FORMULA MANIPAL

Engineered with Passion

DECEMBER 2022

FORMULA MONTHLY

KEEPING UP WITH FM

As the last month of 2022 comes to an end, we finish the year on a beautiful note. The last phase of the manufacturing process comes closer to the end before our testing phase for Formula Bharat 2023. Our team has worked countless hours in the workshop perfecting each piece. We have high hopes for the upcoming year and competitions and we are confident that we can face any challenge in the upcoming year 2023.

Structures

- The mounting for the head restraint was redesigned that improves the overall performance of the car.
- The dash was designed into a simpler piece and mounted on the car.
- The quick jack and push bar was combined and manufactured into one integrated design to use on the car.

Aerodynamics and Composites

- The Rear bash plate layup is finished.
- The Front and Rear EB layup is finished
- The Front and Rear box assembly is finished.
- The Intake was fixed.
- Completed layup of side panels
- Completed layup of-
  - Egress panels
  - SIS panels
  - ECU cover
  - Floor Plan

Engine

- The old intake was repaired
- The new intake was printed
- New Catch cans were installed.

Transmission

- The limited slip differential was serviced and new differential mounts and bearings were press fitted.
- Pneumatic circuit was tested statically and a faulty 3/2 DCV was replaced.
- The transmission assembly was assembled onto the car, tested dynamically and checked for technical inspection compliance.
- The differential bolts were not torquing causing the bolts to loosen and the lubricant to leak. This was resolved by torquing the bolts to rated value.
- The 3/2 DCV leak in the pressure exhaust is temporarily replaced with a 5/2 value with a closed loop at one end until the new 3/2 DCV (directional control valve) arrives.

Vehicle Dynamics

- Brake bleeding was finished
- Tie rods were changed
- Suspot adaptors and steering sensor mounts made
- Suspension links were painted
- New tires have been put as old ones were worn out in testing

Electronics and Control Systems

- Changed the safety Circuits, using SMD components.
- Designed custom DAQ and telemetry software.

Safety Regulations

The HALO- CONTROVERSIAL?

The Halo. F1's most controversial safety feature Formula 1, or motorsports in general, has come a long way during the course of its decades old history, and in no area so much as in terms of safety. In earlier times, it was widely accepted that racing came with a real risk of severe injury or death and it took some time before the culture of 'striving to protect lives' set in. When Formula 1 was started back in 1950 there were essentially two rules: your engine needed to be naturally aspirated and under 2.5 litres in size. All you had in the name of safety was a gentle suggestion of a leather helmet and all the courage you woke up with on that day. Of course, no seatbelts too. Former racing car driver Jacky Ickx once famously said, "To survive, in that time, it wasn't a question of talent, it was purely a question of luck."

The Halo is a driver crash-protection system which consists of a curved bar placed to protect the driver's head. It consists of a bar that surrounds the driver's head and is connected by three points to the vehicle frame. The halo is made of titanium and weighed around 7 kilograms in the version presented in 2016, then rose to 9 kilograms in 2017.

The system is not developed by the teams, but is manufactured by three approved external manufacturers chosen by the FIA and has the same specification for all vehicles. While it doesn't look like a lot, the Halo can withstand up to 25 kN of force from above and from the side for multiple seconds. After extensive testing by the FIA, it was observed that the halo was responsible for a 17% theoretical increase in the driver's survival rate and hence, the FIA, in 2018, made the Halo mandatory in all its categories. For all the promises it showed on paper, the implementation was met with a huge backlash. By the way the community reacted, one would think that the FIA had banned the motorsport itself. F1 'purists' thought that an unprepossessing piece of titanium plopped over a driver's head was both an unnecessary safety feature and a rather unaesthetic addition.

This romanticization of peril and hazard, and the thrill that comes with it, has led to a lot of misfortune. Fast forward to 2020, the mountains of safety regulations and improvement ensured the survival of French driver Romain Grosjean in a crash that many thought would cost the driver his life. Even though his car was ripped in two, his head got pushed through a barrier and the entire car went up in flames; he survived. Despite of such a fatal accident, he started driving again less than a year later.

