4 | 6 | 40% |
| Model Integration and Optimization | 9 | 4 | | | |
| Report | 9 | 4 | | | |



# Q&A

# Multi-Purpose Manufacturing and Testing Facility

BEng Civil 1

# The Group

Riley Male (Group Leader)

Benedict Lee

Faisal Raja

Mohammed Shariff

# Project Scope

## Project Objectives

- Produce a Facility capable of Designing Modifying and Testing specialised vehicles

## Deliverables

- Structural Design – Portal Frame and Connections
- Geotechnical Design – Foundation

## Constraints

- Climate Conditions – Weather
- Location Data – Transport link, Ground Condition and Flooding
- Sustainable Design
- Efficient Workflow within Building
- Sufficient Health Safety and Welfare – Living Amenities as well as ventilation a

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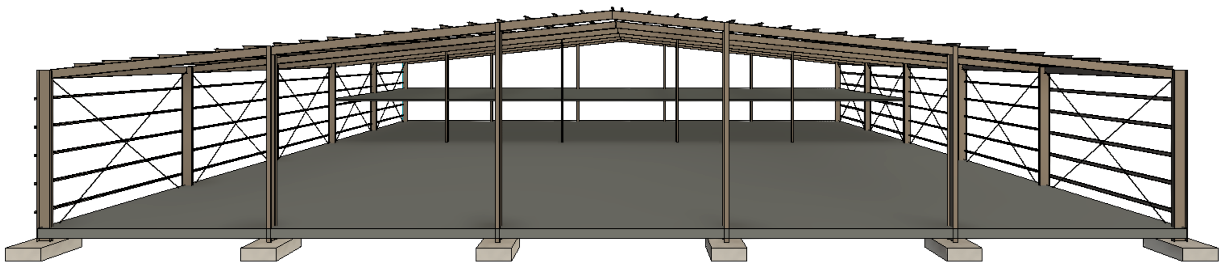
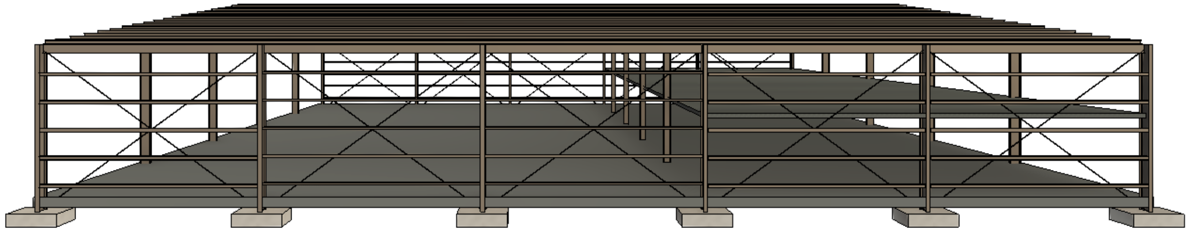
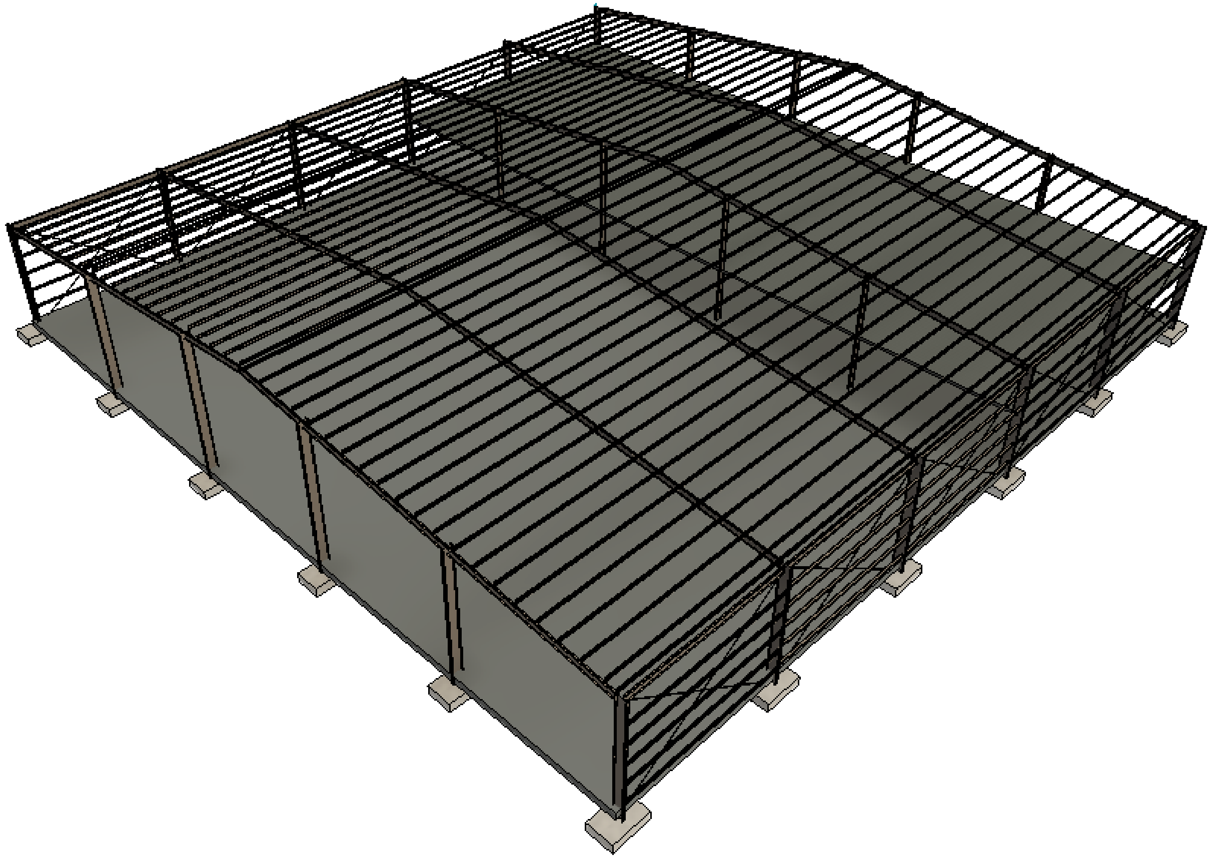
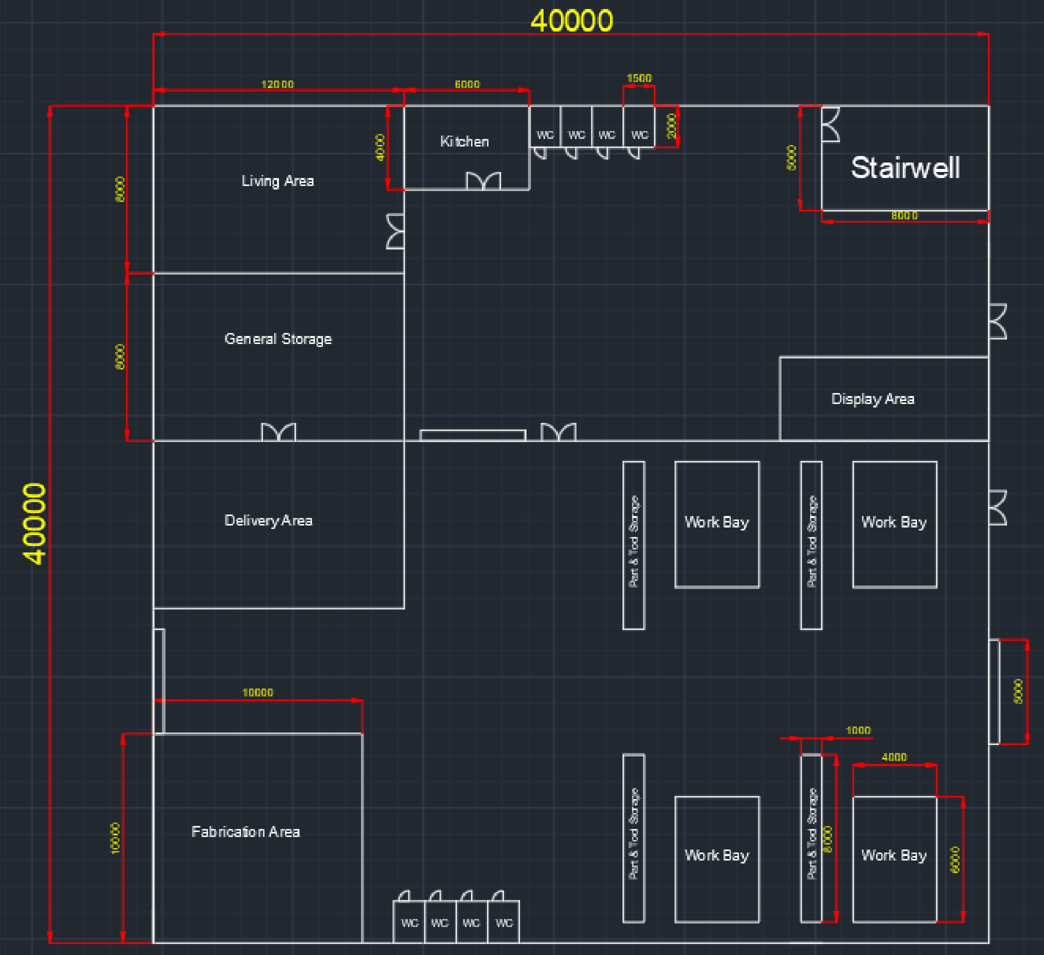
# Concept Design

