Orion Racing India, the formula student of K.J.Somaiya College of Engineering, Mumbai is a team of 40 Mechanical and 20 Electronics Engineering student.

Problem Definition –
Construct a vehicle For –

Type - Open Wheel Race Car for Weekend Race Enthusiast
Market Slot – Between GoKart and Formula 1000 Car costing less than 25000USD

After extensive study of the competition and competitors a list of parameters were shortlisted around which the vehicle concept for the 2010 car is required to fit the above Market.

Parameters considered for Concept building

- Rules compliant
- Weight Audit 2009 car
- Competition Perspective
- Analysis of 2009 car goals and achievements
- Safety
- Ergonomics
- Serviceability and maintenance
- Tunability
- Cost effective
- Ease of Manufacturing
- Drivability

Working methods –

To enable effective construction of the vehicle we divided our team into three main systems and further their subsystems.

Structural
Powertrain
Electronics

Each and every system followed the below mentioned outline

Concept, Preliminary Calculations and feasibility
Software Validation
Physical Validation

The details of which are given system vise

<u>2010 Concept-</u>
After studying the various parameters we finalized the entire concept.

"Beauty lies in Simplicity, but a Dash of complexity with reliability adds spice"

The main goal was to create a neutral, agile, low weight, cost-effective car to appeal to a majority.
System Specific goals were classified as mentioned below.
Weight was reduced by using light weight components.

An overall weight reduction of 70 kgs was achieved over the last year.

Structural –
Goal – to provide for a versatile platform for application of Vehicle dynamic systems

Chassis –
Spaceframe Construction
Material –AISI 1020
Weight - 28 kg

- Main goal was to design by keeping suspension design paramount/

- Compromise between Torsional Stiffness and Weight

Suspension and Steering System

This year a major emphasis was given to Vehicle Dynamics. The suspension is designed for tight circuit with roll gradient of 1 deg roll/g.

This was achieved by first using basic vehicle dynamics formulae, Tire Data and trivial values of suspension parameters and then by simulation in software, namely, Susprog 3D, IPG Kinematics and IPG Carmaker. For example, the ARB stiffness was first calculated using trivial formulae and results obtained from Susprog 3D. The car was then simulated using IPG CarMaker. An optimum value was selected after 5 - 8 iterations. This procedure was also followed for Spring Stiffness and Damping co-efficient. We are planning to further validate our results by testing and Data Acquisition.(Ref Image 1,2)

Shims are used on the uprights in order to adjust the static camber angle. The front static camber has 2 settings -1.5 degrees and -3 degrees. Similarly, rear static camber has 2 settings 0 degrees and -1.5 degrees. For changing the Ackerman settings, we can change the Tie rod pick up bracket on the Uprights. 2 brackets were made, 0% Ackerman and Anti-Ackerman. These values were selected in accordance with the Tire Data.

The testing parameters are:

- ARB stiffness,
- Tire Pressure,
- Spring stiffness,
- Damping Co-efficient,
- Static Camber Angle,
- Steering Ackerman Angle
- Drive Ratio

The tuning will be done on the basis of the data obtained from the Sensors Data and the derived quantities such as Slip Angle, Slip Ratio, Yaw Moment, Roll Moment etc. This will be obtained using the capability of MATLAB and SIMULINK.

However, before any dynamic testing is conducted, we have computed the actual Centre of Gravity and the Moment of Inertia of the car physically using an inertia test rig created by the team.

Considerable amount of weight reduction was achieved. About 31Kgs of unsprung mass and 38Kgs of Sprung mass was reduced. The Centre of Gravity height was brought down by 20mm. An effort was made to distribute the weight across the car so that the weight distribution of 45-55 was achieved.

Brakes System

The brakes system this year had a goal to balance the braking torque appropriately in front and rear.

This was achieved by doing dynamic calculations. We also had a major goal of weight reduction this year. The major achievement was the CV integrated rear hub. A detailed FEA was conducted and Aluminium 2014-T6 was selected. The material was hard anodised. A Destructive Testing was conducted on the hard anodised material to find out the Micro hardness.

Powertrain

Goals – To provide a competitive yet reliable engine package
Target Power Band - 7000rpm to 10000 Rpm, Weight Reduction.

