PRAVEGA RACING

ERGONOMICS

FORMULA BHARAT 2021

CAR #254, VIT VELLORE

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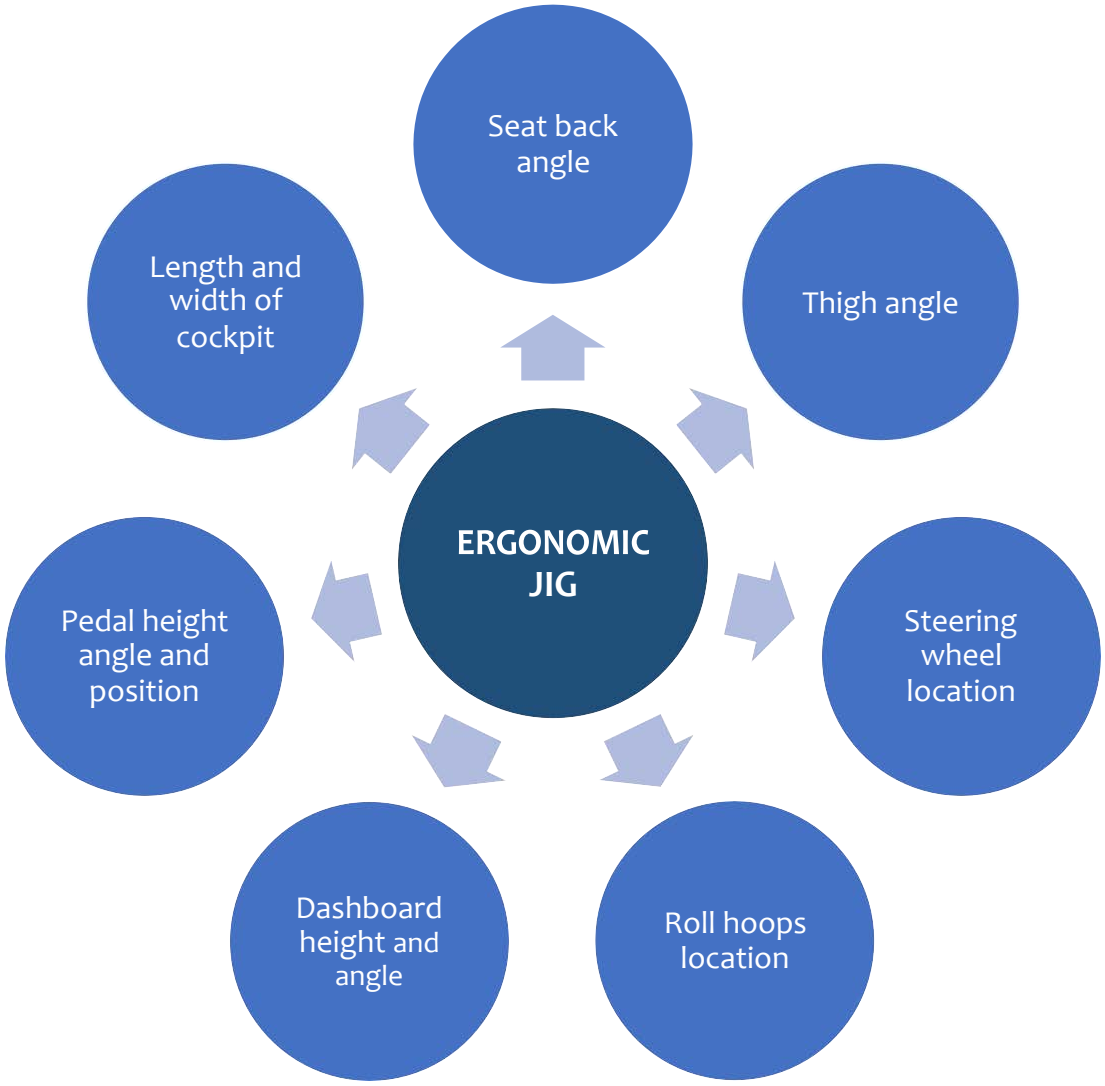
Overall Design Concept

To design and fabricate a reliable and tunable car with enhanced drivability

Department Design Concept

To design a car which provides optimum comfort and assist the driver to achieve its peak performance

