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# Study of Small Gas Turbine Engines of Thrust 1-5KN

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**Abstract:- Small gas turbine engines present a significantly lower performance when compared to large ones. The major reasons for that are the lower component efficiencies and size effects. The present work accomplishes an investigation of data available in the open literature for small turbojet and turbofan engines, covering a range from 1 to 5 kN of thrust, to find the most important parameters for these engine configurations. This study aims to evaluate the parameters used in engines in this thrust range, for the possible development of an engine for a specific application. This overview relies on a correlation between some of the major parameters of the engine, namely thrust, specific fuel consumption, pressure ratio, turbine inlet temperature, weight, length, diameter, and mass flow.**

***Keywords*:-** *Bypass Ratio, Overall Pressure Ratio, Revolutions Per Minute, Specific Fuel Consumption.*

## I. INTRODUCTION

The gas turbine, also called a combustion turbine, is a type of continuous and internal combustion engine. The main elements common to all gas turbine engines are • an upstream rotating gas compressor • a combustor • a downstream turbine on the same shaft as the compressor. The gas turbine's basic operation is a Brayton cycle with air as the working fluid. Atmospheric air flows through the compressor, increasing its pressure, and energy is then added by spraying fuel into the air and igniting it, resulting in a high-temperature flow. The unused energy in the exhaust gases can be repurposed for external work such as directly producing thrust in a turbojet engine or rotating a second independent turbine known as a power turbine that can be connected to a fan propeller or an electrical generator.

The purpose of the gas turbine determines the design so that the most desirable split of energy between the thrust and the shaft work is achieved. The fourth step of the Brayton cycle (cooling of the working fluid) is omitted, as gas turbines are open systems that do not reuse the same air. Gas turbines are used to power aircraft, trains, ships, electrical generators, pumps, gas compressors, and tanks.

## II. COMPONENTS

- **Compressor:** Both the air compressor and the turbine are mounted on either end of a common shaft with the combustion chamber between them. Because gas turbines do not self-start, they require a starting motor. An air compressor is used to suck air and compress it, increasing its pressure. For the most advanced and large gas turbines, axial design type compressors (multi-stage) are preferred.

- **Combustion chamber:** The compressed air is combined with fuel here, where the resulting fuel-air mixture is burned and the combustion products are delivered to the gas turbine. The fuel mixture burns well under high air pressure. In modern gas turbines, liquid fuel, gaseous fuel, or natural gas is used. There are three types of combustion chambers used in general combustor annular chambers • chambers for can (multi can) combustor • chambers for can-annular combustor Fuel is injected into the burner as a highly atomized spray at the upstream end. Fuel nozzles can be either simplex or dual fuel. Some gas turbines are "bi-fuel," which means they can burn a combination of gas and liquid fuel.

- **Turbine:** A multistage gas turbine moves hot gases, and the kinetic energy is converted into shaft horsepower. A gas turbine, like a steam turbine, has both stationary and moving blades. The stationary blades' purpose is to direct moving gases to the rotor blades and then adjust their velocity. The shaft of the turbine is connected to a generator.

## III. GAS TURBINE DESIGN PROCEDURE

The design process starts from a specification, resulting from either market research or a customer requirement; the process is similar for both aero and industrial engines. The development of a high-performance gas turbine is extremely costly and may be shared by several companies. Successful engines are those which find a variety of applications, and their life cycle from the start of design to final service use may be more than 50 years. The specification is rarely a simple statement of required power and efficiency. Other factors of major importance, which vary with the application, include weight, cost, volume, life, and noise, and many of these criteria act in opposition. An important decision facing the designer is the choice of the cycle. It is essential to consider at an early stage what type of turbomachinery and combustor to use, and this will in large measure depend on the size of the engine. The first major design step is to carry out thermodynamic design point studies. These are detailed calculations taking into account all important factors such as expected component efficiencies; air bleeds, variable fluid properties, and pressure losses, and would be carried out over a range of pressure ratios, and turbine inlet temperatures. Once the designer has selected a suitable choice of parameters, the specific output can be used to determine the airflow required to give the specified power. Having determined the airflow, pressure ratio and turbine inlet temperature, attention can be turned to the aerodynamic design of the turbomachinery. The aerodynamic design of the turbomachinery must take into account manufacturing feasibility from the outset. The mechanical design can start only after the thermodynamic and aerodynamic design teams have established the key dimensions of the engine. It will then probably be found that stress or vibration problems may lead to further changes. A successful engine may have its power tripled during a long development cycle. Eventually, however, the engine will become outdated and no longer competitive with newer technology designs. The timing of a

