1 Powertrain

The powertrain is a significant framework in the plan, advancement, and assembling of a race vehicle, since it manages both the power transmission from of the Engine towards the different parts in the middle. Every one of these parts must be picked for a specific point and set of characteristics, and they all needed to work alongside the wide range of various subsystems. All open answers for each piece were examined to choose the best again for application, remembering our points of effortlessness and cost while being cutthroat. [1]

It is basic to test the powertrain whenever it has been fabricated and created to affirm that it fits the recently characterized plan necessities. After the powertrain testing is finished, the bundle should be incorporated into the general vehicle plan. This is the place where the pressing of the parts will be chosen. Regardless of the way that these parts have been partitioned into discrete classifications, there is a solid connection between them all.

1.1 Basic Project criteria

There are a couple of imperatives that apply to all parts of planning a powertrain of a racing style vehicle and these are examined exhaustively in most of the accompanying segments so that the total powertrain is planned in correspondence to the Formula rule books.

Weight	• Weight decrease is a need that applies to each part of the poertrain. This weight decrease permits the vehicle to hold most extreme ability to weight proportion
Solidness/Reliability	•It is vital that we create powertrain plan that will permit greatest power and force to be sent to the wheels.
Feel/Neatness	•One of the significant perspectives in making the drivetrain or complete vehicle is tidiness.
Execution	• While the spotlight this year was on making tough plans there was a longing to have everything perform well to permit the group to get done, yet dominate in the opposition.

1.2 Engine performance

Ford's turbocharged, gasoline fuel injected EcoBoost engines are expected to play a key part in the company's attempts to cut fuel consumption by allowing downsizing in the near future. With comparable torque and power to a 5.4L port fuel injected (PFI) V8 engine, the first application of this technology package in a 3.5L V6 engine provides up to 13% higher fuel economy and 16% fewer emissions and comparable torque and power.

There are many types of research carried out on improving the performance of the engine from the conventional engine to a turbocharged engine. Common problems of poor engine performance are especially when accelerating and mechanical problems and malfunction of actuators. In this research, some systems that can be improved or modified for better performance are the Inlet manifold, injection system and external power source.

1.3 Combustion System of the engine

Ford engineers concentrated on fundamental physics when creating the system, with a concentration on injectors sprayer, piston shape, intake ports design, and operating strategy innovation. 3D CFD models, as well as tests with photonic, single-cylinder, and multi-cylinder engines, were employed in the technique. The strategy drastically reduce the number on hardware iterations needed.

Regrettably, the two criteria are frequently in conflict. Higher flow capacity equates to lower in-cylinder flowing motion, whereas a higher flow motion intake port equates to lower flow capacity. The EcoBoost engine's port optimization focused on ensuring enough flow capacity and rapid tumble flow velocity, which resulted in superior fuel-air mixing uniformity and knock resistance. The engineers discovered that the shape on the port's short side and the top nose area had a significant impact on tumble flow movement and port flow capacity.

1.3.1 Intake manifold

The intake manifold system is one of the most important system of the engine system, which acts to pass air flows equally to each cylinder of the engine. With the limited air intake law, the intake air system for a car must be properly developed to reduce the lack of output generated. The main function of the intake manifold is to distribute the combustion mixture equally to each intake port in the cylinder head. Even distribution is important to optimize the efficiency and performance of the engine. The air that flows through the cylinder must be clean without impurities. Impure airflow can cause the combustion process to slow. An air filter id added to this and it filters the intake air, and it balances the mass of air.

Different types of intake manifolds can be used in formula ford by considering different parameters like type of fuel used, and the number of cylinders, maximum torque to produce. A typical; inlet manifold design consists of a runner open diameter, runner length and plenum volume. however, the formula ford doesn't have the plenum which stored the air obtained at high-speed on the track and used as instant power by producing the proper amount of air-fuel mixture. By changing the length and diameter of runner engine performance can be increased by volumetric efficiency and mass flowrate.

And also, normal intake manifold is made with Aluminium alloy or cast iron, A typical manifold made with Al-2024 which have some weight if this system is replaced with aluminium alloy carbon nanotubes it helps to reduce the weight of the system by 40 per cent or more depends on CNT composition which helps the machine lighter and can gain more speed. There are many types of research done on this system to improve the system there is one main thing to consider on this is the cost it may double the normal type of system if we added CNTs. As of now if we consider it will be more than £3000.