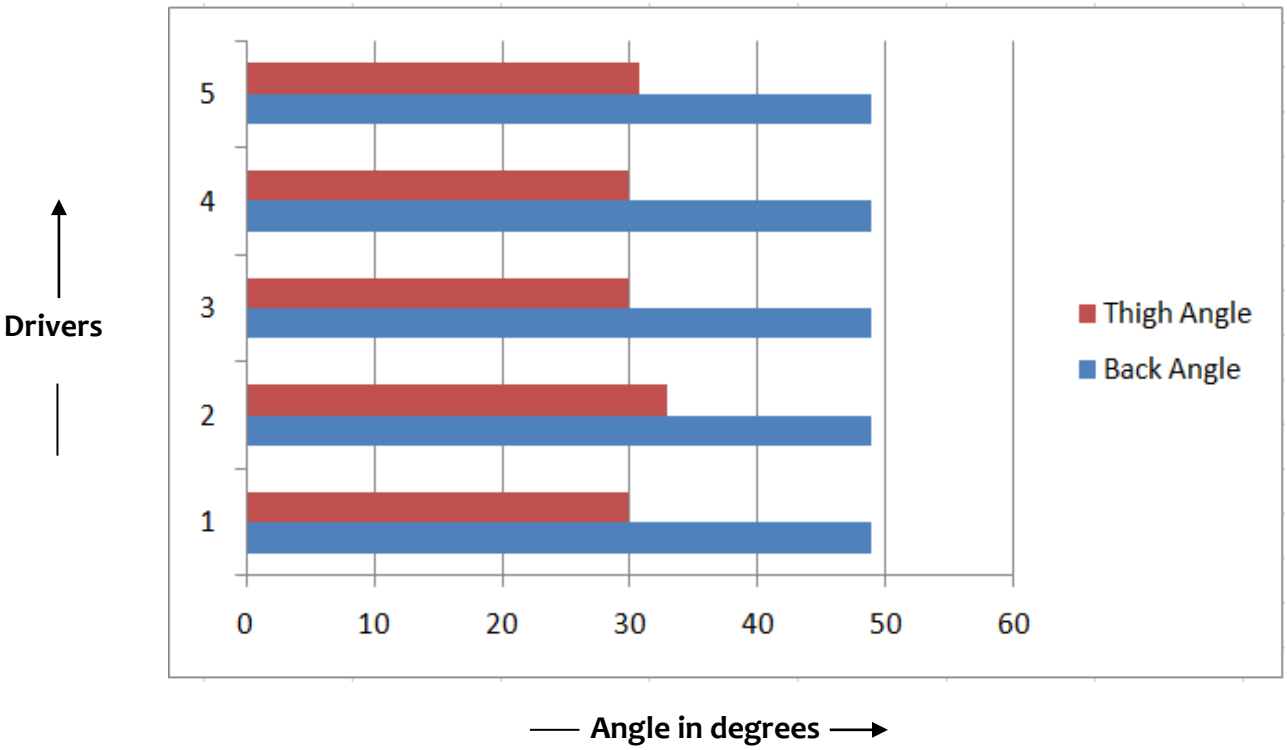
Ergonomic Parameters



ERGONOMIC JIG

- Adjustable driver jig to incorporate data for all drivers for cockpit design
- Stable support using mild steel tubes ensured correct data collection.
- Stable wooden support ensured correct seat, back ,thigh angles and pedal position.

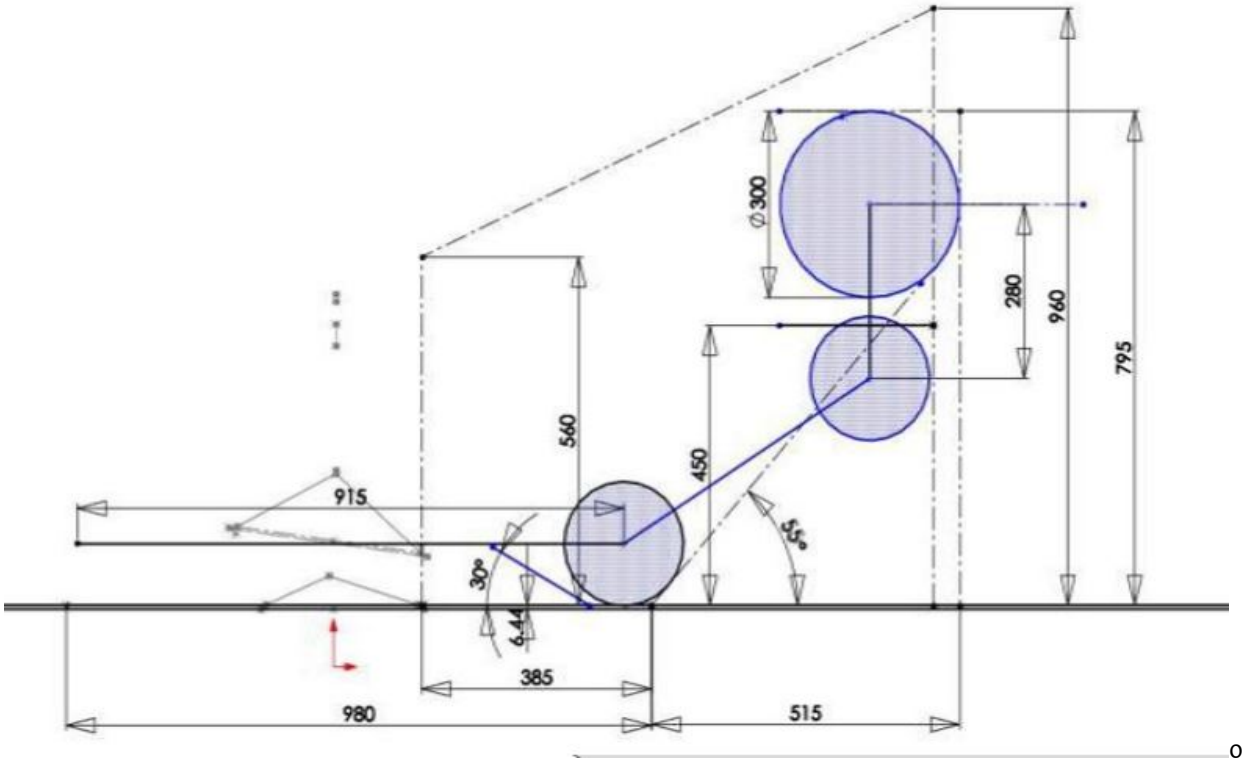
Driver data collected using ergonomic jig



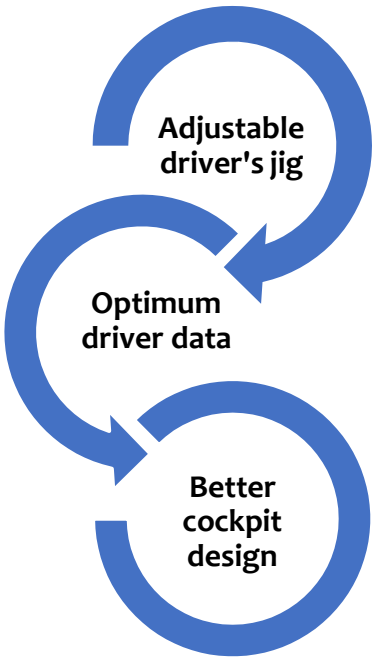
Back and thigh angle

Parameters	Driver 1	Driver 2	Driver 3	Driver 4
Back Angle (°)	55	55	55	55
Thigh Angle (°)	30.6	29.5	30.5	27.8
Distance between hip point and main hoop **(mm)**	395	395	395	415
Distance between hip point and front hoop **(mm)**	420	420	407	385
Distance between hip point and pedal **(mm)**	1013	1015	980	958
Front Hoop Height (mm)	560	560	560	560
Main Hoop Height (mm)	1095	1100	1095	1100
Shoulder Height **(mm)**	535	545	530	534
Foot Height **(mm)**	21	25	21	20
Front Hoop width **(mm)**	370	370	390	355
Main hoop width **(mm)**	420	435	420	400
Shoulder width **(mm)**	490	485	480	440
Elbow width **(mm)**	500	490	530	500
Knee width **(mm)**	370	370	390	355
Lap width **(mm)**	435	450	445	410
Steering Shaft Height (mm)	480	485	495	495