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decision to start a new design is of critical importance for the economic well-being of the manufacturer.

## IV. TYPES OF GAS TURBINE

### A. *Turbojet Gas Turbine*

Turbojet is the first gas turbine although they look completely different as compared to reciprocal engines their operating principle is the same as intake, compression, power & exhaust. In this type of turbine, air moves at a high speed toward the inlet of fuel & igniter of the chamber. Once the air expands then the turbine induces accelerated exhaust gases. The advantages of turbojet turbines are being small in size, less weight, simple design, and running at high speed. The disadvantages of turbojet turbine are; they generate high noise, their performance is low at high performance, consumes a high amount of fuel and cannot be used for traveling long distances.

### B. *Turboprop Gas Turbine*

This type of turbine includes a turbine, propelling nozzle, an intake, a combustor, a reduction gearbox & compressor. This turbine is mainly used in small, medium commuter, and big aircraft. Turboprop turbines need a reduction gearbox because the finest propeller performance can be achieved at much less speeds than the operational speed of the turbine. So this type of turbine approximately uses the 6 generated power from 80% to 85% to drive the propeller. The remaining accessible energy utilizes as a force to eliminate the exhaust gases. The advantages of turboprop include; these turbines are available with less weight, are small in size, are most efficient for a short distance, and burn less fuel every hour as compared to jet engines. The disadvantages of turboprops include; they have less speed, generating high noise, are at a high altitude, losing efficiency, and are not suitable for long journeys.

### C. *Turbofan Gas Turbine*

When the jet engine generates power through a ducted fan then it is known as a turbofan turbine. It is the combination ofa fan and a turbine. In a turbofan turbine, the turbine gets mechanical power from the combustion chamber whereas the fan gets the power from the turbine. A turbofan turbine can be simply connected to the front side of the turbojet turbine through a duct fan. After that, the fan creates an additional push to cool the turbine & also reduce the noise output. These turbines are used in aircraft. The advantages of turbofan include; consuming less fuel, less noise, and being suitable for long-distance traveling whereas the disadvantages are; available in large size, cannot control unexpected variations within the load, and use a ducted fan to generate power.

### D. *Turboshaft Gas Turbine*

When the gas turbine is optimized to produce shaft power rather than jet propulsion is known as a turboshaft engine. The turboshaft engine working principle is extremely similar as compared to a turbojet type. The main dissimilarity between a turboshaft & a turbojet is that in a turboshaft, the highest energy part generated through the expanding gas is used to power the turbine rather than generating thrust. Theseturbines are used where small size, less weight, continuous high performance & high reliability is required. Most helicopters, large aircraft & liquefaction stations of natural gas use turboshafts. The advantages of turboshafts include; reliability is high, availability in small sizes, and continuous high performance whereas the disadvantages are; generate high noise, they use high power for starting and manufacturing cost is high.

## V. SMALL GAS TURBINE ENGINES

### A. *PRATT & WHITNEY CANADA PW610F*

Eclipse Aviation announced the selection of this engine at a T-O rating of 4.00kN to ISA +10℃ as a replacement engine to power the eclipse 500 baby business jet. The prototype had previously made one flight with the original Williams FJ22 engine which eclipse then declared to be insufficiently powerful. The PW610F began its first flight testing on an Albuquerque-based Pratt & Whitney B-720 on Dec 20. The PW610F was certificated by Transport Canada on 22 June 2006.