The system was further classified into

- Air Intake and Exhaust
- Motor Block and Engine Management System
- Cooling
- Lubrication
- Gearbox
- Drivetrain

Air- Intake and Exhaust -

Intake manifold and restrictor was Modeled on Solidworks and were imported on Ricardo for simulation using Ricardo's Wave mesher
(Ref image 3,4)
Both intake and exhaust manifolds incorporated kinetic energy conservation (KEC) rolling flow plenum chamber design. In this design, the kinetic energy of the flow is assumed to be conserved in a vortex about the axis of the plenum. A flow path where the inlet and outlet ducts are offset and placed tangentially to the plenum walls. KEC log style rolling flow design had successfully been applied to intake manifolds. [SAE Technical Paper Series (2006-01-0745),(2007-01-1562)]

Exhaust lengths were iterated (both primary and secondary in Ricardo wave to get a flat torque curve in several steps
Material – Carbon Fibre for intake and Stainless Steel for Exhaust
Weight – Air Intake – 630 gms.

Motor Block – We are using a 2003 Honda CBR 600 F4i It was selected due to its Power characteristics and High power to Weight Ratio.
Modifications –

- Weight Reduction of 536 gms
- compression ratio Increased to 13.5

Cooling-

Part Description: Single Aluminum radiator, 80Lpm electric water pump, Single 8” thermatic fan, rubber hoses, Aluminum header tank, three coolant temperature sensors.
Design Procedure: By using the VB software designed previously, by NTU method, verified by experimental data.
Cost: $120.
Weight: 10.3 kg (including water).
Maximum Current: 12.5 Amps compared to 17.5amps previous year
Data Acquisition system: Completed and tested integrated data acquisition system capable of taking 3 inputs from coolant temperature sensors and logging it on a memory card in the form of an excel sheet.
Testing: Sensor re-calibration test, single (2009) radiator test run, data logging under various conditions.

Gearbox- We designed and developed a shifter drum for changing the shift pattern from 1-N-2-3-4 to N-1-2-3 on Solidworks and using its Cam utility software.(Ref image 5)
A RPD model was Mfg and tested during Static Conditions.

Weight reduction – 340gms by removal of 6th gear.

Lubrication- dry sump system, two Stage pump Dailey Engineering. A need for the system arised due to oil starvation issues while testing of the 2009 car.

Drivetrain
We are using a Drexler differential system this system was chosen for its ease of tuning and light weight.

<u>Electronics</u>
Goal: To make a robust and reliable electronics system which aids vehicle analysis and quick troubleshooting.

Design Process: Proteus Simulation→Breadboard Testing→ Rough implementation→ Final implementation. This helped to identify many redundant circuits. All units except ECU designed and developed In-House. Maximum use of locally available resources. (Ref image 6,7)

Sensors: 2* 3-axis accelerometer, 4* wheel speed sensor, 4* shock travel sensor, 1* gyroscope, 1* steering angle sensor, 3* temperature sensors, 1* gear position sensors, 1* fuel level sensor.

DAQ: Built around PIC18F4680. Single unit capable of taking input from 20 sensors (ADC channels expanded using CD4052 analog MUX), parsing incoming data from on-board G.P.S receiver(CP3838) and storing in MMC/SD card. Capability to control radiator fan and coolant pump using relay and IRFZ48 respectively. Very economic compared to modules available in market.

Steering wheel with Color GLCD display: Built around ARM7 based LPC2388. Shift lights and other LEDs eliminated. Page wise display.