After his miraculous escape at Bahrain, he said: "I wasn't for the halo some years ago, but I think it's the greatest thing that we brought to Formula 1 and without it I wouldn't be able to speak to you today." As shown by these recent incidents, F1 and fellow racing categories have now become safer than ever. However, that doesn't mean that the safety precautions are foolproof and can't be worked upon. It must be understood that some fans and officials will protest any and all changes to the sport over historical and emotional value but that must not, in any shape or form, reorient the greater journey of saving as many lives as possible. There is always a certain amount risk and danger inherent and accepted to this sport, but the mileage varies from person to person. Yes, this very danger adds to the appeal of the whole circus but fans, officials and drivers must strive to find the balance between reasonable risks and unambiguously preventing the inevitable.

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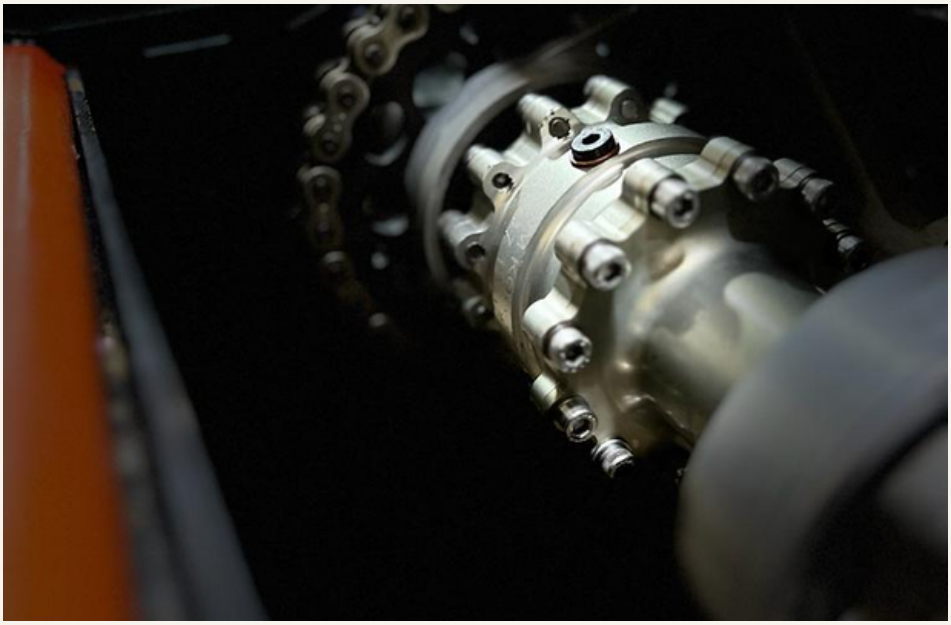
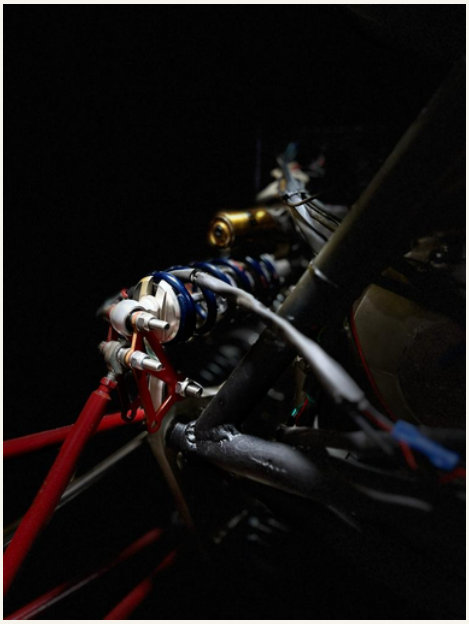
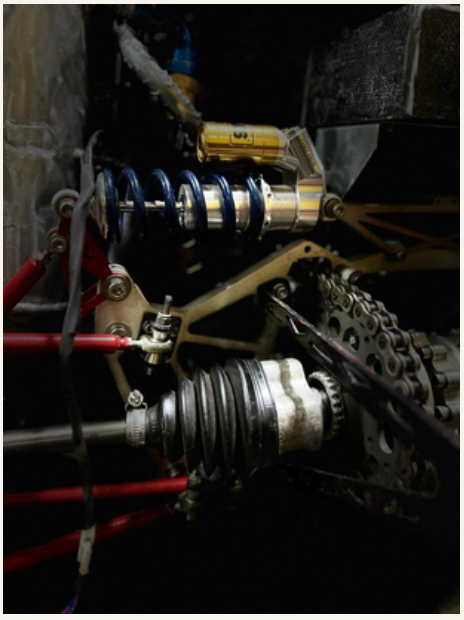
TRANSMISSION