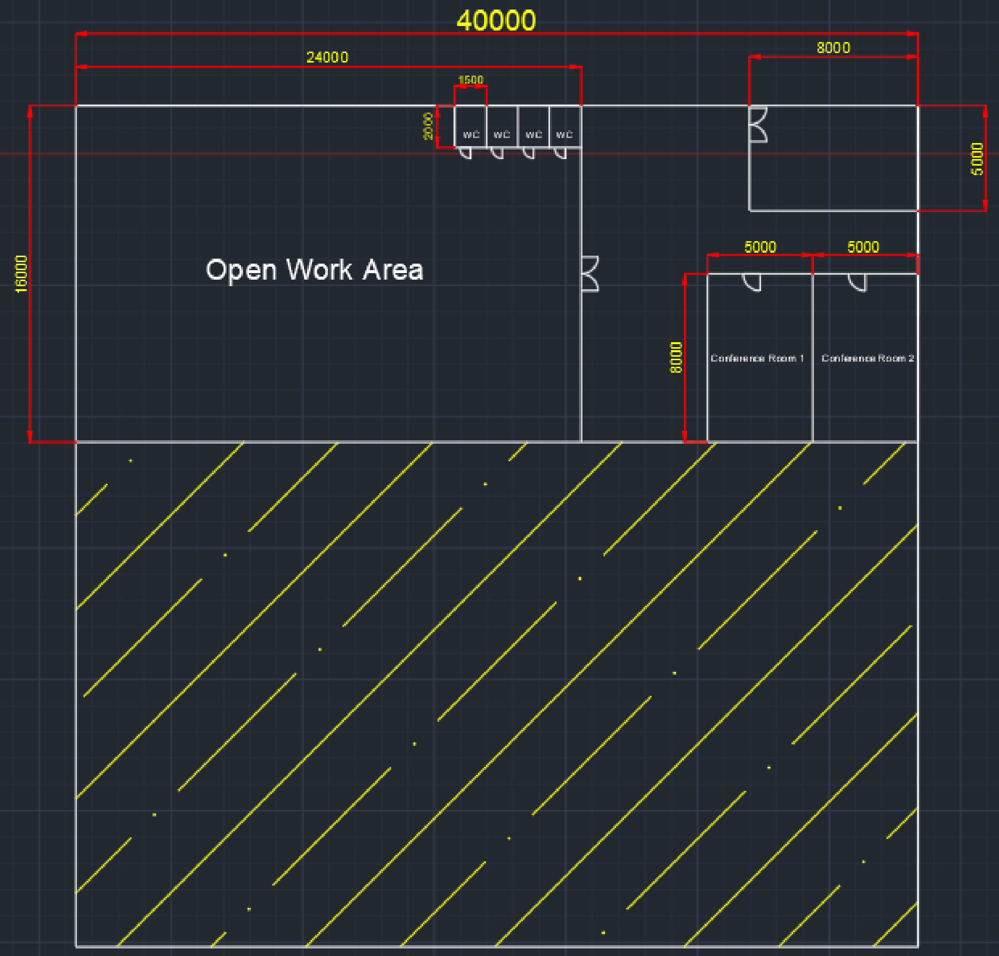









First Storey




Second Storey

# Site Location

**1**

**Market Demand**

Proximity to key markets with higher demand

**2**

**Labour Costs**

Cheaper labour may increase profits

**3**

**Access to Suppliers**

The ability to transport components is crucial

**4**

**Infrastructure and Technology**

Adequate infrastructure and technology will ensure operability

**5**

**Risks**

Account for any ground risks, flood risks etc.

**6**

**Economic Stability**

A stable economy will reduce any risks regarding investment

**7**

**Environmental Considerations**

Locations that prioritise sustainable practices are preferred

# Site Location

**Our facility will be in the UK due to:**

- An established market demand, particularly regarding rally racing
- UK boasts a well-developed transport network
- Abundance of automotive suppliers within the UK
- Economic and political stability reducing risks regarding investment
- Regulations regarding sustainable development align with our ethics

**Tongwell Industrial Estate:**

- Home to major global automotive companies (e.g Mercedes-Benz)
- Well-maintained and secure industrial estate
- Convenient motorway access via J14 of M1
- Provides car parking facilities for employees

**Potential Issues:**

- Expenses regarding labour, energy and raw materials may induce higher costs
- Tongwell is a town which is prone to flooding, and lies just outside flood zones identified by UK government
- Possible delays to supply chains due to ongoing Brexit negotiations

# Site Location

# Flood Risk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# Health, Safety and Welfare

- Training
- PPE
- Risk Assessment
- Workplace Inspections
- Ventilation
- Lighting
- Emergency Systems
- Welfare Facilites

# Sustainable Development Goals



# Sustainability

- Wind and Solar Integration
- Sustainable Materials
- Passive Design Elements

# SWOT analysis

## Strengths

- Uk has a strong Industry reputation in motorsports and automotive
- Strategic location with skilled workers and local suppliers
- Integration of Sustainable Resources in building as well as Vehicle Design

## Weaknesses

- High Initial Investment
- Complex Supply Chain logistics
- Niche Client Base, could limit Revenue
- Can be Difficult to  ensure compliance with all relevant regulations