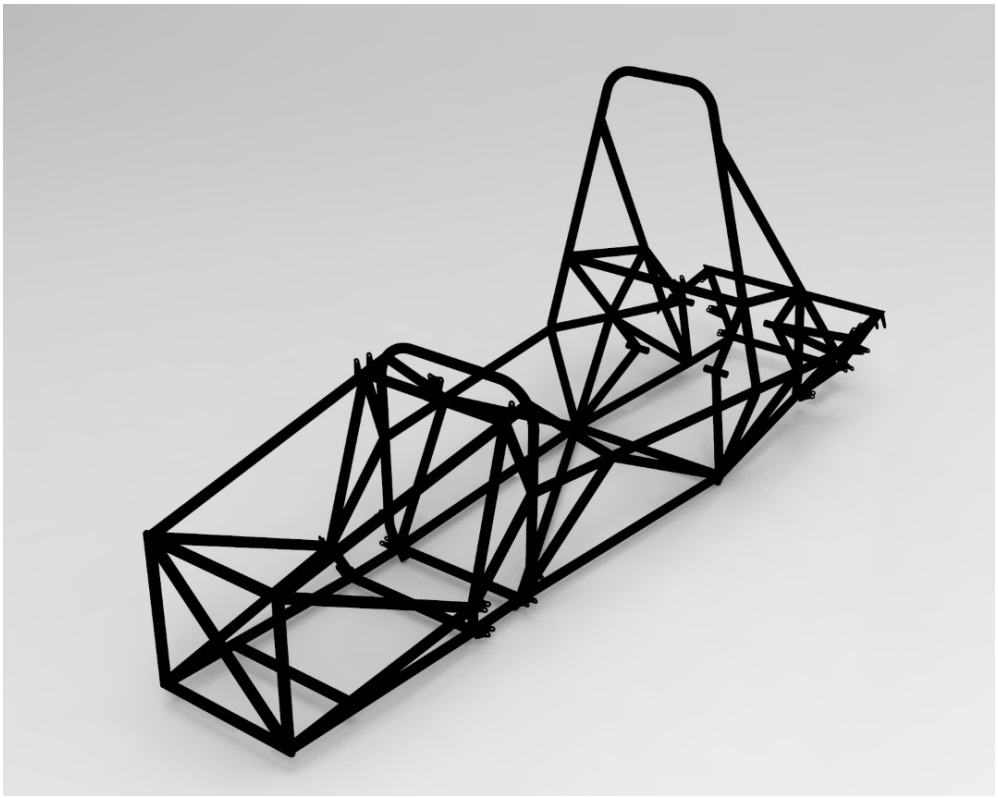
Ergonomic Jig Data



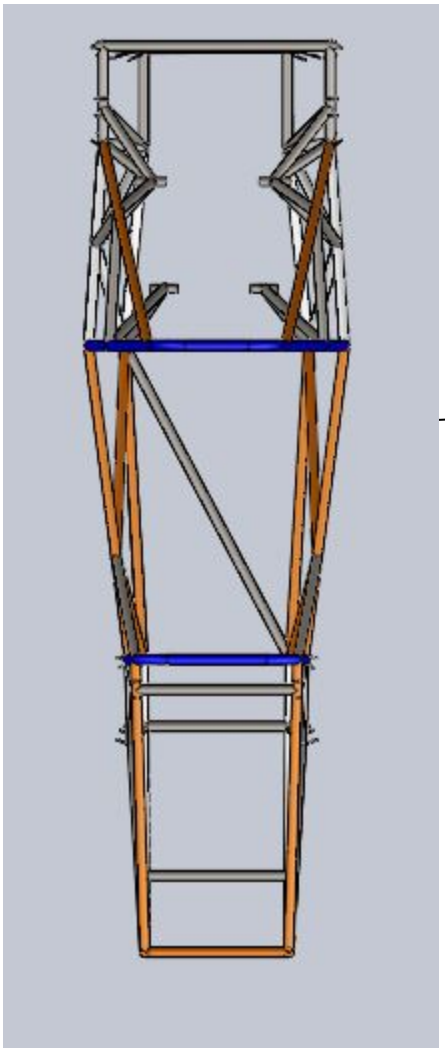
Optimum driver data for chassis design



Cockpit Parameters

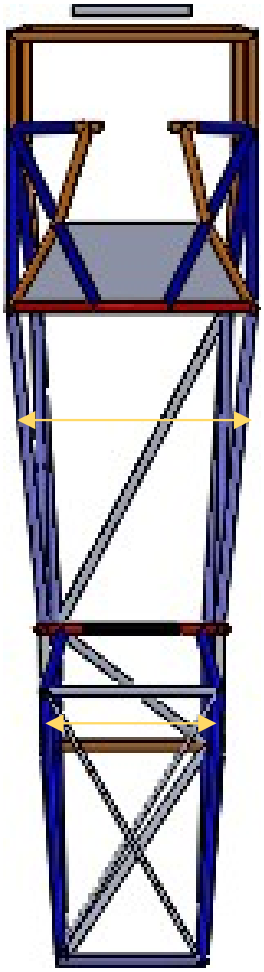


DRIVING ANGLE	• BACK ANGLE - 55 ⁰ (reclined driving) • THIGH ANGLE – 30 ⁰
ROLL HOOP HEIGHT	• MAIN HOOP - 1040mm • FRONT HOOP - 560mm
COCKPIT	• MAXIMUM LENGTH - 810mm • MAXIMUM WIDTH -520mm



