



FORMULA MANIPAL

Engineered with Passion

NOVEMBER 2022



FORMULA
MONTHLY

KEEPING UP WITH FM.

Bruce McLaren once said “To do something well is so worthwhile that to try to do it better cannot be foolhardy.”. This month has been quite eventful for Formula Manipal. Each subsystem has been working extra hours in the workshop ever since FMXX1 finally came back into the workshop. After a quick and detailed inspection to see the damage caused by the harsh conditions while shipping the car from Germany, the team has successfully managed to repair and start working on integrating the new ideas and designs on the car to get FMXX1 prepared for Formula Bharat 2023 taking place from 20th to 25th January.

MECHANICAL

- Our Vehicle Dynamics subsystem is working on implementing Carbon Fibre Suspension links which will reduce the overall weight of the suspension system.
- We have also made significant progress in the research on designing and manufacturing a carbon fibre monocoque chassis.
- The manufacturing of the aluminium wheel hubs is underway which will reduce the unsprung mass significantly for this upcoming season. The Unsprung mass of a vehicle is the total weight of the suspension, wheels and any other component directly attached to it.
- The team has designed a new head restraint that is ergonomically validated and that complies with the rules. They are also working on modifying our chassis to support the new additional components to be fitted onto the car.
- Our team has designed a new Aero package that consists of designing new front and rear wings, an undertray and a new nose cone for the car that will help produce more downforce and control the drag produced more efficiently.
- Our transmission subsystem is designing and analysing a dual chain drive and custom made open differential which will help improve the overall performance while reducing the weight of the final drive train.

DRIVERLESS

- We have made major breakthroughs in our driverless subsystem and we have high hopes on manufacturing a competition winning driverless car in the upcoming year 2023. Our team has been working long hours in the workshop debugging and experimenting with new algorithms to help manufacture the first driverless car from India in the Formula Student Competitions.



ELECTRONICS

- We are implementing a full-scale battery pack designer software using AI algorithms that will be able to select the battery configuration on its own as well as make a geometrical representation of the same.
- Our team is also implementing an entire EV car simulation using MATLAB SimScape module that will include the battery module designed according to the best possible cell selected, which will have an entire powertrain model with vehicle dynamics and aerodynamics.
- We have also been designing a new battery pack using additive manufacturing which utilizes Generative Design Algorithms with lesser weights while maximizing the overall output of the car.
- Our Controls subsystem is researching on more innovative designs to improve the overall output produced by the car.



Formula Student has been an educational engineering competition for the last 25 years. It has always been a competition that tests young engineers to innovate technologies that will drive the industries of tomorrow. Every year Formula Manipal designs and manufactures 2 cars. A combustion vehicle and an electric vehicle. Fueled by the motto “Engineered with passion” our team strives to be a better and stronger component each year by innovating and developing better designs that take us closer to our goal of being the best in the field. This year Formula Manipal also has plans on manufacturing our first ever driverless vehicle. Our team’s 3 year long extensive research on building a driverless vehicle will finally reach fruition.

What is the basic difference between CV and EV?

Combustion vehicles are powered by an IC engine that exploits energy from spontaneous chemical reactions which generate heat and is the driving force for the rotation of wheels, whereas in an Electric Vehicle we utilize electrical energy and use Electromechanical devices to convert it for the rotation of wheels. The power source of a combustion vehicle is usually the chemicals which combust in the engine cylinder, i.e., Fossil Fuels which have high energy density but, in an EV we store electrical energy with the help of Batteries and Fuel Cells.

Formula Manipal working on EV.

The 3rd Generation Formula Manipal EV targets for the 15th anniversary of Formula Manipal and a switch over to a more competitive environment which shows our courage and gratitude towards a fair and equal competitions. Interacting with international industry experts provides us with the opportunity of representing our team and the knowledge we gained on an international stage, this makes us one of a kind team in India which has proven themselves over difficult scenarios multiple times.

Powertrain of an EV vs CV.

CV consists of an internal combustion engine that runs on fossil fuels stored in a fuel tank, this produced energy goes to the wheels with the help of a gearbox which houses multiple gears to help achieve different speeds.

In an EV, the powertrain usually consists of an Electric Motor which is powered by a battery pack and is associated by a sophisticated motor controller which is responsible for the power supply to the motor. The EV doesn’t have a gearbox as the motors work efficiently in a very wide range of RPM and can provide usable power across its RPM range.

Why did Formula Manipal decide to build an EV car?

The search for alternative fuels for CV made us realise that how other types of energy sources can be beneficial and efficient at the same time, this race proved a disruption in the automotive world with the introduction of Electric Vehicles as a whole new concept that was proved and accepted globally for its efficiency and feasibility in the long run.

We at Formula Manipal are aspiring engineers to enter the automotive world and contribute for the changes in the automotive world and by researching and implementing an EV at undergrad level will provide enough experience and knowledge that will be sufficient to call ourselves as a change maker in the Formula Student World. By adopting to an Electric Powertrain we make sure that we are moving towards a sustainable method for powering our world and at the same time reducing the impact on the environment by cutting down on carbon emissions and generating higher efficiencies.

FORMULA MANIPAL DRIVERLESS

Formula Manipal launched its driverless subsystem in 2018, a few months after the driverless competition was launched. We set out on a path to build India's first-ever autonomous formula-style racecar. The team focuses on designing a driverless racecar while dwelling deep into the world of autonomous systems and advanced robotics. We research, implement, and simulate software systems that can control the vehicle completely without needing the driver's assistance.

WHAT IS A DRIVERLESS VEHICLE?

A driverless vehicle performs various tasks, like object detection and pose estimation, simultaneous localization and mapping, real-time path planning, and controls. Cameras and lidar are used for object detection and pose estimation. Localization estimates the current position and orientation of the car using the car's GPS and IMU sensors. Various computational geometry algorithms are deployed to determine the optimal path for the car to follow, in this case, the racing line. The car then follows this path by giving throttle, braking, and steering commands. Most importantly, autonomous vehicles require fail-safes and safety measures, like Remote Emergency System (RES), Emergency Braking System (EBS), etc. that ensure the well-being of the car and the people around in case of any faults. Our work aims to push the boundaries of performance and efficiency of autonomous vehicles while maintaining the highest level of safety.

PERCEPTION

Our team uses a stereo camera setup for the perception pipeline. A stereo camera is a type of camera with two matched lenses separated about the same distance as a person's eyes. This allows the camera to simulate human binocular vision and therefore gives it the ability to capture three-dimensional images. Machine learning algorithms help in detecting the objects on the track, and the 3D image helps in estimating the position of the objects.

STATE ESTIMATION

Localization of the car is estimated using probabilistic and kinematic methods using the car's GPS and IMU (Inertial Measurement Unit) and the previously known position of the car, to give the current position and orientation of the car. To improve the reliability of the model, Extended Kalman Filter (EKF) is used. It converts a non-linear equation into a linear equation.

PATH PLANNING

Path planning deals with the task of constructing the optimal path for the car to follow, using computational geometry algorithms like Rapidly-exploring Random Trees (RRT) and Delauney Triangulation.

CONTROL

Our control system follows the path generated by using algorithms such as PID control, Pure Pursuit, Stanley, and Model Predictive Control, giving the throttle, brake, and steering values to the car. The car is then moved by actuating the engine throttle body, the brake pedal, and the steering column to provide throttle, braking and steering respectively.



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RS 1000 OR \$20 IS ALL IT TAKES TO BE A PART OF
THE FORMULA MANIPAL FAMILY!

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