- *Type*: Simple Two-shaft turbofan, turboprop ,or turboshaft engine.
- *Inlet:* Varies with the type of output. Turbofan inlet feeds core and full-length bypass duct.
- *Fan:* Turbofan only, single axial stage with 11 wide chord blades.
- *Compressor:* Single stage mixed flow followed by single stage centrifugal on the same shaft.
- *Combustion Chamber*: Folded annular reverse flow. *HP Turbine:* Single stage driving the compressor.
- *LP Turbine:* Single stage driving the fan or output shaft.
- *Jetpipe:* Turbofan versions, a 16-lobe mixer nozzle for minimum, noise levels; Other versions a plain pipe.
- *Accessories:* Driven off HP shaft on the underside of turbofan and aft face of gearbox of turboshaft engine or turboprop.
- *Revereser:* Turbofan versions have a target type reverser.
- *Starting:* Electric
- *Control System*: Dual-channel Fadec for simple control & intelligent health monitoring.
- *Length:* 1059mm
- *Diameter:* 355.6mm
- *Dry Weight:* 113 to 249 kg
- *Performance rating*: Take-Off, Sea Level 4.00Kn

### B. *TJ100C*

Fig. 1: TJ100C

One of the smallest engines for manned aircraft. It embodies the experience gained with several types of APUs. The TJ100A of identical dimensions but with a slightly higher thrust rating powered a Blanik L-13 all metal testbed glider during flight trials in 2007.

- *Type:* Single shaft turbojet
- *Compressor*: Single stage centrifugal. Radial followed by an axial diffuser.
- *Combustion Chamber*: Annular
- *Turbine*: Single stage axial
- *Jetpipe*: Simple centerline pipe for the whole jet
- *Accessories*: Electric power supply from an integral generator and AC/DC converter. Low voltage, high power ignition system.
- *Starting*: Electric
- *Control System*: Digital electronic
- *Fuel System*: Electrically driven fuel pump
- *Fuel Specifications*: Jet A-1
- *Oil System*: Autonomous system serving main shaft bearings
- *Oil Specifications*: MIL-L-23699
- *Specific Fuel Consumption*(take-off): 33.14mg/Ns
- *Diameter*: 272mm
- *Length*: 485mm
- *Dry weight*: TJ100A →20.6kg TP100 →55kg
- *Performance ratings*: Take-off(5min) 1kN

The main features include a neat compact design, Excellent power thrust-to-weight ratio ,and Low fuel consumption. The PBS TJ100 is a 4th-GENERATION turbojet engine, which is ideal for unmanned aerial vehicles (UAVs) and is particularly suitable for use by the rescue services, the police, the military for reconnaissance purposes and also for other projects, assignments ,and missions within military applications. These turbojet engines are also ideal for gliders and light sports and experimental airplanes.

*C. TURBOMECA MARBORÉ*

Fig. 2: Turbomeca Marbore

The Marboré turbojet is still the most widely used of Turbomeca's range of gas turbines. Designed in 1949, it was a direct scale of the company's first engine for aircraft propulsion, the 0.98 kN Piméné of 1948. It first ran in 1950, and the 2.94 kN Marboré I powered the Gémeaux II on 16 June 1951. Marboré II Rated at 3.92 kN at 22,600 rpm. Fitted to many aircraft, notably including the Fouga Magister twin-jet trainer. The following particulars relate primarily to the Marboré VI series

- *Type*: Single-shaft centrifugal-flow turbojet.
- *Intake*: Annular sheet metal nose intake bolted to the front of the light alloy compressor casing.
- *Compressor*: Single-sided impeller machined from two alloy forgings, shrunk on a steel shaft ,and locked and dowelled to maintain alignment. Externally finned light alloy compressor casing supports front ball-bearing for rotating assembly in a central housing supported by three streamlined struts. This housing also contains gears for accessory drives.