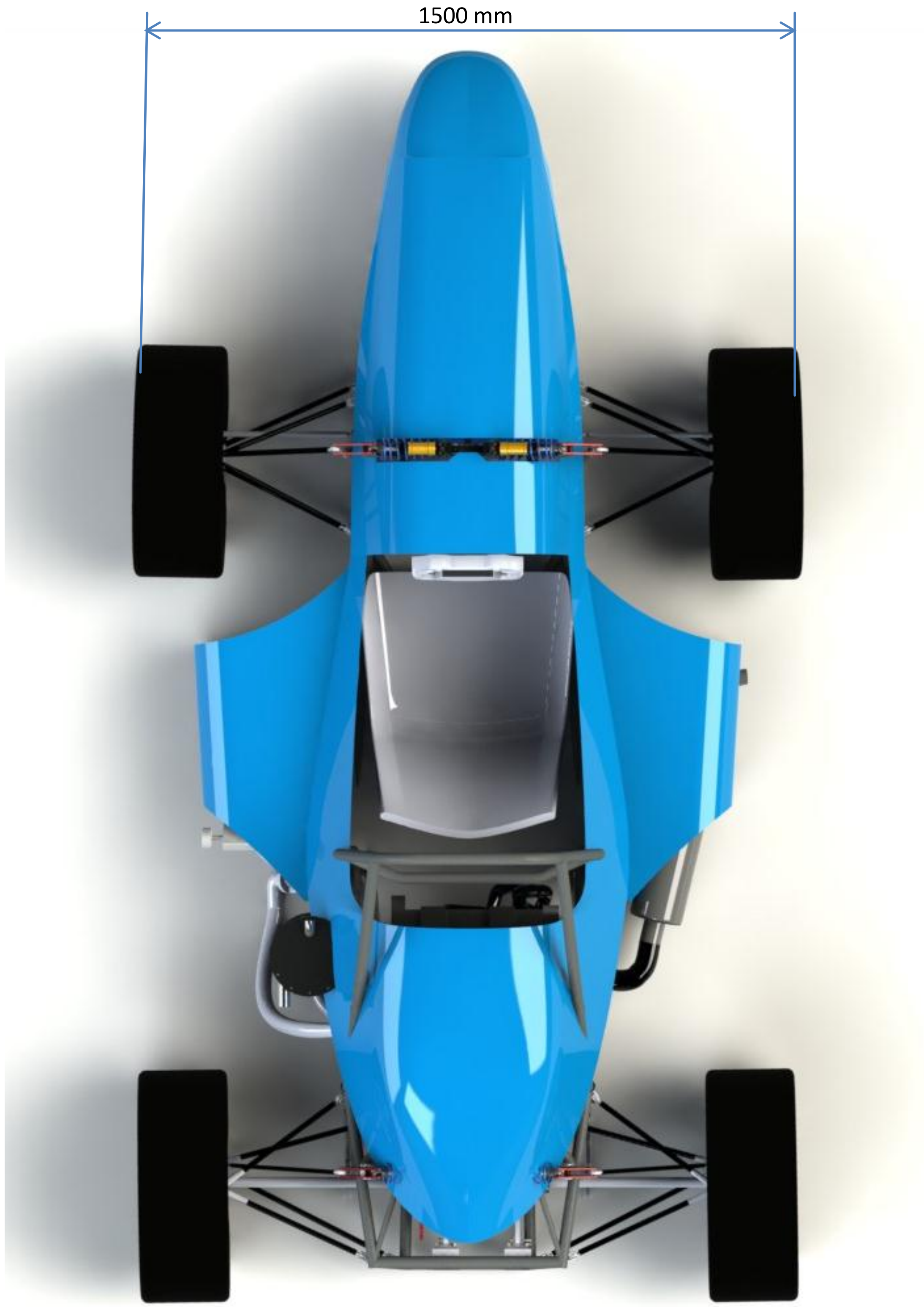
Page1 : Shift lights, RPM, Gear, G.P.S track, battery level, lap timing, fuel level, oil pressure and coolant temperature warning lights.
Page 2: G.P.S Track, accelerometer.
Page 3: G.P.S Track, Shock travel, steering angle.
Joystick for reducing switches. Rotary switch for brake bias. Work done on LPC2388 will provide platform for shifting DAQ and other systems on single controller.

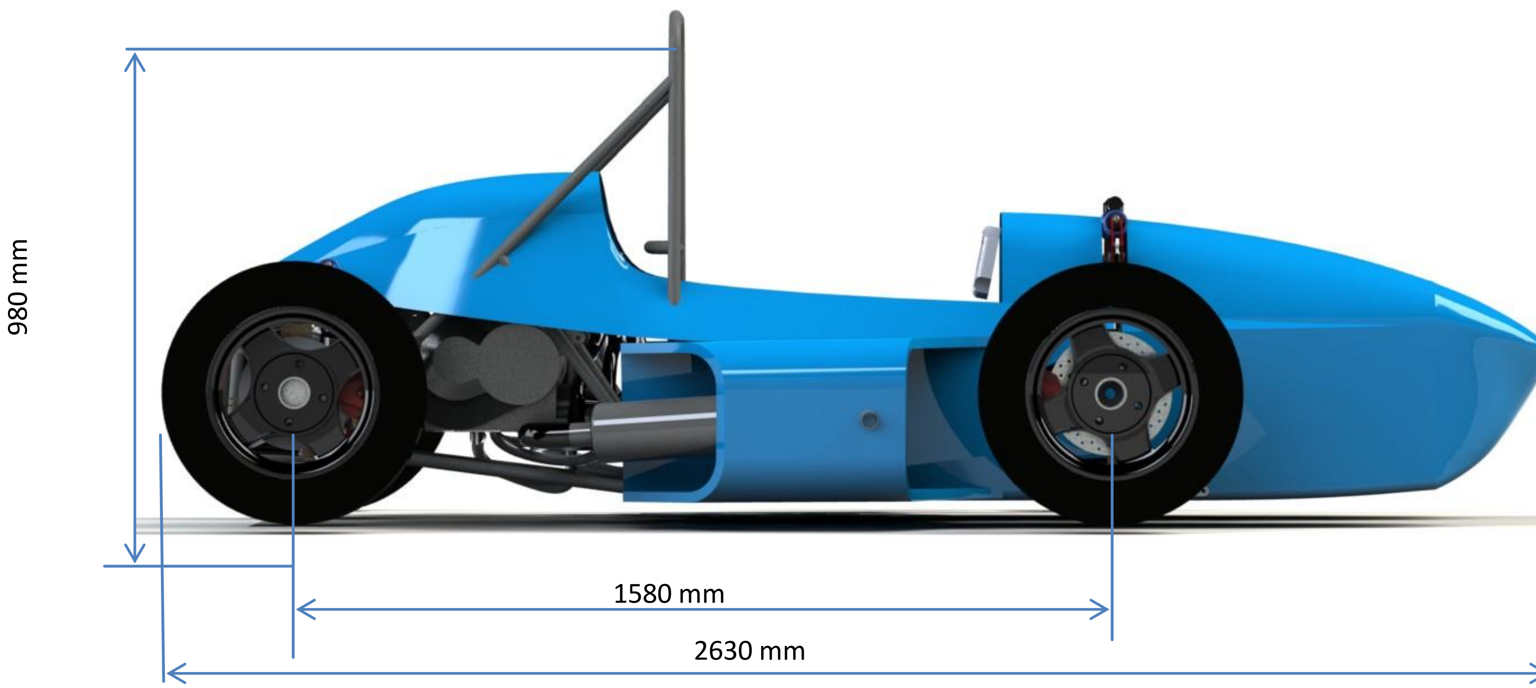
E.C.U: Motec M400 used for engine tuning.

