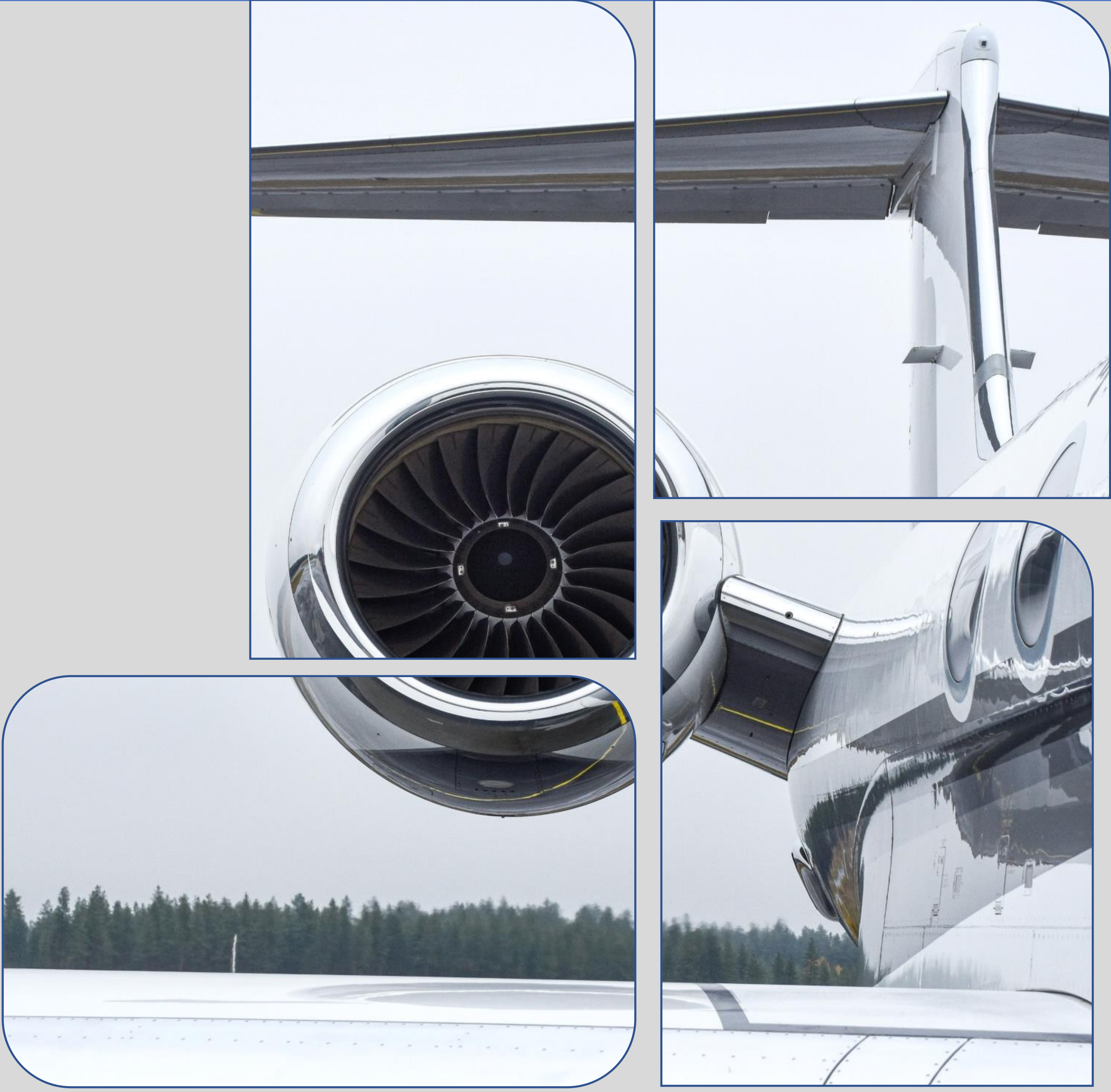

3D MODELLING OF JET ENGINE GAS TURBINE

A REPORT SUBMITTED BY
SUMANTA DAS

CERTIFICATE FROM SUPERVISOR

This is to certify that “SUMANTA DAS, 35000719043” have successfully completed the project titled "3D Modelling of an Jet Engine Gas Turbine in SolidWorks" under my supervision during the period from “15.11.21” to “15.12.21” which is in partial fulfilment of requirements for the award of the B.Tech degree and submitted to the Department of “Mechanical Engineering” of “Ramkrishna Mahato Government Engineering College**”.**

Signature of the Supervisor

Date –

Name of the project Supervisor: **Prof. ASIM KUMAR BATABYAL**

ACKNOWLEDGEMENT

The achievement that is associated with the successful completion of any task would be incomplete without mentioning the names of those people whose endless cooperation made it possible. Their constant guidance and encouragement made all our efforts successful.

We take this opportunity to express our deep gratitude towards our project mentor, *Prof. Asim Kumar Batabyal* giving such valuable suggestions, guidance and encouragement during the development of this project work.

Last but not the least we are grateful to all the faculty members of Ardent Computech Pvt. Ltd. And our Mechanical Department for their support.

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PROJECT OBJECTIVE

The objective of this project is to design a Jet Engine turbine by designing the component parts first, assembling them to create a model of a working proper jet.It consists of design , fabrication, assemble and testing a jet engine, using a large truck turbocharger, on a small scale level.

Facinated by turbojet engines, we decided to learn all that we can about jet engines is to build one. Like us thrilled by the gas turbine propulsion, quite a few experiments have gone to extent of buiding their own custom gas turbine engines. The first military turbine engine was constructed by Garrett/ Aireseach on experimental basis using a simple turbocharger. It was built as a research project for US government. Many experimenters have uploaded their experimented gas turbine based projects on the internet. There is good amount of the information available on the subjects with all kinds of designs being employed. We want to use these ideas study how actual gas turbines operate, what variables go into picture while designing a working gas turbine and what sort of difficulties are encountered while construction of an actual working gas turbine from a scrap turbocharger, this encouraged us to build our own turbocharger based turbojet engine that will be a research test bed for our project.

Our objective is to construct a working scaled model of a turbojet engine using diesel truck turbocharger which will be self sufficient and requiring no separate power sources to operate thus allowing the unit to be mobile. The turbojet engine project consists of Design, fabrication, assembly and testing of a Jet Engine, using Solidworks.