1.3.2 Fuel Injection

The Purpose of the fuel injection system is to deliver fuel into the engine cylinders while precisely controlling the injection timing, fuel atomization and other governing parameters needed.

The Formula Ford has a 1.6 Eco-boost engine with a multi-point fuel injection system from which the fuel is injected into the cylinders. The multi-point fuel injection is accompanied by a high pressurize injector at the top of the cylinder head. To achieve proper combustion in the formula ford engine the fuel injector is placed a little away from the air inlet port such that it creates proper atomization of both fuel and air which favours proper combustion along with low emissions. However, there are constraints regarding the right temperatures for atomization of fuel and also placing both fuel injector port and air inlet port apart cannot be adopted due to design complexity. It also costs about £1500 for highly expensive manufacturing.

1.3.3 Power Generator

Performance of engine can be improved by obtaining high torque and power this can be done by additional power generators, hear there are some systems, which helps to improve the efficiency of engine.

1.4 Design calculations for powertrain for formula ford

During its 17-year peak, which spanned the 1970s and well into the 1980s, the FORD COSWORTH DFV won over 150 Formula One races. With the debut of the turbocharged DFX variant in the mid-seventies, it also dethroned the famed Offy engine for USAC/CART Indy Car racing. Before parting gracefully with a last participation in the 1987 Formula 1 campaign, DFV series engines dominated endurance racing, Formula 3000, and hill climbing with unmatched domination.]

The inclusion of a Ford engine with some of Europe's most formidable race chassis may appear strange to many entry-level automobile enthusiasts. True, the corporation did supply its products to teams and cars outside of the United States, and in certain cases, they became rather prominent in their respective fields.

We're included the transcendental business on our list again, this time because of its 7.0-liter FE engine, which is a departure from Ford's superbly made Cosworth DFV V8.

1.4.1 Comparative analysis of the Formula Ford engines

The Formula One engine had four valves per cylinder, which was unusual at the time. BRM & Climax had both tried this format with limited success, whereas Honda had been able to fully leverage the technology. With intakes on the right and exhausts on the left, the engine was a crossflow design with such a 40-degree tilt between both the cylinders and a double overhead cam. To operate the water pump, a regular Ford camshaft was employed.

The 400cc per cylinder in the Formula 1 V8 was lowered to 375cc by cutting the strokes form 2.73 inches to 2.56 in, necessitating an increase in con-rod length to minimise excessive piston acceleration and hence reduce wear. It was determined that a V8 would be utilised instead of a V12 because it had lesser moving components and hence less friction.

The more resistance there is like an engine, the more power is required to overcome them, and Duckworth determined that getting as much power as possible was very important. The block was made of an aluminium alloy (LM8WP) for lightweight, necessitating the usage of cast iron cylinder liners closed with O-rings on top and bottom. Magnesium was used to make the cover castings on each side of the 90° V..

The motor was to be an underlying individual from the vehicle, giving additional unbending nature to the skeleton, and it was strange in being more extensive than it was long, being 26.5 x 21.6 inches (67.3 x 54.9 cm). Toward one side of the motor were suspension connection focuses, and at the other were vehicle connection focuses at the top and lower part of the motor. The lower bolts were sited 9 inches (22.86 cm) separated, as the forthcoming Lotus 49 was to have side barges located 9 inches separated to flawlessly fit the collection of driver Jim Clark! As the motor extends when it gets hot, the mountings were made so the sheer powers were engaged onto the base bolts. This approach to mounting the motor endure the entire way through to 1985, and was for the most part preferred by the planners.

Because of the motor's width, it was hard to put fuel channeling around the sides of the motor, so it was directed that the gas tank must be sited before the motor, inside the monocoque, a training utilized today. Albeit this was constrained onto the creator, it had the advantage of finding a significant wellspring of weight near the vehicle's focal point of gravity, and it empowered a steady weight dissemination in the vehicle as the fuel load went down. Because of the area of the gas tank in the vehicle, it was important to make the motor as short as conceivable to limit the wheelbase of the vehicle, in this way keeping away from a split the difference in the vehicle's taking care of. The flywheel on the motor was additionally made as little as could really be expected, to keep up with the low focus of gravity. This required the starter engine being switched and organized onto the gearbox packaging.