Pressure ratio 3.84:1. Air mass flow 9.8 kg/s (Marboré II, 8.0kg/s.

- *Combustion Chamber*: Composed of inner and outer sheet metal casings, forming an annular flame tube. Air from the compressor passes through both radial and axial diffuser vanes and divides into three main flows, two primary for the combustion and one secondary. Two primary flows enter the combustion zone from opposite ends of the chamber, the rear stream through the turbine nozzle guide vanes which cools. Secondary flow enters through the outer casing for dilution and cooling of combustion gases. Two torch igniters.

- *Turbine*: Single-stage turbine with 37 blades with fir-tree root fittings in steel disc. Bolted to main shaft and tail shaft, latter supported by a rear roller bearing for 11 rotating assemblies. 25 hollow sheet steel guide vanes cooled by part of primary combustion air. Gas temperature 613ºC at 21,500rpm.

- *Jetpipe*: Inner and outer sheet metal casings, latter supported by three hollow struts. The inner tapered casing extends beyond end of the outer casing to induce airflowthrough struts to cool the rear main bearing and inner casing. *Mounting*: Four points, with Silentbloc rubber mountings, two at the front and two at the rear.

- *Accessories*: Gear casing in central compressor housing with drives for fuel and oil pumps. Connecting shaft to the underside of accessories gear case above compressor casing. Accessories include a tachometer generator and electric starter. Take-off (4 hp continuous) for a remotely driven accessory box.

- *Starting*: Air Equipment 24 V electric starter or compressed air starter. Two Turbomeca igniter plugs.

- *Control System*: Fuel, pumped through hollow impeller shaft, is fed to combustion zone by rotating injector disc around periphery of which are number of vents which act as nozzles. Fuel is vented by centrifugal force, being

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atomized in the process. Fuel delivery at low thrust settings regulated by bypass valve.

- *Fuel Specification*: AIR 3405 (JP-1).
- *Oil System*: Pressure type. Single gear-type pump serves front gear casing, two main bearings and rpm governor. Three scavenge pumps return bearing oil to tank via cooler. Normal oil pressure 2.8 kg/cm2
- *Oil Specification*: AIR 3512 (mineral) or AIR 3513A (synthetic).
- *Dimensions*: Length with exhaust cone but without tailpipe 1,416 mm
- *Width*: 593 mm
- *Height*: 631 mm
- *Weight, Dry* 140 kg
- *Specific Fuel Consumption* 30.3 mg/Ns
- *Performance Ratings* (ISA, S/L): T-O, 21,500 rpm→ 4.71 kN Cruising, 20,500 rpm → 4.11 kN

*D. TOLLOUE 4*

This engine, the first aircraft engine to be revealed as designed and constructed in Iran, is claimed to have been created entirely indigenously, with the exception of reverse-engineering certain compressor parts. Its existence was revealed in September 1999 by Rear-Admiral Ali Shamkhani, the Iranian Minister of Defence. A simple engine intended for the propulsion of targets, cruise missiles and other UAVs (for example, for reconnaissance and electronic warfare).

- *Type*: Single-shaft turbojet.
- *Compressor*: Three axial stages. Pressure ratio: 3.75
- *Combustion Chamber*: Annular.
- *Turbine*: Single-stage axial.
- *Jetpipe:* Sheet-metal, fixed-area nozzle.
- *Length*: 1,330 mm
- *Diameter:* 330 mm
- *Weight, Dry*: 54.7 kg
- *Performance Rating:* T-O → 3.7 kN at 29,500 rpm

*E. AMNTK Soyuz R123-300*

Projected engine for low cost propulsion of light jet aircraft

- *Type*: Two-shaft turbofan
- *Fan*: Single stage
- *Bypass ratio*: 6
- *Compressor*: Two axial stages with variable inlet vanes and single centrifugal stage
- *Turbines*: Single stage HP, Single stage LP *Jetpipe*: Mixer leads to combined nozzle *Performance rating*: 4.22kN class

*F. AMNTK Soyuz R125-300*

A projected small turbofan of outstanding simplicity. In late 1990's AMNTK Soyuz studied many small jet engines of which one of the simplest was the R125. Essentially it would be a simplified derivative of the R-95TM-300. It is a small turbofan for RPV propulsion. The derived R125 was again intended for short-life 14 applications but from 2002 was being considered for manned aircraft. Its single stage turbine would have to drive both fan and the three stage compressor. Among its suggested features are Fadec control and an automatic lubrication system.