FDR(Final Drive Ratio) is one of the most important decisions made while building the car as it involves striking a balance in the trade-off between power and torque to the wheels. To begin with, the torque coming from the gearbox is sent to the differential through the chain drive which contains the driving, driven sprockets, and roller chain; this drive decides the amount of torque being sent to the differential and wheels.

The ratio of the no. of teeth on the driven sprocket to the no. of teeth on the driving sprocket decides the amount of torque or rpm that is given to the wheels. If you have a smaller sprocket and a larger sprocket it would result in a higher FDR, implying the car can put down more torque and accelerate easily but cannot attain top speed as effectively. A lower FDR would achieve top speed easily but cannot give better starts as it would require more torque to be sent to the wheels. FDR was narrowed down based on the dynamic events and track layouts of those events for the competition using optimum lap software; and 2.727 was finalised to be the FDR of the car.







Once FDR is decided, no. of the teeth on the sprockets are to be finalised and this involves a lot of parameters to be considered, and based on the car's space constraints, working limitations, vibrations, wear, and fatigue that can arise on the sprockets are to be kept in mind while decision making. After a research extensive trial and error process to determine the no. of teeth on the sprockets, our team members design the sprocket and run simulations and test its structural integrity. Finally, the material selection for the sprockets is analyzed and decided based on parameters such as for example if the driving sprocket is smaller in size, it performs at higher rpms implying the chain tooth engagement is more frequent, so the material chosen should have high surface indentation resistance or hardness. Lastly, based on previous taken parameters, the team members decide the roller chain that is to be used in the process. A chain drive is more efficient than a drive shaft because it causes less vibration resulting in a more efficient transmission.

GEAR SHIFTS AND CLUTCH SYSTEM

We use a pneumatic system for the gear shifts and clutching in our car. Pneumatic system works with the help of compressed air filled in a pneumatic tank. We use three 3/2 Direction Control Valves (DCV). 3/2 means that the DCV has 3 ports and 2 switching positions. The positions are switched electrically with the help of ECU. Direction control valve allow fluids or gases to flow into different paths from valve ports, which provide a passageway for flow to or from other components/sources. A pressure regulator is present is appropriate position for regulating to required pressures. With the help of pneumatic actuator, the shifting and clutching is carried out.

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Testing

The testing of the car happens at every stage of the manufacturing process. There are three major testing phases, i.e.

- Mechanical Testing
- ECS Testing
- Driver/Dynamic Testing

Mechanical Testing

The mechanical part of the testing involves firstly stress testing each and every mechanical component of the car starting with the chassis. From torsion analysis to tilt testing, We gather important datasets from our chassis to improve and validate the design and manufacturing processes. Our team works around the clock to ensure that everything component has undergone testing and has proven itself safe, secure and up to the mark set during the extensive research based design phase.

ECS Testing

The testing begins with testing the electrical harness of the car.After which we test smaller but vital components such as the master switch, shutdown button and the various complex circuits that are situated with the same. After all this hard work the team also then prepares a custom Data Aquisition setup and a wireless telemetry software for wireless data analysis. The testing then involves training datasets based on various inputs given by sensors present all over the car, to create the best fit strategy for the race.

Driver/Dynamic Testing

The main phase of testing is based on the simple principle of extracting the maximum performance out of the car. Every driver present has their own unique way of driving, so we make sure that each driver is placed into his own comfort zone by fine tuning different components of the car using the data points from the ergonomic analysis. By running the car under various conditions to replicate the conditions that the car will experience in the dynamic events, we make sure that both the car and the driver are prepared to the level best to maximize the chances of winning the competition. With rigorous testing day in and day out , working late nights in the workshop surrounded by teammates, Formula Manipal has officially finished its manufacturing phase for Formula Bharat 2023.

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