1.4.2 Jet ignition engine operation

In the past, pre-chamber-based combustion approaches have had little success in providing adequate combustion stability at low loads, such as idling and catalyst light-off. These circumstances necessitate a significant level of spark retardation, which is generally missing in jet ignition approaches. M.P. Bunce performed a research to assess the challenges affiliated with idle as well as catalyst lamp jet ignition operation, investigate the underlying causes, and consider potential solutions with the goal of achieving performance comparable to that of a conventional spark-ignited engine under such conditions. [2] Test results from a specialised 1.5L 3.0-liter jet ignition engine are shown, together with comparisons to the same engine's traditional spark ignition counterpart. Potential strategies for reaching performance metrics equivalent to those of a traditional spark-ignited engine are offered and analysed.

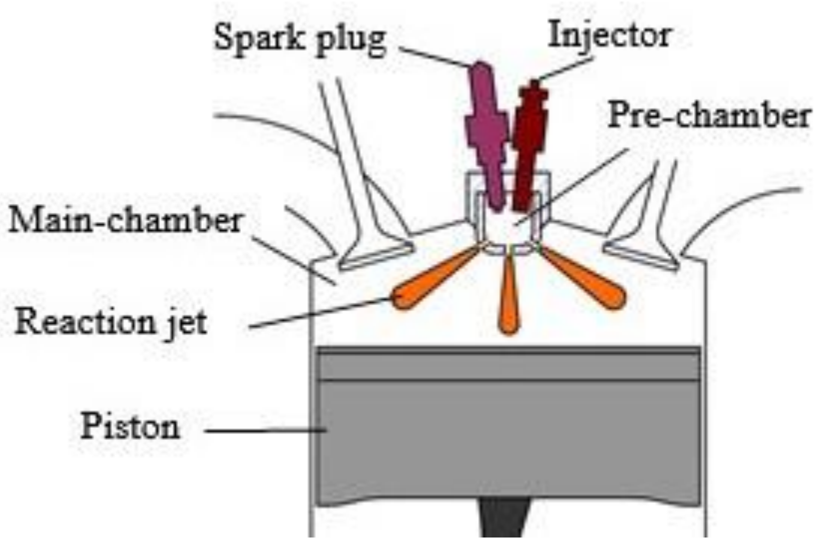

Figure 1 Jet ignition engine [Image credit [3.]

Low load operation has always been a difficulty for pre-chamber ideas. This issue expresses itself in two ways: poor combust stability at low loads that are strongly throttled, and poor ignition retard capability at idle and CSSR loads. Only if a solution towards the low load pre-chamber constraint is found, the well-documented efficiency benefits from jet ignition under part loading load cannot be successfully applied to non- nor mild hybrid engine applications.

2 Suitability of fuels for the Formula ford

Despite the fact that commercial gasoline and FORMULA FORD fuel are created with the identical ingredients, each manufacturer's final product for each Formula ford team is highly optimised for optimal performance. This means that Shell's gasoline is tuned specifically for Ferrari and would not perform as well if utilised by the Mercedes squad. [4]

FORMULA FORD has always been ahead of the curve when it comes to fuel technology, and seen many of the innovations in the field used in a commercial situation. The FORMULA FORD rules, for example, required that gasoline include 5.75 percent bio-components until the end of the 2021 season. This regulation was made a law all industrial fuels in Europe two years after it was introduced by the FIA.