- *Performance Rating*: Take-off, Sea level →3.73kN
- *Overall Diameter*: 315mm
- *Length*: 535mm
- *Dry Weight*: 50kg

*G. Motor Sich MS-400P*

Fig. 3: Motor Sich MS-400P

This small turbofan is the first to be designed by Motor Sich which has previously mass-produced to the designs of others. It is being developed for use in small jet aircraft, especially entry-level small business jets and UAVs.

- *Type*: Single shaft turbofan
- *Fan*: Single stage axial with 22 blades *Compressor*: Probably single stage centrifugal *Combustion Chamber*: Annular
- *Turbine*: Probably single stage *Jetpipe*: Mixed flow fixed geometry*Length*(basic engine): 875mm
- *Diameter*: 320mm*Height*: 455mm *Dry Weight*: 85kg
- *Performance Rating*: Take-off, sea level → 3.92kN
- *Specific Fuel Consumption:* 24.05mg/Ns

*H. TCM Turbine Engines J69*

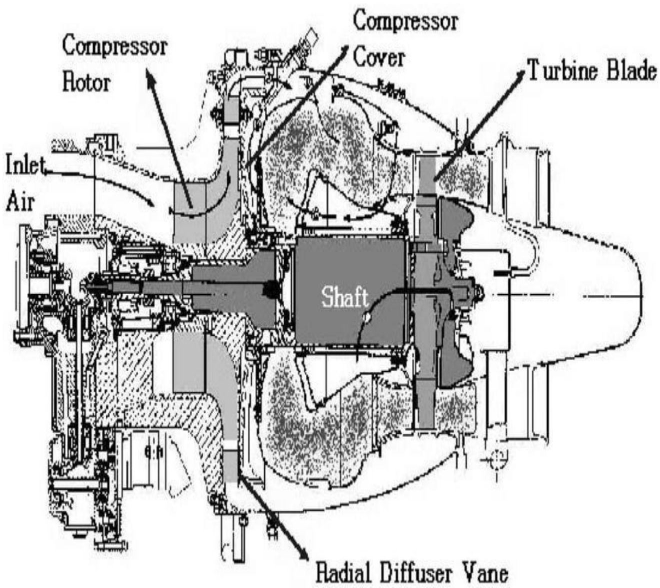


Fig. 4: TCM Turbine Engine Schematic

This turbojet is a licensed version of the French Turbomeca Marboré II, further developed by the former Continental Motors and built in several versions. Most applications are for unmanned vehicles, but the most important version is the J69- T-25A. This is the current version fitted to the USAF's primary jet pilot trainer, the Cessna T-37A. Several thousand engines of the basic T-25 (Model 352) family have been in USAF service in this aircraft since 1954, and they will not be replaced for many years, even though the turboprop-engined T-6A Texan II is entering full service from 2000. J-69 compressor inducer rotor assemblies are machined from a light-alloy forging and guides air into the centrifugal compressor to which these curved vanes are attached. In 2000 it was estimated that the T-37A will continue to train pilots until 2012 with the USAFand possibly until 2030 with other nations.