SWOT

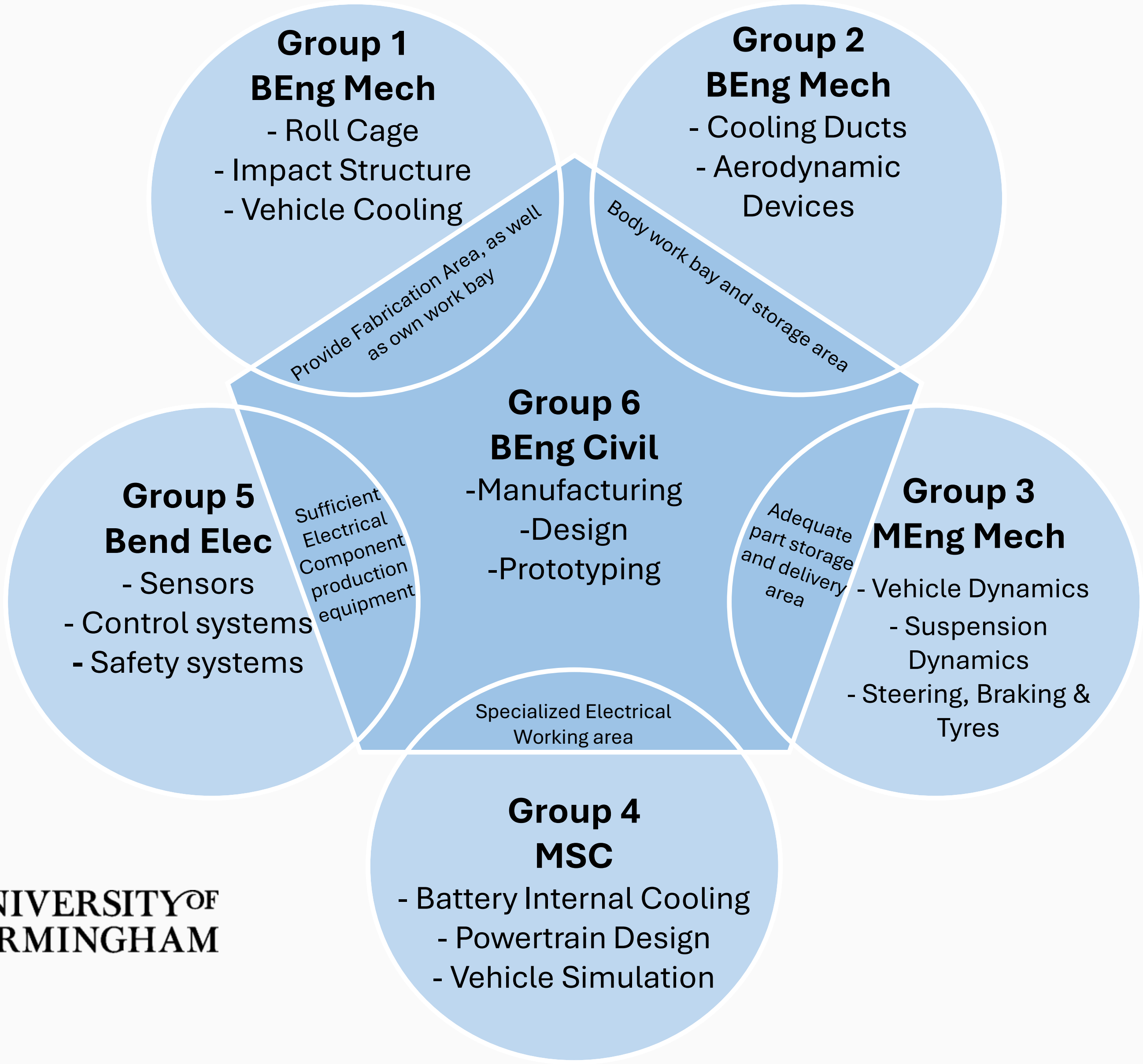
## Opportunities

- Increase global interest in motorsports
- Develop Cutting edge technologies
- Opportunities for EV development in Off-road motorsports
- Diversification into other industries such as military, possible government grants

## Threats

- Supply Chain Disruptions
- Economic Uncertainties with Fluctuation within the UK
- Regular change within Emissions regulation which may limit cliental
- Heavy reliance on a few major clients