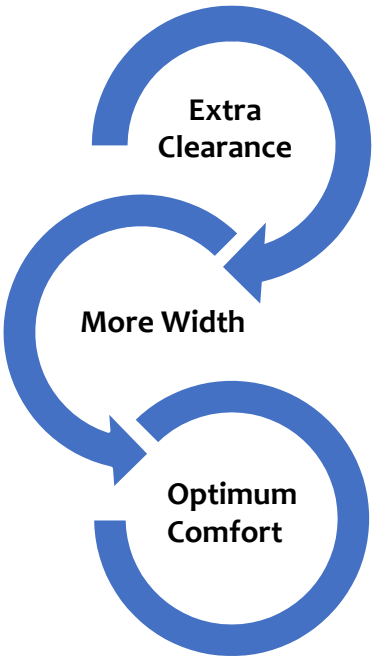
Current Car maximum width – 520mm

Previous car maximum width – 480mm

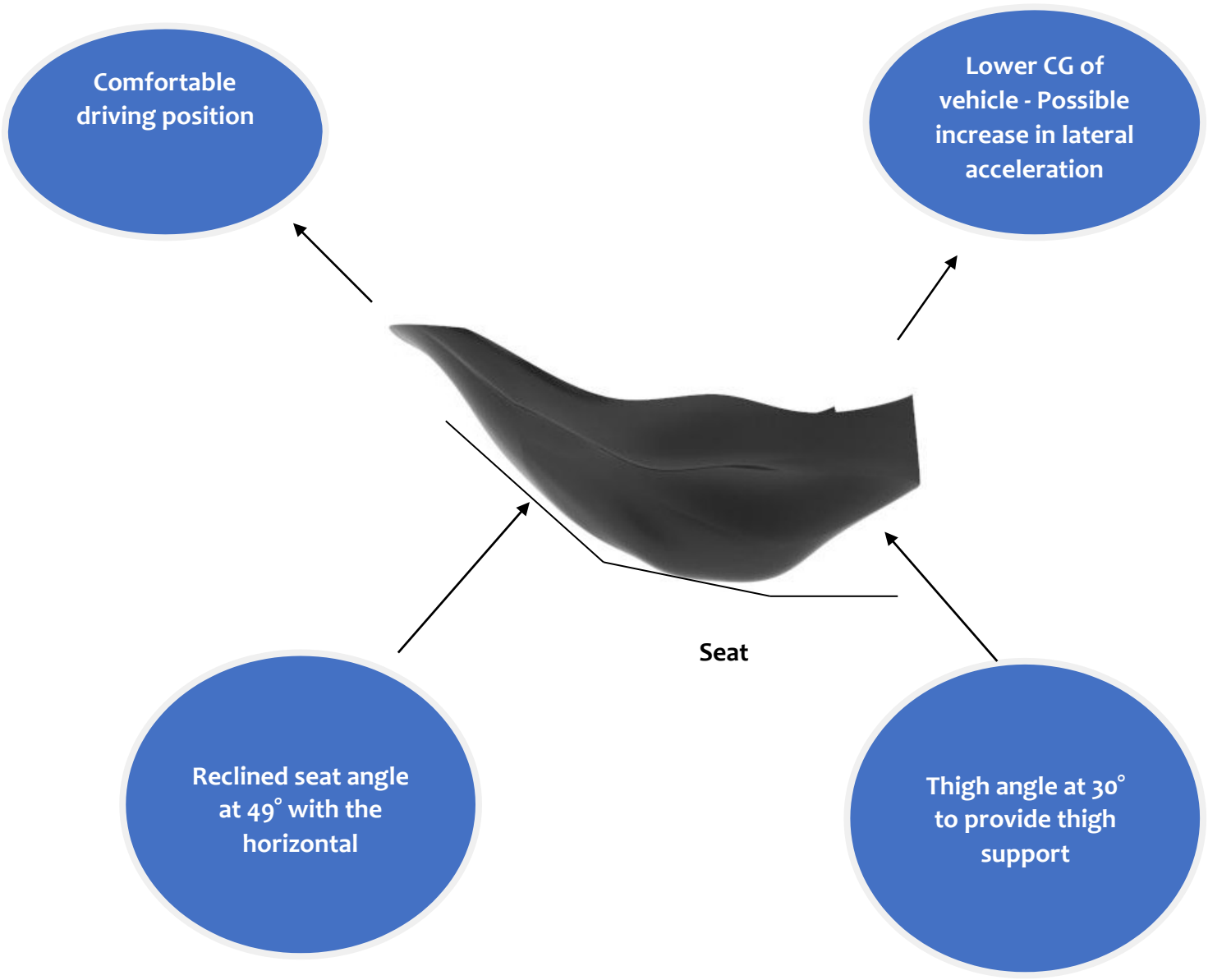


Current Car

Previous Car

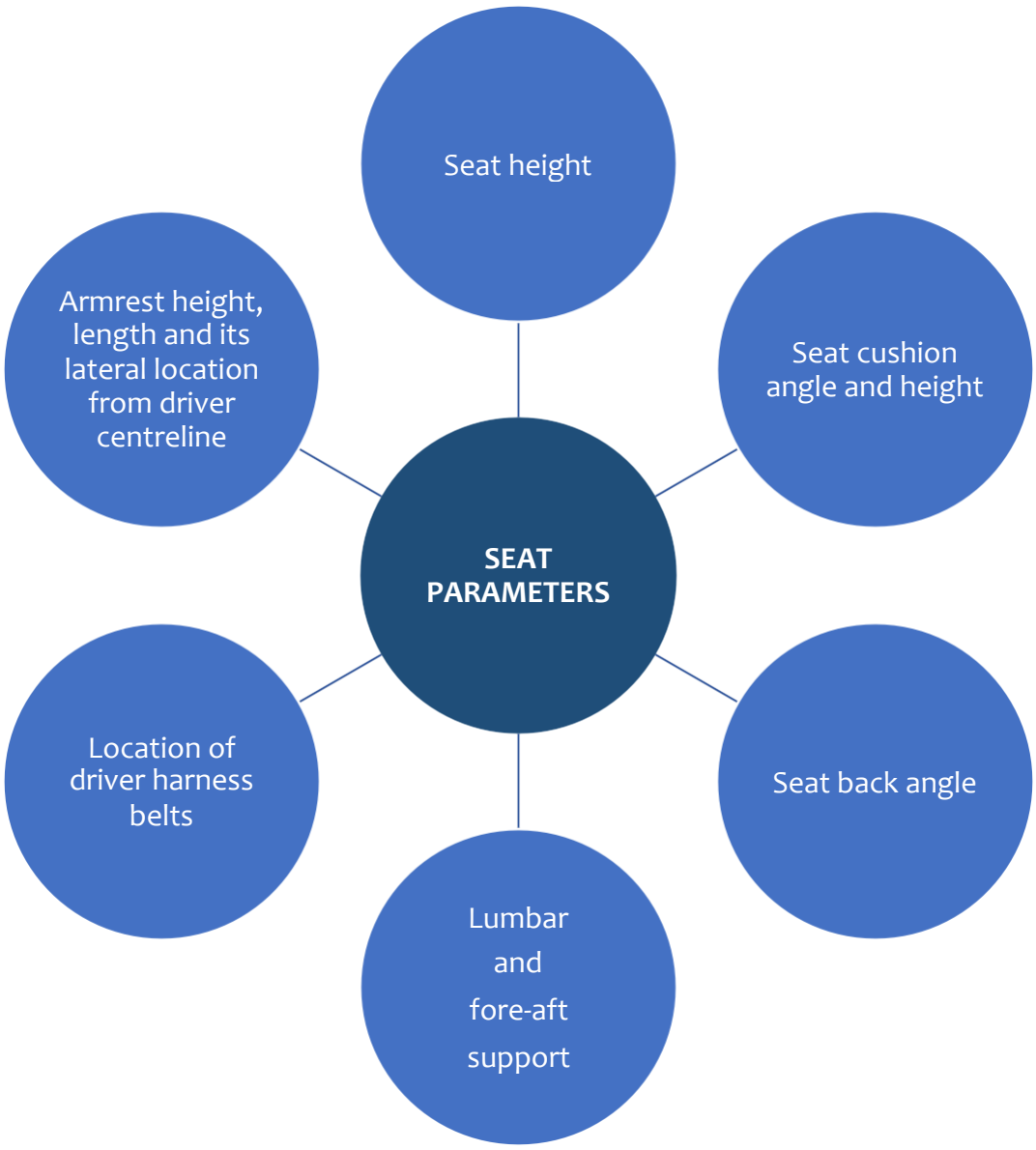


Seat design


Comfortable driving position
Lower CG of vehicle - Possible increase in lateral acceleration
Seat
Reclined seat angle at 49° with the horizontal
Thigh angle at 30° to provide thigh support

Seat design parameters

To accommodate all the drivers at their preferred driving position cockpit parameters, ergonomics parameters and anthropometric data were referred to decide the following seat parameters.

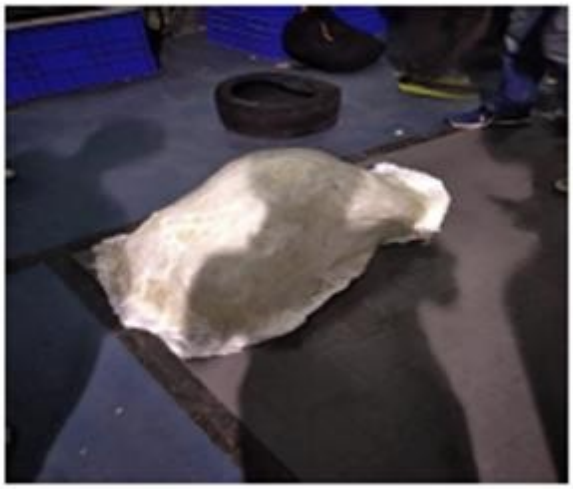


MANUFACTURING:

- For carbon fibre seat, mould was made by taking driver impression on the vacuum bag filled with two-part foam with driver seated in proper driving position in accordance with adjustments of back and thigh angle.

Seat mould (2 part foam)

- Then the mould was shaped according to the seating posture to give support to vertebral disk in lumbar region and better elbow room. The two-part foam mould was then polished and sanded for glass fibre layup to make positive mould for carbon fibre layup for seat.



Glass fibre mould

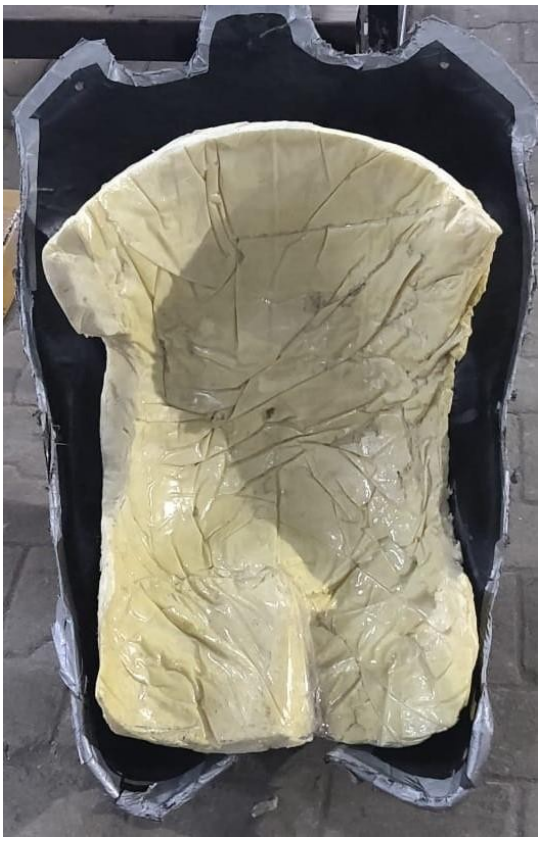
- Then on the glass fibre mould epoxy coat was done and sanding was done to smoothen and polish it for carbon fibre layup.