- *Type*: Single-shaft turbojet.
- *Compressor*: Single-stage centrifugal. Mass flow 9.07 kg (20.0 lb)/s. Pressure ratio 4.1.
- *Combustion Chamber:* Annular, rotary centrifugal fuel distributor.
- *Turbine:* Single axial stage with replaceable blades. *Jetpipe*: Fixed area, maximum gas temperature 663ºC. *Accessories:* Fuel and oil pumps, electric starter/generator, tachometer and hydraulic pump, off front of shaft.
- *Control System*: Hydro-mechanical.
- *Length*: 898.9 mm
- *Diameter:* 566.9 mm
- *Weight, Dry:* 162.4 kg
- *Performance Ratings:* (S/L, ISA) T-O → 4.559 kN at 21,730 rpm Normal → 3.914 kN at 20,700 rpm
- *Specific Fuel Consumption*: T-O → 32.29 mg/Ns Normal → 31.72 mg/Ns

### I. *WILLIAMS - WILLIAMS INTERNATIONAL*

This company was formed in 1955 by Sam Williams, who believed that gas turbine jet engines could be effective propulsion systems in very small sizes. The first manned application of a small Williams engine did not materialize until 1977 when the WR44 turbofan was chosen for the foxjet. The project never came into fruition and in 1989 Williams accepted that for the time being there appeared to be no significant market for very small civil jets. He began full scale development of WR44 into the FJ44 into a higher thrust category. Williams gained the major shares of the large markets for cruise-missile propulsion, as well as important contracts to power targets and unmanned reconnaissance vehicles. Williams engines for unmanned vehicles include the following:

- *F107-WR-402*: turbofan, 3.11kN, class, Tomahawk cruise missile.
- *F122-WR-100*: turbojet, 4.45kN, tri-service standoff attack missile
- *F415-WR-400:* turbofan, 3.11kN, tactical tomahawk cruise missile
- *WJ24-8*: turbojet, 1.2kN, BQM-74E target

### J. *WILLIAMS INTERNATIONAL FJX*

This small turbofan is being developed under the GAP (General Aviation Propulsion) programme. A co-operative effort with NASA, this is intended to revolutionize and revive the once-flourishing American light-aircraft industry. Key features will be the lowest possible capital and operating costs, minimal fuel burn, very low noise and emissions and light weight.

- *FJX-1*: T-O rating 3.11 kN. Powers second Chichester-Miles Leopard light business jet which has been flying since April 1997.
- *FJX-2*: T-O rating 3.11kN class. The first complete engine ran in December 1998. Among many potential customers for this engine is the British Chichester-Miles company, for the third Leopard prototype. Another application is a jet derivative of the Piper Aerostar.
- *EJ-22*: T-O rating 3.42 kN. Variant being developed for twin-engined Eclipse 500. Similar to FJX-2 apart from increased ratings.
- *FJ22:* T-O rating 3.56kN. The French Ameur Altajet was powered by two FJ22's.
- *Type*: Two-shaft turbofan
- *Fan*: Single stage rotor with 20 integral blades Bypass ratio 4.6 LP
- *Compressor*: Six stage axial spool machined from single monolithic forging.
- *HP Compressor*: Single stage centrifugal
- *Combustion Chamber*: Folded annular
- *Turbines:* Probably 3 single stage axials
- *Control System*: Fadec
- *Length*: 1,041 mm
- *Diameter*: 368.3 mm
- *Weight, Dry*: EJ-22 about 39.55 kg

### K. *Williams International FJ33*

Basically an FJ44-2 on a reduced scale 19 FJ33-4A: T-O rating selectable from 4.448kN to 6.7kN Safire jet, a conventional small bizjet, was to be powered by two FJ 33-4 engines each rated at 4.89Kn.

### L. *Williams International FJ44*

Williams International planned the FJ44 as its first engine intended specifically for conventional manned aircraft, especially light business jets and training aircraft. Design of what was at first called the WR44 began in 1971, using the WR19 as a basis. BPR and OPR were both increased. Prototype engines were tested in a two man VTOL vehicle in 1973. At a rating of 3.78 kN, the first WR44 was chosen for the Foxjet, but the engine was then again redesigned to increase BPR and thrust, being redesignated FJ44. The first FJ44 achieved design thrust at a very modest TET. Since then different FJ44 versions have appeared. All are characterised by simplicity, low cost, high reliability and the ability to replace turboprops in aircraft operating from small airports. All versions allow fan or hot section replacement whileinstalled on aircraft.