# Team Integration



# Future Plans

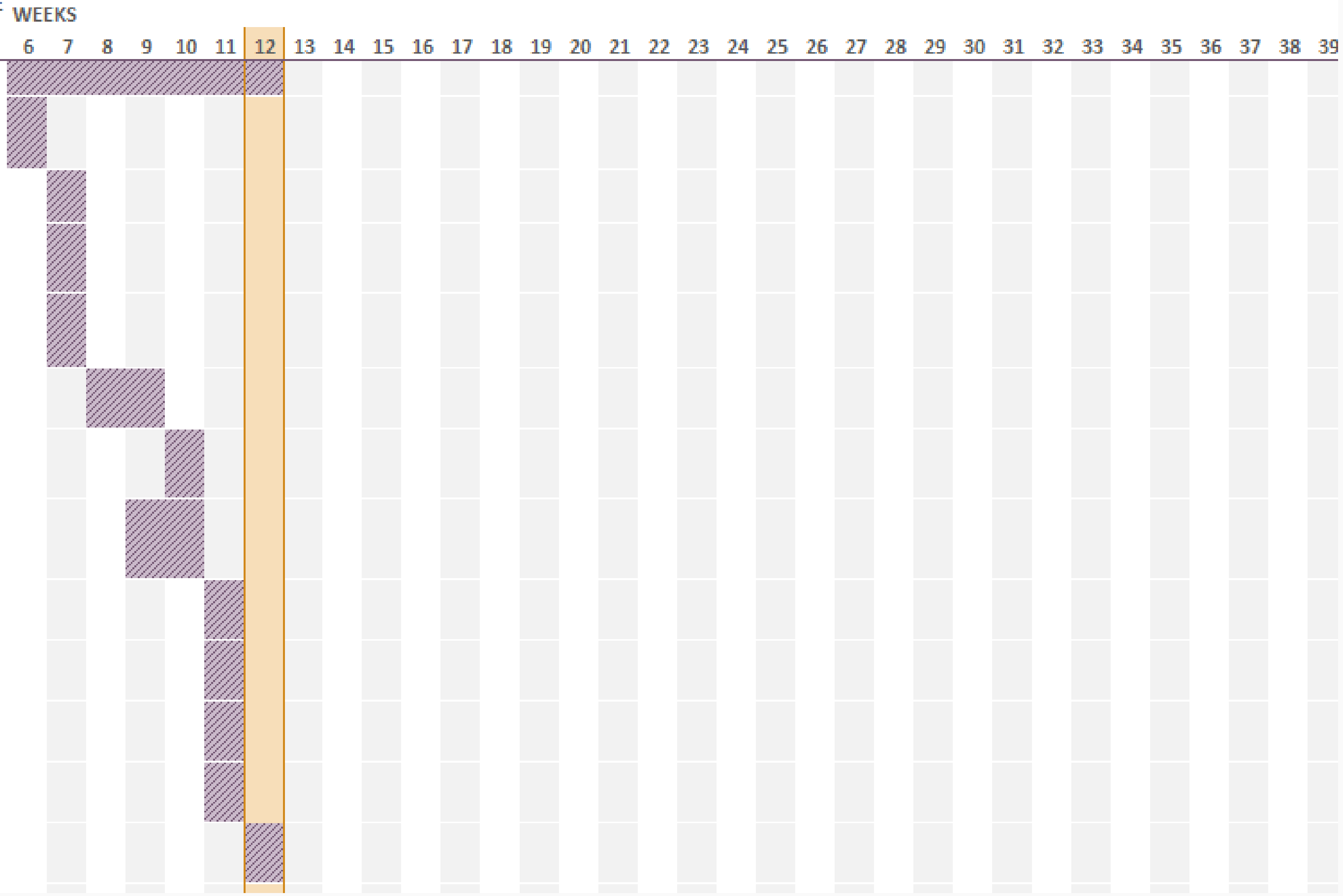
- **Final Design** – Finalise design of facility and produce Revit model.
- **Structural Design** – Analysis of beams and connections
- **Geotechnical Design** – Analysis of foundations
- **Design Loads** – Determine design loads acting on facility
- **Material Selection** – Decide upon building materials
- **Life Cycle Analysis** – Consider carbon footprint of facility
- **Health and Safety** – Consider factors to improve H&S
- **Business Plan** – Produce BoQ and consider financial aspect of project
- **Report** – Use points discussed to produce a detailed report

# Gantt Chart

Project Deadline: 12

Plan Duration | Actual Start | % Complete | Actual (beyond plan) | % Complete (beyond plan)

| ACTIVITY | PLAN START | PLAN DURATION | ACTUAL START | ACTUAL DURATION | PERCENT COMPLETE |
|---|---|---|---|---|---|
| Produce Final Report | 6 | 7 | 6 | 7 | |
| Finalise Concept Design | 6 | 1 | 6 | 1 | |
| Complete Introduction | 7 | 1 | 7 | 1 | |
| Complete Design Load and Actions | 7 | 1 | 7 | 1 | |
| Determine Initial Beam And column Size | 7 | 1 | 7 | 1 | |
| Carry out full structural analysis in skyciv | 8 | 2 | 8 | 2 | |
| Carry out strucutral design of connections | 10 | 1 | 10 | 1 | |
| Carry out Geotecnical analysis of foundation | 9 | 2 | 9 | 2 | |
| Complete Sustainability Section of Report | 11 | 1 | 11 | 1 | |
| Justify Material selection using Granta Edupack | 11 | 1 | 11 | 1 | |
| Complete LCA | 11 | 1 | 11 | 1 | |
| Complete Health, Safety and Welfare | 11 | 1 | 11 | 1 | |
| Finalise and Submit on time | 12 | 1 | 12 | 1 | |



# Q&A

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