Electro-mechanical gear shifting using 250w rated DC motor. Lighter and more reliable than previous year's solenoid based shift system.

Power Card: Provides stable supply to the electronics, with surge voltage, over current and reverse voltage protection. PPTC fuses have been used.

Other Features:
Zigbee based Telemetry.
MATLAB used as curve fitting tool, analysis tool and for design of GUI.
GPS readings used for verification of logged sensor data. Future scope for developing it as driver aid.
DAQ data has been useful for validating theoretical design of single radiator based cooling system.
Brake light with rain mode similar to F1 cars.
CAN bus implementation, further data validation and up gradations in progress.


1500 mm



980 mm
1580 mm
2630 mm

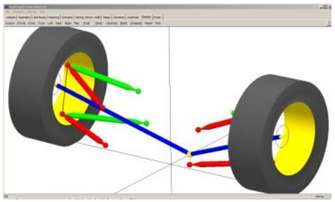
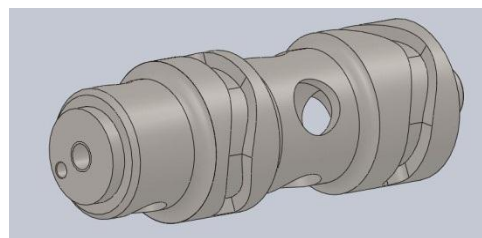


Image 1

Image 6

Image 2



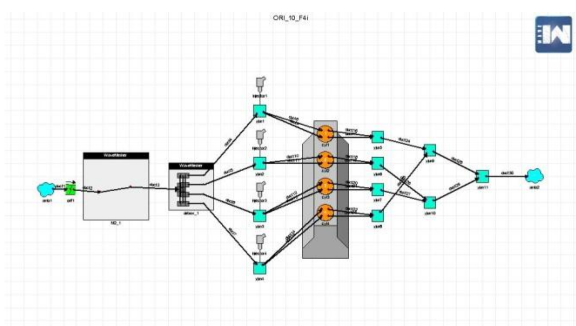


Image 3

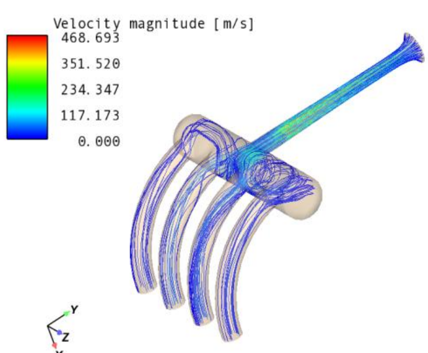


Image 4

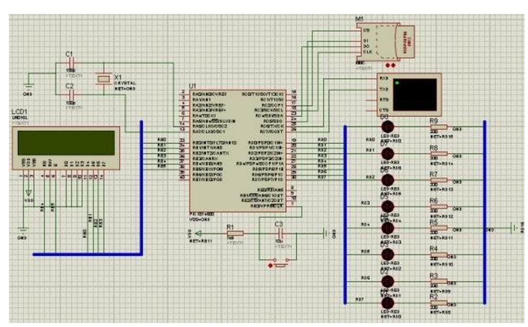


Image 5