Seat just after demoulding

Finished Seat

Seat Inserts

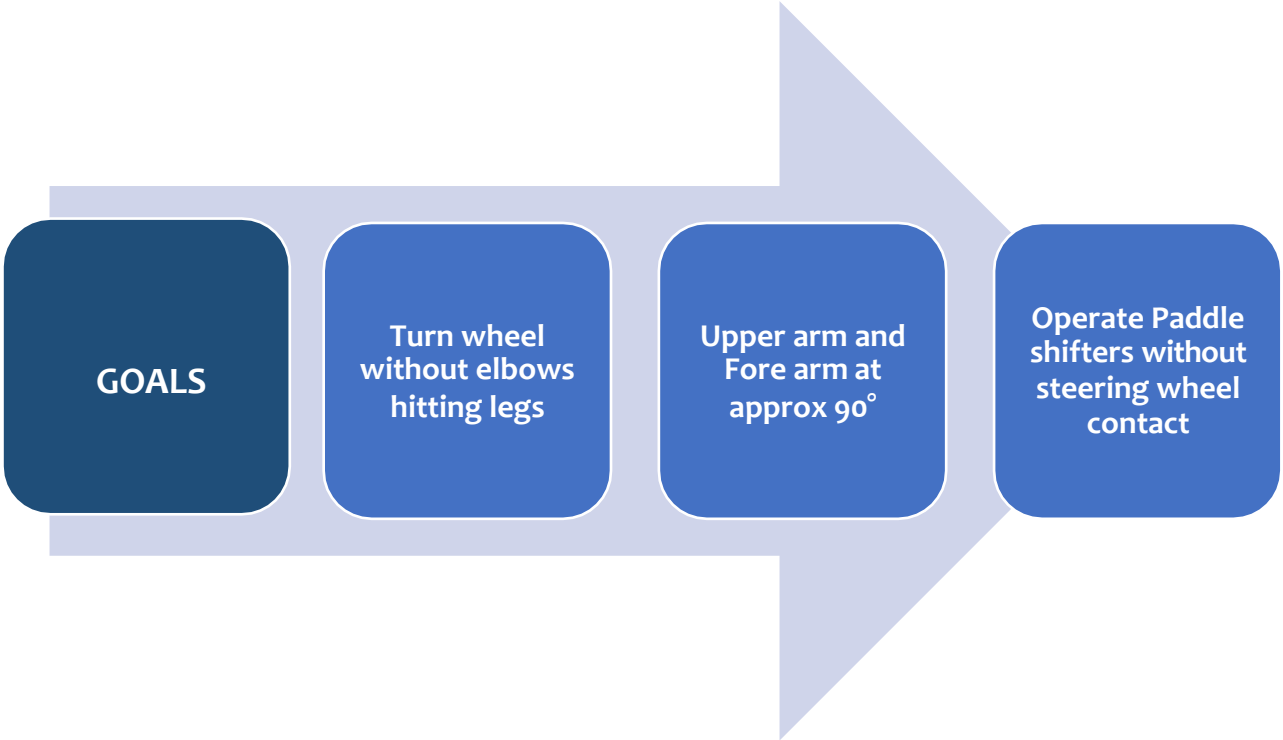
- Seat Inserts using polyurethane foam were manufactured by mixing isocyanate and polyol resin in proportion 1:1 by volume to accommodate all the drivers.



Seat Insert

- Provide raised height
- Accommodate drivers of different statures
- Provide customized lumbar support

Steering wheel Design:-



Acquiring Information available

Processing the sensed information to understand the situation

Selecting what to do

Executing the response

Manufacturing:

1. Steering has been made in three parts.

2. The steering wheel base plate has been lasercut.

3. The electronic panel and the grips have been 3-D printed using FDM process and ABS, TPU material respectively.

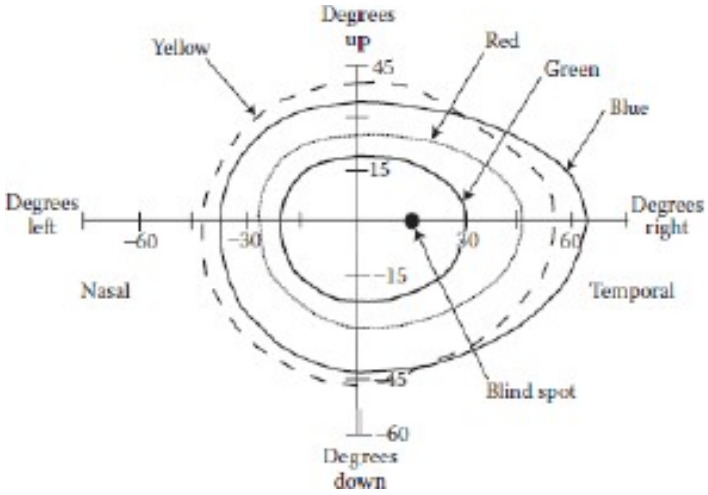
4. Electrical PCB, LCD display and shifter lights have been installed on it for driver acquaintance.

Steering wheel baseplate

Electronic panel

TPU grips

- The cone receptors are specialized in detecting red, green and blue colors, so we haveused these colors as light colors. Red color persists for maximum time in our eyes. Blue color has the largest peripheral region.



Steering wheel mounted on car

Steering Wheel Comparison Chart

Previous car

- Absence of 3D LCD display for driver assistance
- Packaging of electrical components was the major issue
- Absence of cushion compromised driver's comfort

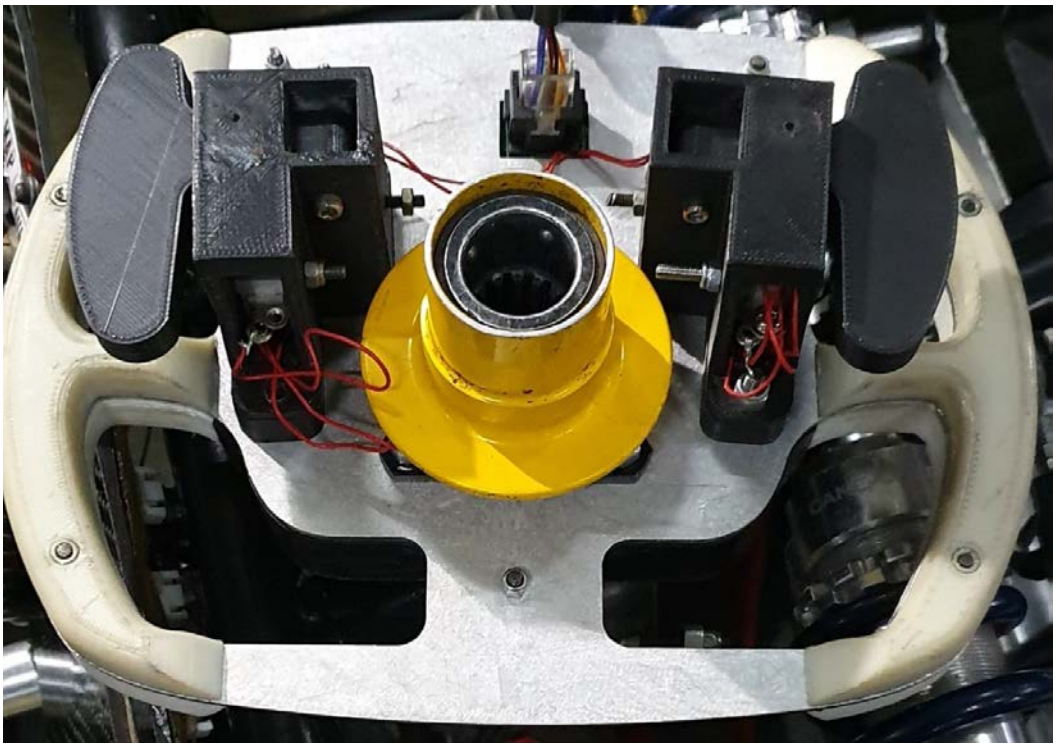
Current car

- LCD display for better drivability
- Incorporating 3D printed enclosure to accomodate electrical components
- 3D printed grips made of TPU material for driver comfort