ABOUT SOLIDWORKS

SolidWorks is a solid modeller, and utilizes a parametric feature-based approach which was initially developed by PTC (Creo/Pro-Engineer) to create models and assemblies. The software is written on Parasolid-kernel.

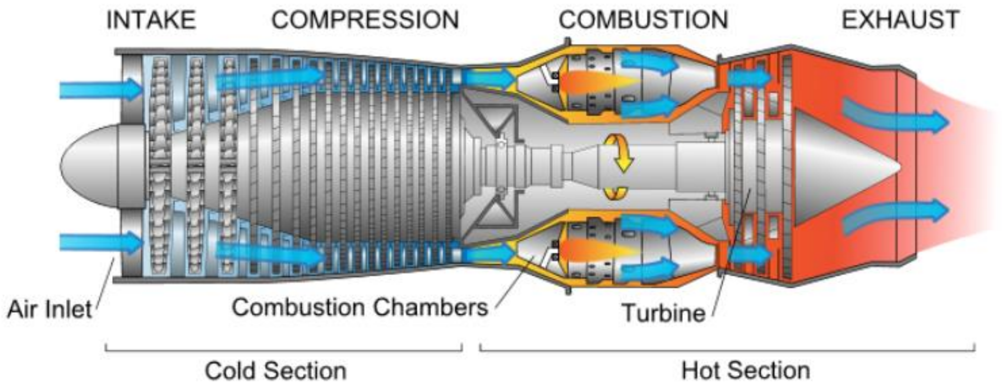
Building a model in SolidWorks usually starts with a 2D sketch (although 3D sketches are available for power users). The sketch consists of geometry such as points, lines, arcs, conics (except the hyperbola), and splines. Dimensions are added to the sketch to define the size and location of the geometry. Relations are used to define attributes such as tangency, parallelism, perpendicularity, and concentricity. The parametric nature of SolidWorks means that the dimensions and relations drive the geometry, not the other way around. The dimensions in the sketch can be controlled independently, or by relationships to other parameters inside or outside the sketch.

In an assembly, the analog to sketch relations are mates. Just as sketch relations define conditions such as tangency, parallelism, and concentricity with respect to sketch geometry, assembly mates define equivalent relations with respect to the individual parts or components, allowing the easy construction of assemblies. SolidWorks also includes additional advanced mating features such as gear and cam follower mates, which allow modelled gear assemblies to accurately reproduce the rotational movement of an actual gear train.

Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed. The drawing module includes most paper sizes and standards (ANSI, ISO, DIN, GOST, JIS, BSI and SAC).

INTRODUCTION ABOUT JET TURBINE

A Jet gas turbine, also called a combustion turbine, is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber or area, called a combustor, in between.



The basic operation of the gas turbine is similar to that of the steam power plant except that the working fluid is air instead of water. Fresh atmospheric air flows through a compressor that brings it to higher pressure. Energy is then added by spraying fuel into the air and igniting it so the combustion generates a high-temperature flow. This high temperature high-pressure gas enters a turbine, where it expands down to the exhaust pressure, producing a shaft work output in the process. The turbine shaft work is used to drive the compressor and other devices such as an electric generator that may be coupled to the shaft. The energy that is not used for shaft work comes out in the exhaust gases, so these have either a high temperature or a high velocity. The purpose of the gas turbine determines the design so that the most desirable energy form is maximized. Gas turbines are used to power aircraft, trains, ships, electrical generators, pumps, gas compressors and tanks.

ADVANTAGES OF JET TURBINE

- MUCH smaller and lighter for a given amount of power.
- MUCH simpler, particularly compared to larger piston engines.
- Very rugged and reliable. Time between overhauls is greater. And they can reliably produce close to peak power for a long time.
- Capable of burning cheaper and less refined fuels. No need for expensive and toxic leaded avgas.
- Capable of much better performance.
- They are more fuel efficient, at least for larger engines.
- Quieter and less vibration.
- Lower lubrication needs.
- Better high altitude performance.
- Bleed air from the compressor can be used for HVAC and other purposes. This eliminates the need for extra equipment (as well as cost, weight, and space) to accomplish this task.
- Simply air control (only air, fuel, and rpm).

DISADVANTAGES OF JET TURBINE

- The turbojet engine is less efficient at low speed and at low altitude. Noisy Thrust is low at the time of take-off.
- The main one being the cost. Standard jet engines go for around $2,000,000. They take MUCH longer to accelerate than piston engines.

APPLICATIONS OF JET TURBINE

- Jet engines have propelled high speed cars, particularly drag racers, with the all-time record held by a rocket car. A turbofan powered car, ThrustSSC, currently holds the land speed record.

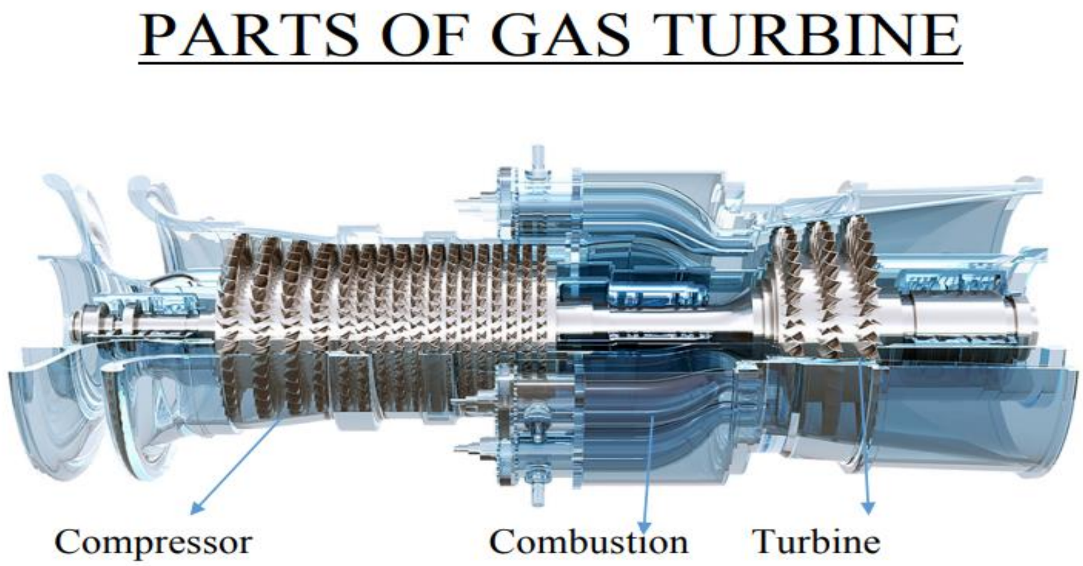
- Jet engine designs are frequently modified for non-aircraft applications, as industrial gas turbines or marine powerplants. These are used in electrical power generation, for powering water, natural gas, or oil pumps, and providing propulsion for ships and locomotives. Industrial gas turbines can create up to 50,000 shaft horsepower. Many of these engines are derived from older military turbojets such as the Pratt & Whitney J57 and J75 models. There is also a derivative of the P&W JT8D low-bypass turbofan that creates up to 35,000 Horse power (HP) .