- *Type*: Two-shaft turbofan.
- *Fan:* Single-stage with integrally bladed rotor in titanium with 20 wide-chord shroudless blades.

- *LP Compressor:* Single-stage axial rotating with the fan on the LP shaft. FJ44-2 has a three-stage core booster.
- *HP Compressor:* Single-stage centrifugal.
- *Combustion Chamber:* Radial delivery from compressor leads to folded annular combustor.
- *HP Turbine:* Single stage with inserted blades.
- *LP Turbine:* Two stages with inserted blades.
- *Jetpipe:* Single fixed-area nozzle for combined flows from core and full-length fan duct.
- *Control System:* Hydromechanical unit (HMU)
- *Performance Rating*: 2.25kN

## VI. CONCLUSION

In conclusion, Small gas turbine engines are employed in several applications such as rotorcraft, cruise missiles, unmanned aerial vehicles (UAV), and light subsonic aircraft. In small gas turbines applied to manned vehicles, the major requirements are higher cycle life and low risk of component failures while keeping the safety and reliability. In unmanned vehicle, for short time use, low acquisition cost and good performance of the engines are the key requirements. Such turbojet and turbofan engines often consist of single-stage centrifugal, a mix of axial-centrifugal, or multi-stage axial compressors and one/two-stage axial turbine. In general terms, a compromise between the performance, engine size, and complexity must be established since low cost is one of the major requirements for small gas turbine engines. Understanding the small gas turbines historical engines origins and other applications gives the gas turbine community a better handle on optimized design, operation and maintenance.

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## AUTHORS PROFILE

**Oruganti Y. S. Prudhviraj** was born on March 12, 2002. I'm a student at the SRM Institute of Science and Technology, where I'm pursuing a bachelor's degree in aerospace engineering. In addition to my coursework, I've developed my skills using industrial tools like SOLIDWORKS, CATIA, ANSYS FLUENT, FUSION 360, XFLR5, and MATLAB. I have completed project-oriented training at organizations like DRDRO-CEMILAC, Eigen Aerospace, and Capgemini Engineering. I am a member of SAE India and the student club SRMSCRO (copter research organization). My area of expertise is aerodynamics andpropulsion, and some of the projects I've worked on there include designing and building an octacopter to study the earth's boundary layer, an urban air mobility vehicle to provide intercity transportation with a 500km range, and many other drone-related ideas. I finished sixth in the IIT BOMBAY drone obstacle race, fourth in the aahrush design competition 2020, and seventh in NACDEC-IV.

**Ravi teja Cheepuri,** was born in 6th January 2002. I have passed Matriculation and Higher Secondary in Andhra Pradesh. At a young age I am fascinated by Aircrafts,drones, fighter jets etc. So, I chose Aerospace as his career path in my Bachelors. During my early years of Bachelors, I have developed my skills by learning some of the important design software like CATIA, AUTOCAD, SOLIDWORKS and simulation software like ANSYS and Fusion 360. I have completed couple of Internships in Omspace Rocket and Exploration Pvt Ltd (6months duration) and at Advanced system laboratory [DRDO] (1 month duration) and currentlydoing a Major Project on Aerodynamics domain i.e., Aerodynamic and stability analysis of different missiles using numerical simulations.

**Sai Rama Priya Raavi,** was born on 21st August 2001. I passed Matriculation and Higher Secondary in Andhra Pradesh. For my Bachelor's Degree I have chosen Aerospace as my career path because of my interests in Air breathing propulsion systems and Aerodynamics . During my early years of B.Tech, I have developed my skills by learning some of the important design software like CATIA, SOLIDWORKS and simulation software called Ansys which is integrated into most of the research laboratories and well developed industries. I have Internship experience from IITM RESEARCH PARK and GTRE (DRDO).