PADDLE SHIFTERS

- Paddle shifters were designed to reduce driver effort and improve shifting time.
- Shifters were designed with driver inputs on steering wheel and the position of shifters were made so as to improve ease of shifting even while cornering.

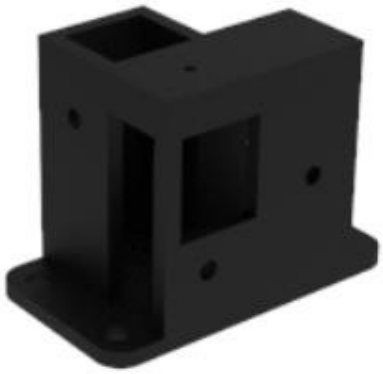
Customised Paddle shifter design



Magnetic actuated paddle shifters mounted on Steering wheel

- The paddle shifters consists of three parts that are 3D printed. Two neodymium magnets were incorporated
    - Paddle was made to pivot about a point and two magnets were pasted on upper and lower parts of paddle and housing respectively

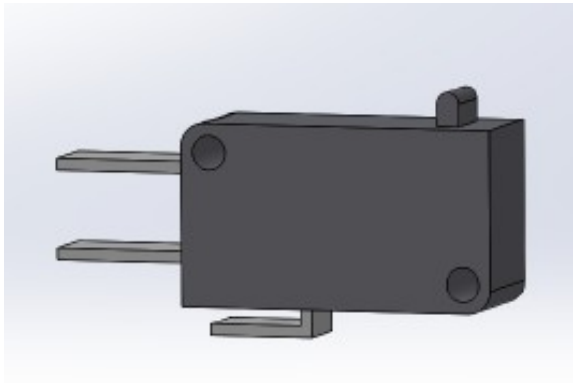
Components



Paddle Housing

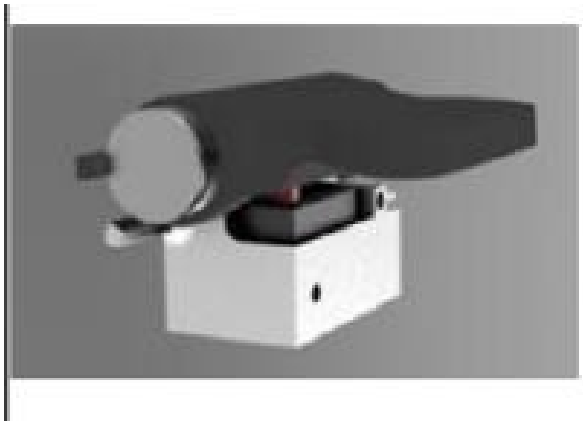
Neodymium Magnets

Paddle



Shifting Switch

Paddle shifters Comparison Chart



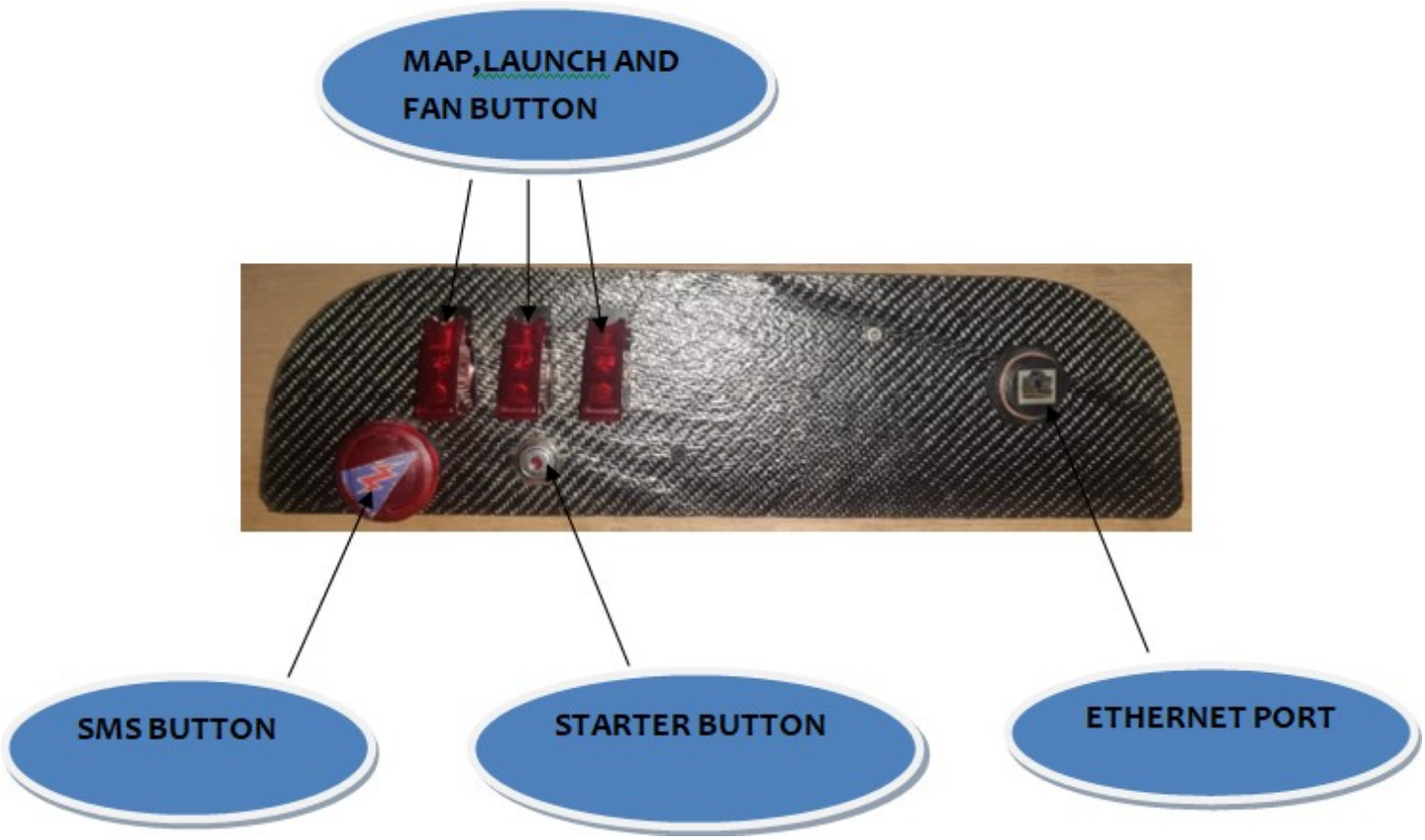
Previous design

- Retracting mechanism using springs
- Torsional spring was under tension all the times therefore had limited life and had to be replaced regularly.
- Fixing the spring inside to pivot the paddle was a big issue and retracting was not efficient.

Current design

- Retracting mechanism using magnets
- Usage of magnets resulted in increased life cycle of the part
- Easy fixing of the system since magnets are used and resulted in better retracting.

Dashboard

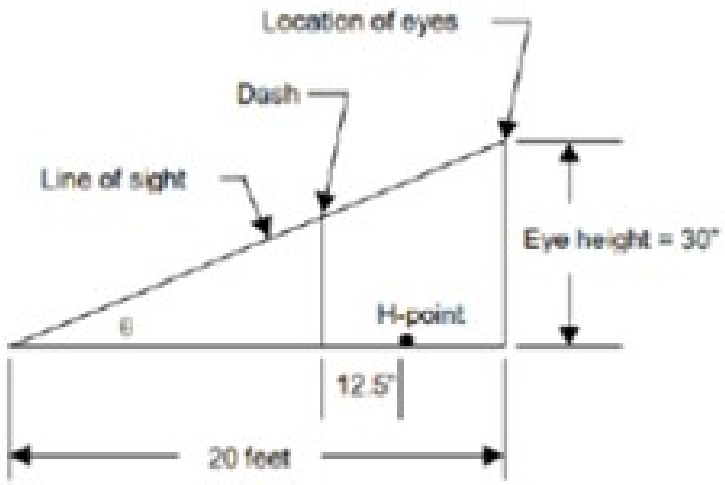


Dashboard Design

Dashboard Location

Located such that driver's visibility is 20 feet ahead

Height decided such that sufficient clearance from floor for Egress