- Jet engines are also sometimes developed into, or share certain components such as engine cores, with turboshaft and turboprop engines, which are forms of gas turbine engines that are typically used to power helicopters and some propeller-driven aircraft.

DESCRIPTION OF COMPONENT PARTS

Compressor: The compressor used in gas power plant is rotating type. The air at atmosphere pressure is drawn by the compressor through a filter which removes the dust.

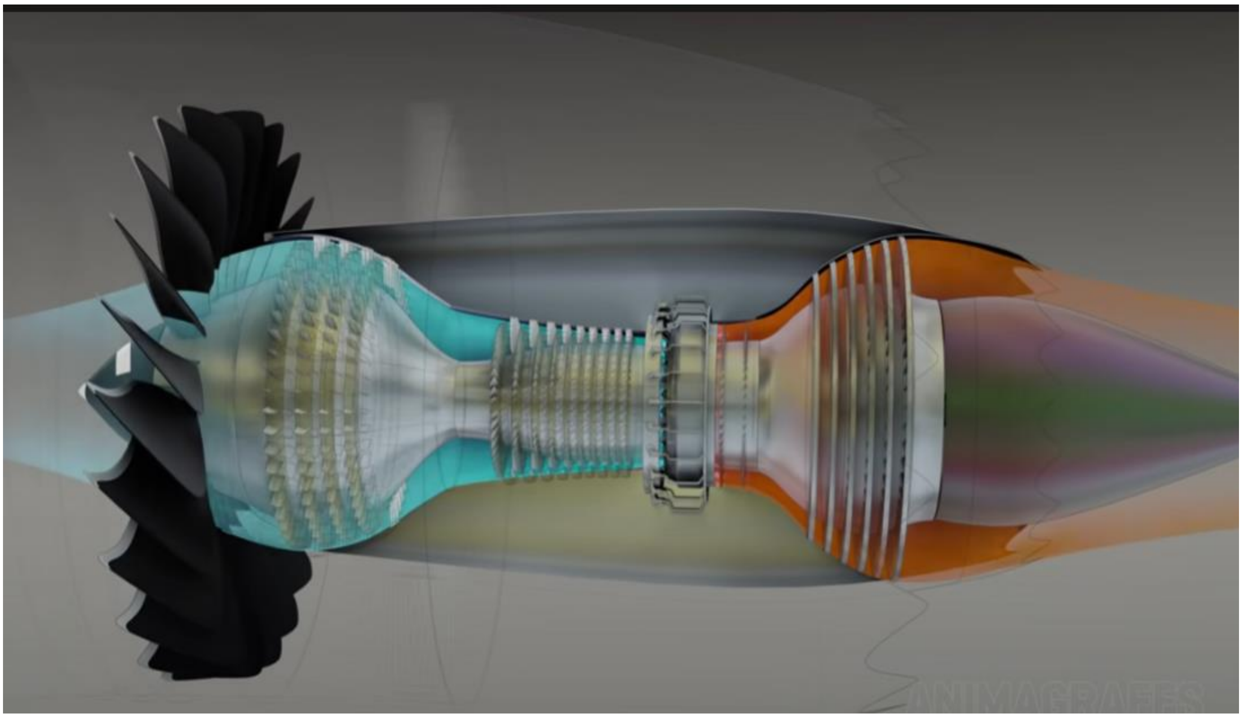
Combustion chamber: This is one of the important components of the gas power plant where the high-pressure air from the compressor is entered in it via regenerator. The air from regenerator is quietly heated which is not adequate to drive the gas turbine. Only hot air with high pressure can only drive the gas turbine.



Gas Turbine: This is heart component of the gas power plant. The hot air with high pressure and temperature is passed through gas turbine. The gases are expanded on the gas turbine blades which causes the rotation of blades to the intended mechanical work. After expanding, the exhaust gases with the temperature about 900 F are applied to the regenerator.

WORKING PRINCIPLE

In an ideal gas turbine, gases undergo four thermodynamic processes: an isentropic compression, an isobaric (constant pressure) combustion, an isentropic expansion and heat rejection. Together, these make up the Brayton cycle. In a real gas turbine, mechanical energy is changed irreversibly (due to internal friction and turbulence) into pressure and thermal energy when the gas is compressed (in either a centrifugal or axial compressor). Heat is added in the combustion chamber and the specific volume of the gas increases, accompanied by a slight loss in pressure. During expansion through the stator and rotor passages in the turbine, irreversible energy transformation once again occurs. Fresh air is taken in, in place of the heat rejection.



If the engine has a power turbine added to drive an industrial generator or a helicopter rotor, the exit pressure will be as close to the entry pressure as possible with only enough energy left to overcome the pressure losses in the exhaust ducting and expel the exhaust. For a turboprop engine there will be a particular balance between propeller power and jet thrust which gives the most economical operation. In a jet engine only enough pressure and energy is extracted from the flow to drive the compressor and other components. The remaining highpressure gases are accelerated to provide a jet to propel an aircraft. The smaller the engine, the higher the rotation rate of the shaft(s) must be to attain the required blade tip speed. Blade-tip speed determines the maximum pressure ratios that can be obtained by the turbine and the compressor. This, in turn, limits the maximum power and efficiency that can be obtained by the engine. In order for tip speed to remain constant, if the diameter of a rotor is reduced by half, the rotational speed must double. as turbines can be considerably less complex than internal combustion piston engines. Simple turbines might have one main moving part, the compressor/shaft/turbine rotor assembly, with other moving parts in the fuel system. However, the precision manufacture required for components and the temperature resistant alloys necessary for high efficiency often make the construction of a simple gas turbine more complicated than a piston engine. More advanced gas turbines (such as those found in modern jet engines) may have 2 or 3 shafts (spools), hundreds of compressor and turbine blades, movable stator blades, and extensive external tubing for fuel, oil and air systems.