Property	Units	Min	Max	Test Method
(RON+MON)/2		87.0		ASTM D 2699/D 2700
Oxygen	wt%		3.7	Elemental Analysis
Nitrogen	mg/kg		500	ASTM D 5762
Benzene	wt%		1.0	GC-MS
DVPE	kPa	45	60(1)	EN13016-1
Lead	mg/l		5.0	ASTM D 3237 or ICP-OES
Manganese	mg/l		2.0	ASTM D 3831 or ICP-OES
Metals (excluding alkali metals)	mg/l		5.0	ICP-OES
Oxidation Stability	minutes	360		ASTM D 525
Sulphur	mg/kg		10	EN ISO 20846

Figure 2 Fuel composition [Image credit: https://f1chronicle.com/what-fuel-do-formula-1-cars-use/]

2.1 Additives used in fuel

Additives are critical for the engine's dependability, both in terms of avoiding failure and the gradual loss of power over time. Fuel additives will minimise ring friction, prevent deposits from developing on piston crowns and hot parts of the engine, lubricate high-pressure petrol pumps, and keep injectors from cocking. Cleaning, anticorrosion, anti-oxidation, emulsion reduction with air, friction modification, combustion improvement, and octane rating are some of the qualities of these active molecules.

2.2 Control of knocking in powertrain

In a few terms, the fuel's role may be summarised. It must burn swiftly in order to free the power, and hence must be evaporated quickly and uniformly. The propagation of the flame must be virtually immediate after lighting to avoid banging. Turbo engines are more susceptible to this problem than regularly aspirated engines since they have a larger temperature and pressure load. [5]

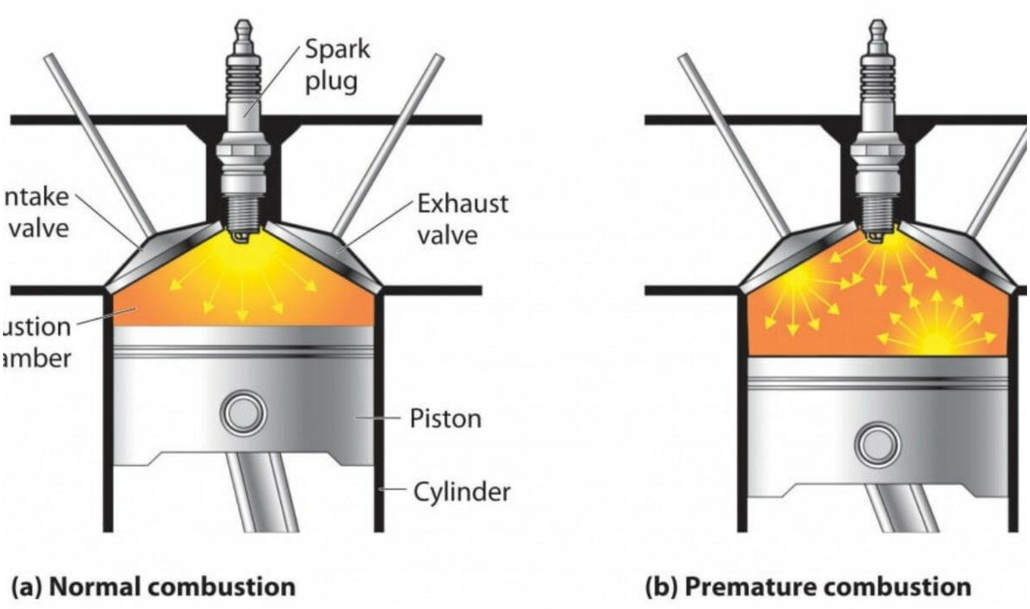

Figure 3 Causes of knocking

Knocking is caused by uncontrolled combustion, which results in explosive explosions that spread quickly through the combustion chamber. This explosive event generates highly pressurized waves bounce off the walls, generating large-amplitude pressure oscillations. Sharp noises, disruption of internal gas dynamics in the combustion process, and heat exchange between the burned gases and the metal are the results. As a result, fusion can hole or destroy a piston in a matter of seconds. The octane rating of the gasoline plays a key part in knock prevention, and an octane rating will postpone the onset of the knock.

3 Conclusion

Powertrain is the heart of vehicle. It generates the power to move the vehicle. We discussed the different parts of the engine like intake manifold and the fuel injection system. We found that turbine jet ignition is the most sizzling trendy expression on the FORMULA circuit right now after various news sources detailed that Mercedes has been using a type of this innovation since the super V6 time showed a few years prior. The fuels used for the formula ford have advanced characteristic like controlling the knocking in the effective way.

4 Reference

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