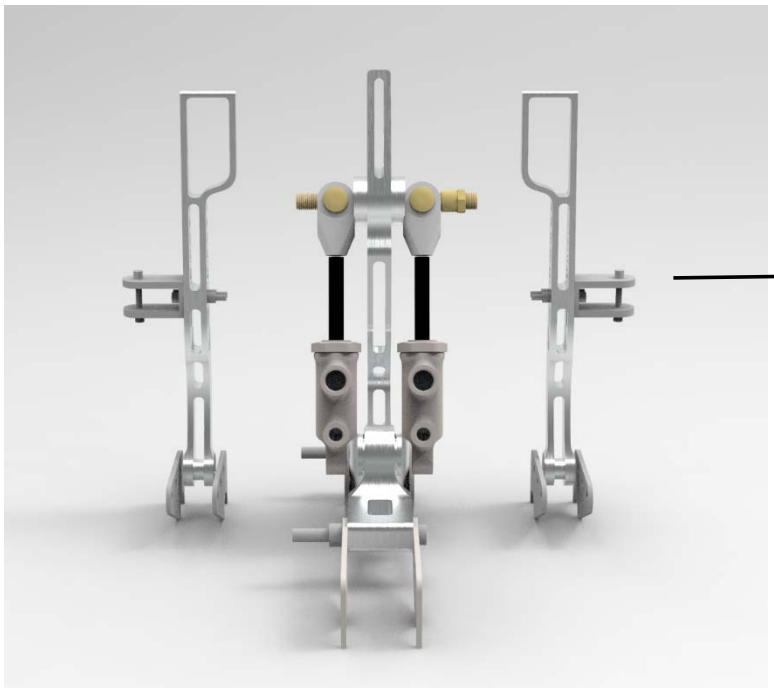


Dashboard Height

27.08 inches

Calculation of Dashboard Height

Pedal Assembly Design



290 mm height of pedal

Adjustability of 50mm , 25mm fore and 25mm aft

5 ° angle from vertical to transmit force perpendicularly

GOALS

Appropriate height for comfort of drivers

Driver can reach and actuate the pedals

Adjustable pedal assembly to incorporate all drivers

Design and assembly was made robust for fast changing

All forces from pedals dissipating into chassis

Pedals mounted to the chassis

Appendix:-

A) DRIVER ANTHROPOMETRIC DATA

A-1. 95th Percentile Male Data

Dimension	Length (in)
Head Circumference	23.5
Head Width	6.1
Head Length	8.0
Erect Sitting Height	36.6
Shoulder to Elbow Length	14.0
Elbow to Finger Tip Length	18.8
Buttock to Knee Length	24.9
Knee to Floor Height	23.4
Total Weight (lb)	223.4

(First Technology Safety Systems)

A-2. 5th Percentile Female Data

Dimension	Length (in)
Head Circumference	21.4
Head Width	5.6
Head Length	7.2
Erect Sitting Height	31.1
Shoulder to Elbow Length	11.6
Elbow to Finger Tip Length	15.8
Buttock to Knee Length	20.5
Knee to Floor Height	18.0
Total Weight (lb)	110.2

B) Cost of manufacturing seat

Material	Unit cost (in euros)	Total Cost (in euros)
Carbon Fibre	16.15 per m^2	44.85
Epoxy+Hardener	E-5.83 per litre, H-8.52 per litre	76.7
Glass Fibre	1.97 per m^2	38.57
Consumables		19.74
Two part Foam	6.73 per litre	20.18
	Total	200.04

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