DESIGN OF PARTS

With the help of Drafting tool of SolidWorks, we get the different views and measurements of the parts or assembly, designed in SolidWorks on a 3D sheet. This is done so that the technicians handling the manufacturing process of the parts clearly understand the specifications of the parts and how they need to build them.

The screenshots of the different views of the component parts of the Jet Gas Turbine are given below:

Compressor housing:

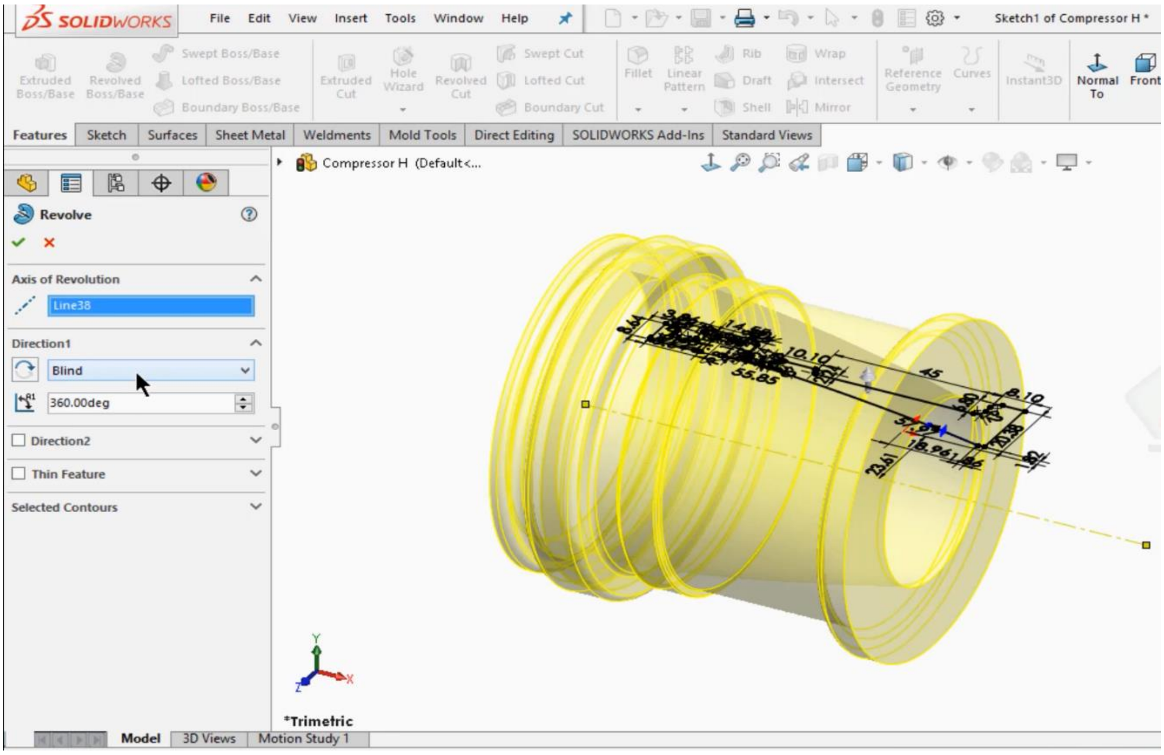


Fig-1: Making of Compressor housing

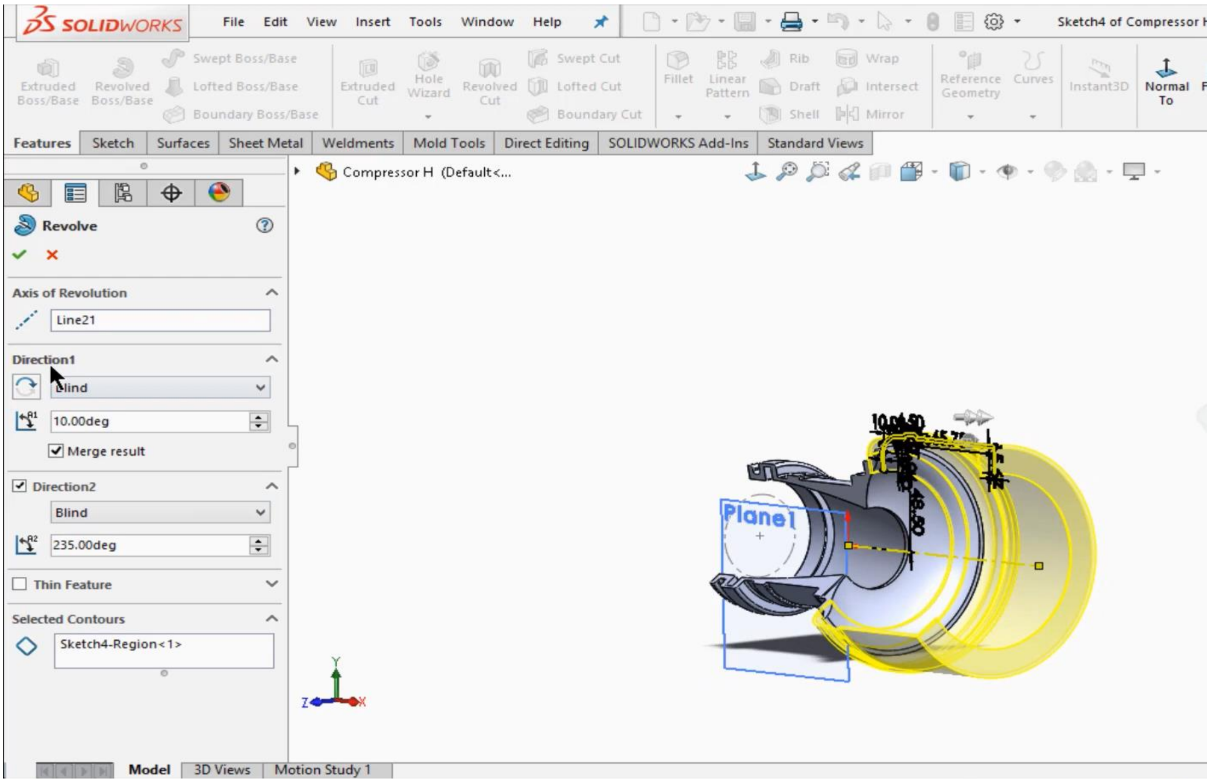


Fig-2

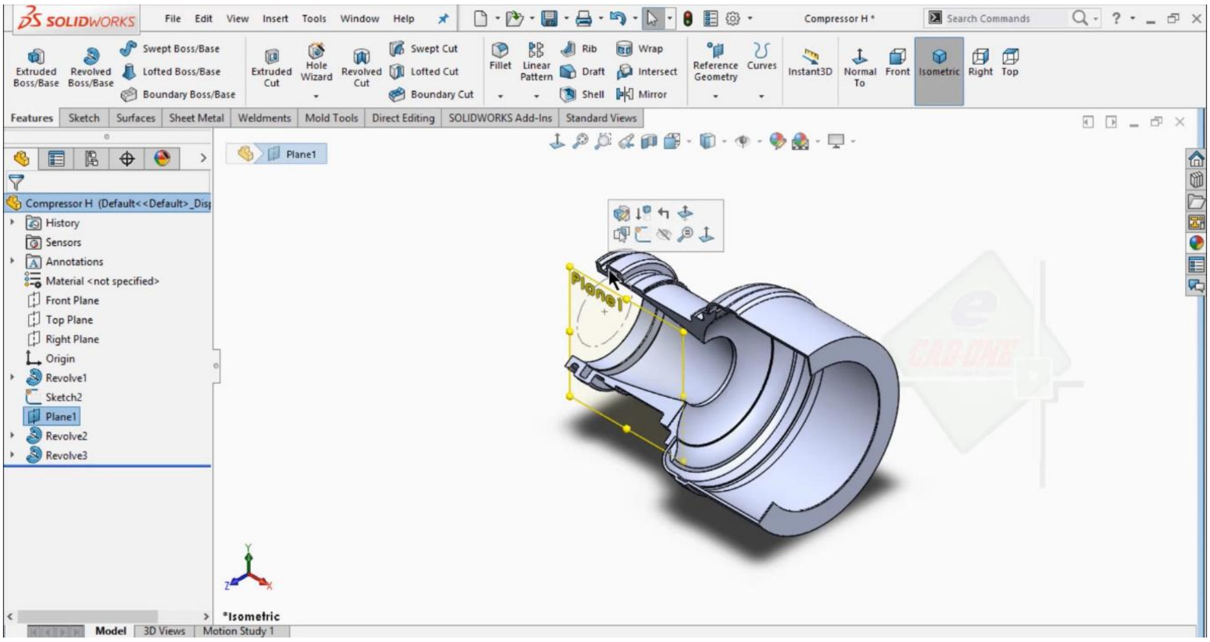


Fig-3: compressor housing

COMPRESSOR BLADE:

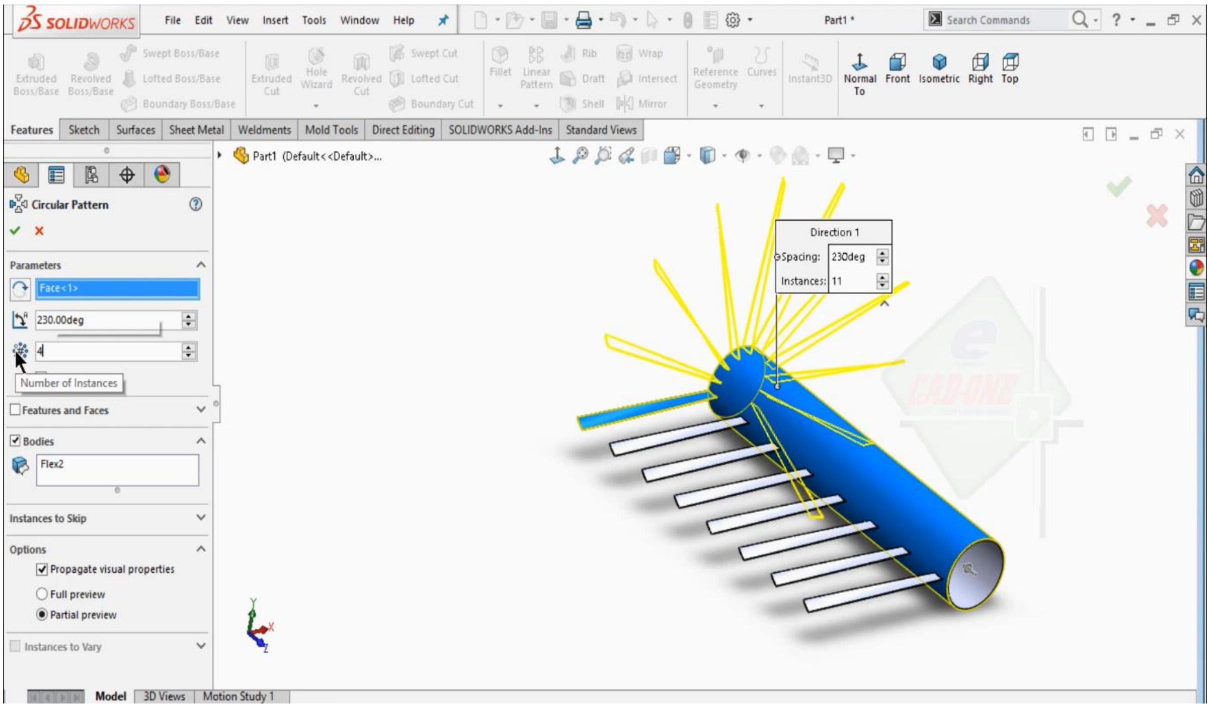


Fig-4: Making of Blade

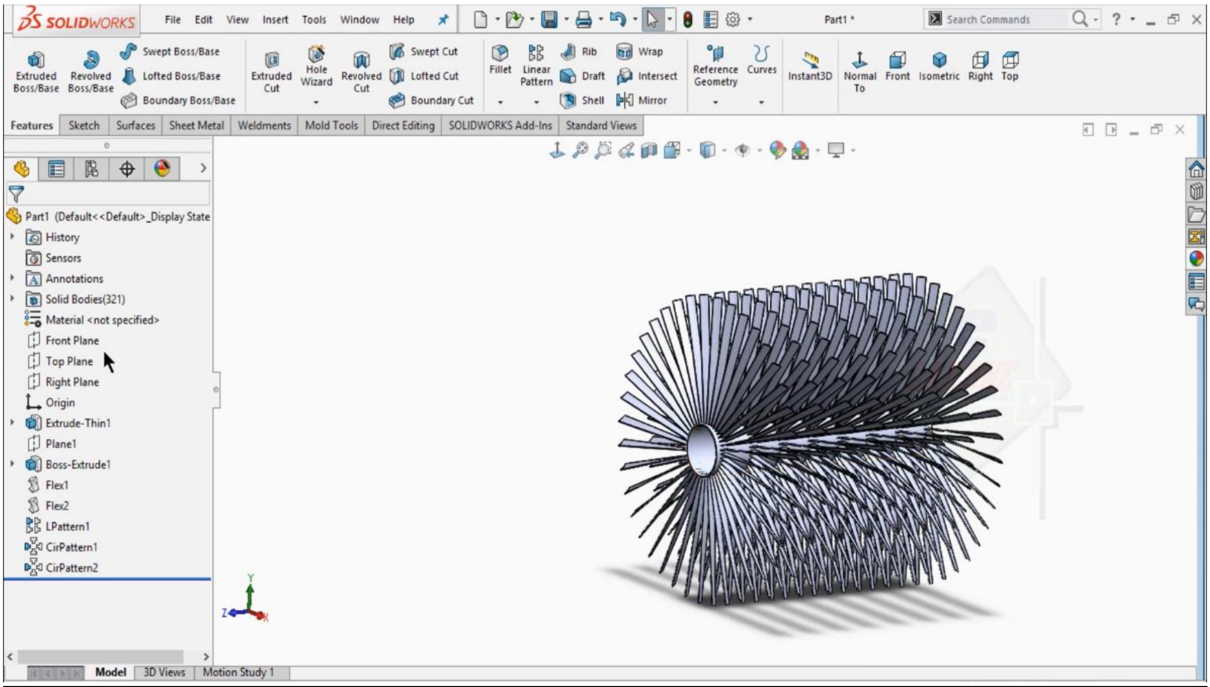


Fig-5: Blade Simulation

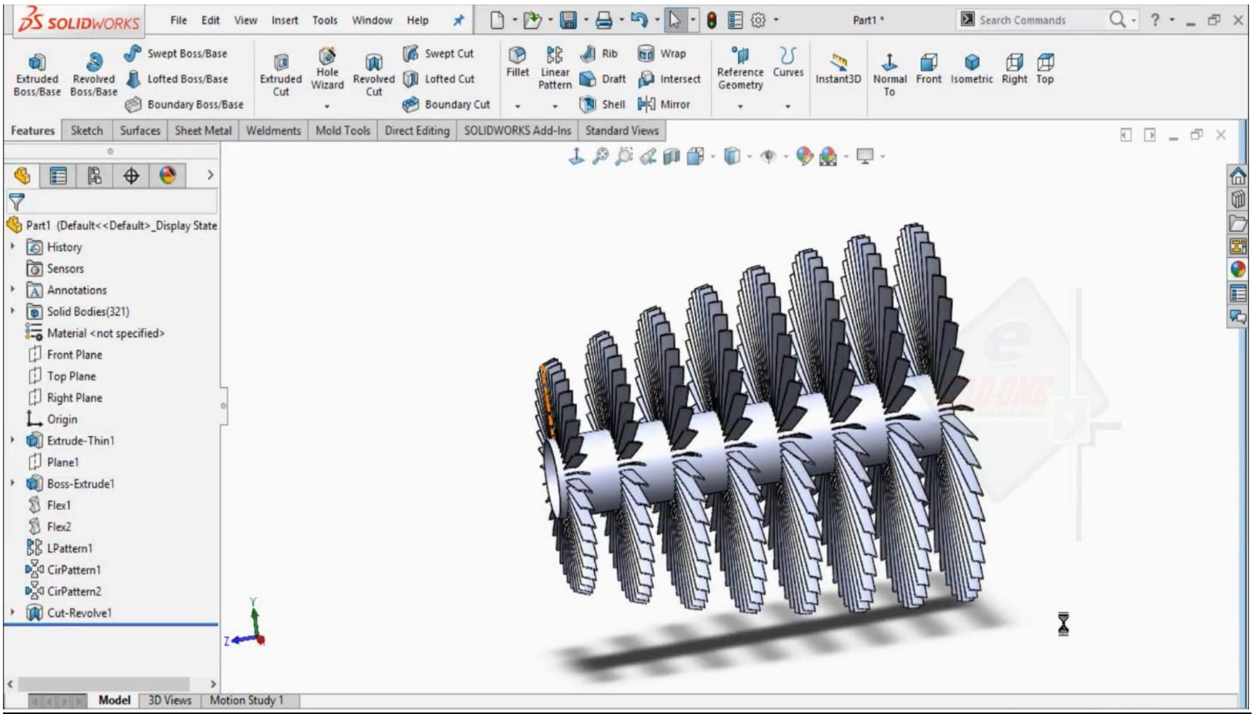


Fig-6: Compressor Blade

COMPRESSOR RUNNER TURBINE:

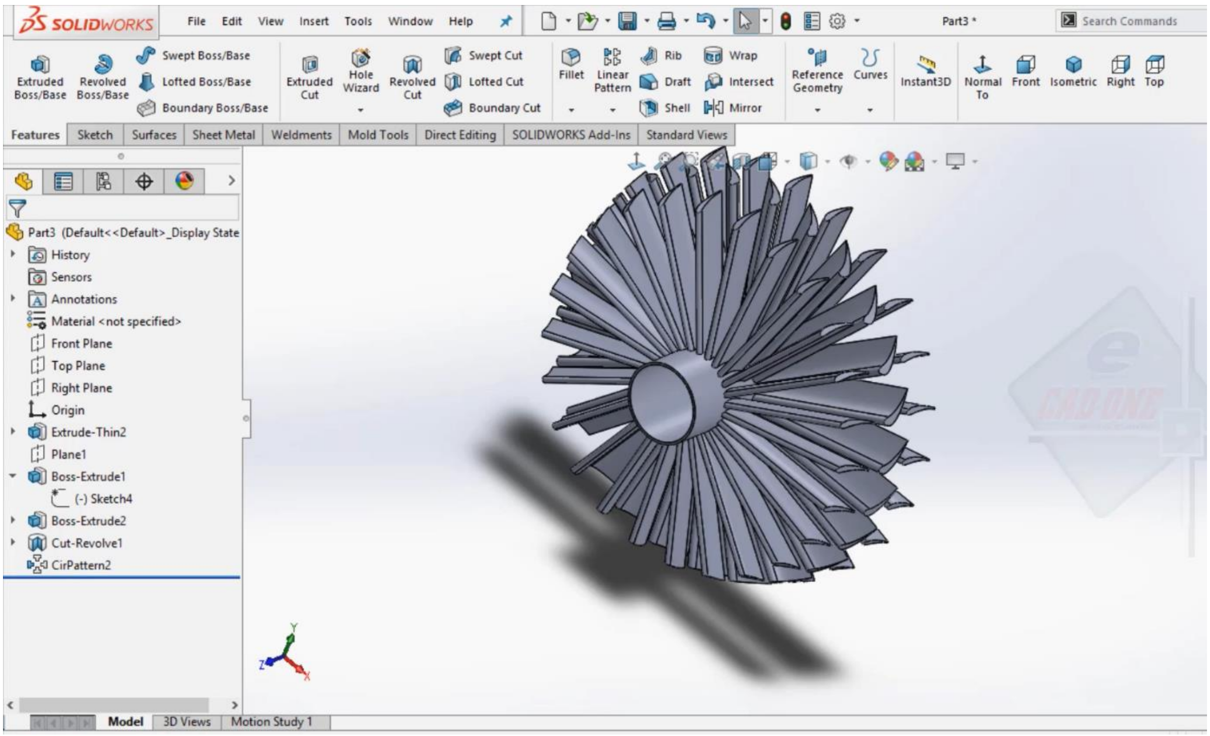


Fig-7: Compressor Runner Turbine

STATOR COMPRESSOR:

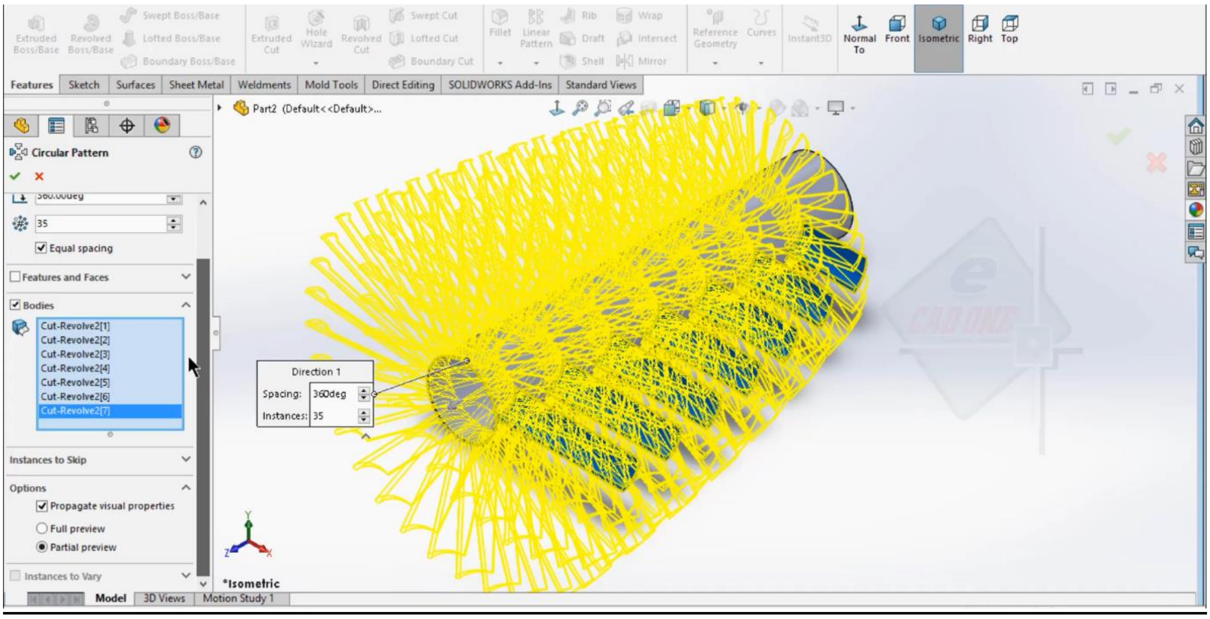


Fig-8: Making of stator

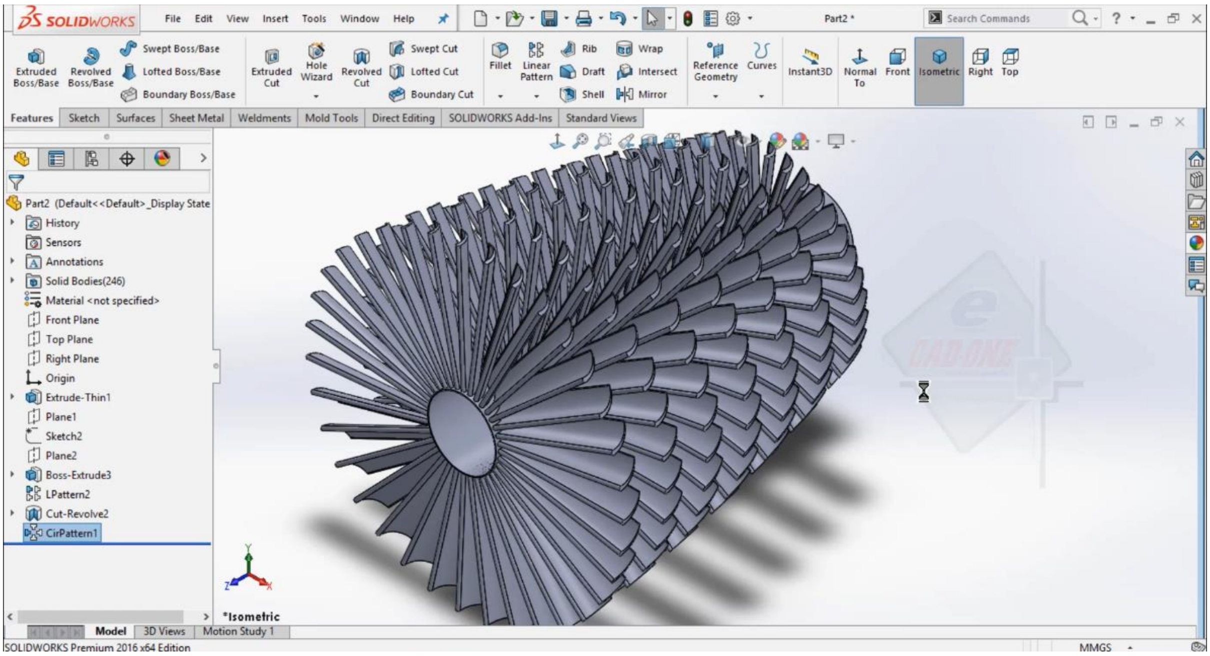


Fig-9: Stator Compressor

ROD:

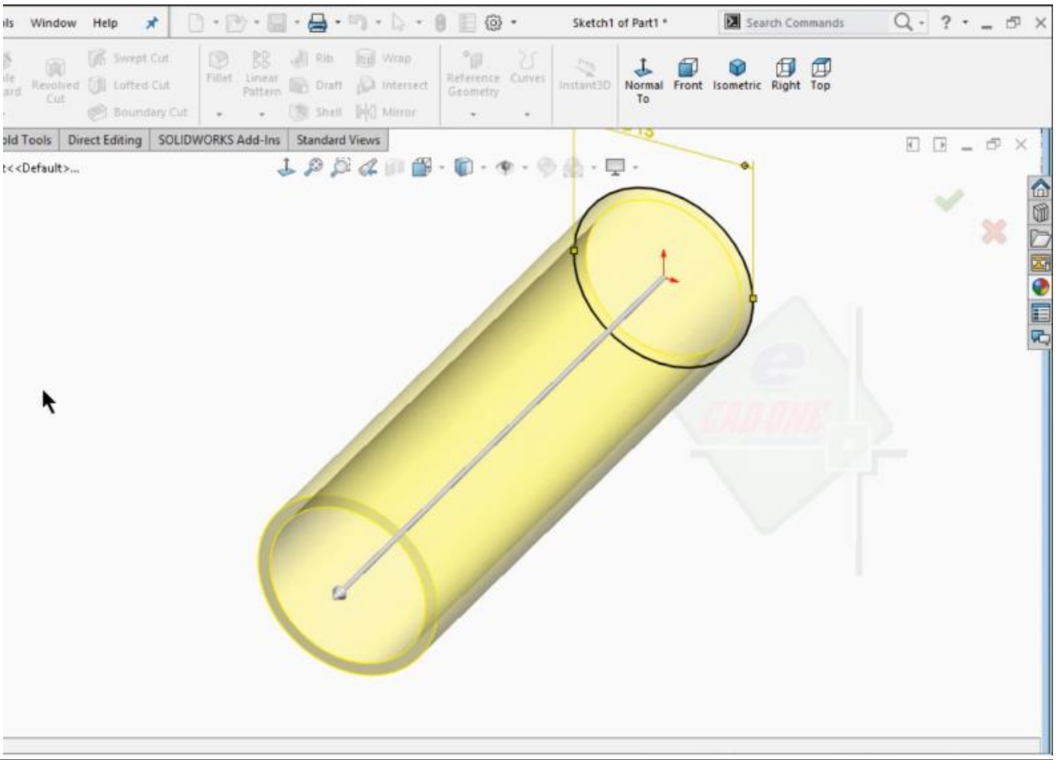


Fig-10: Shaft Rod

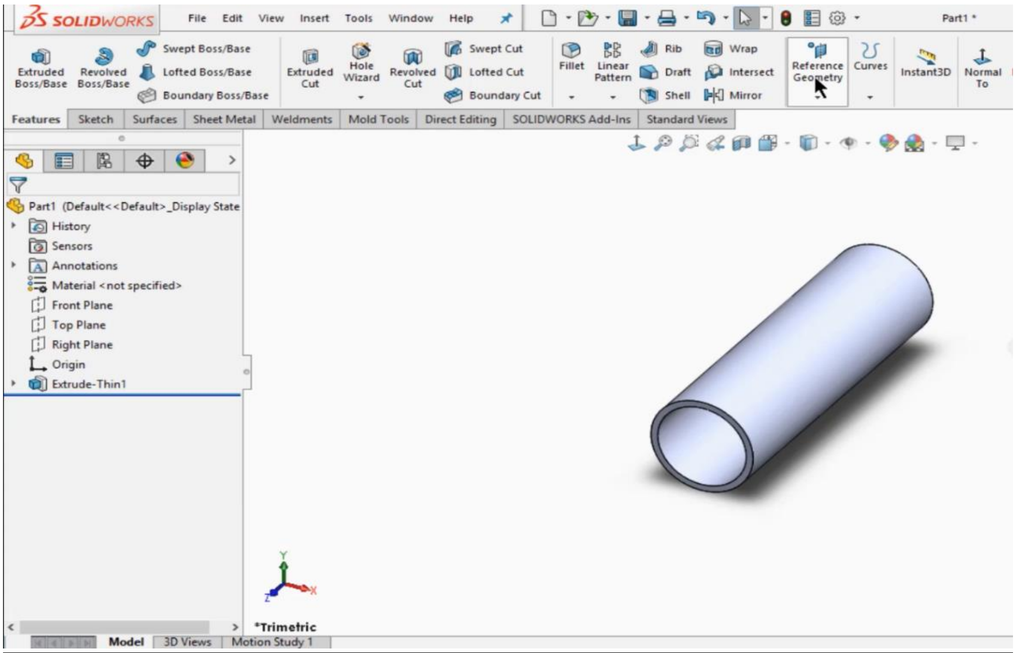
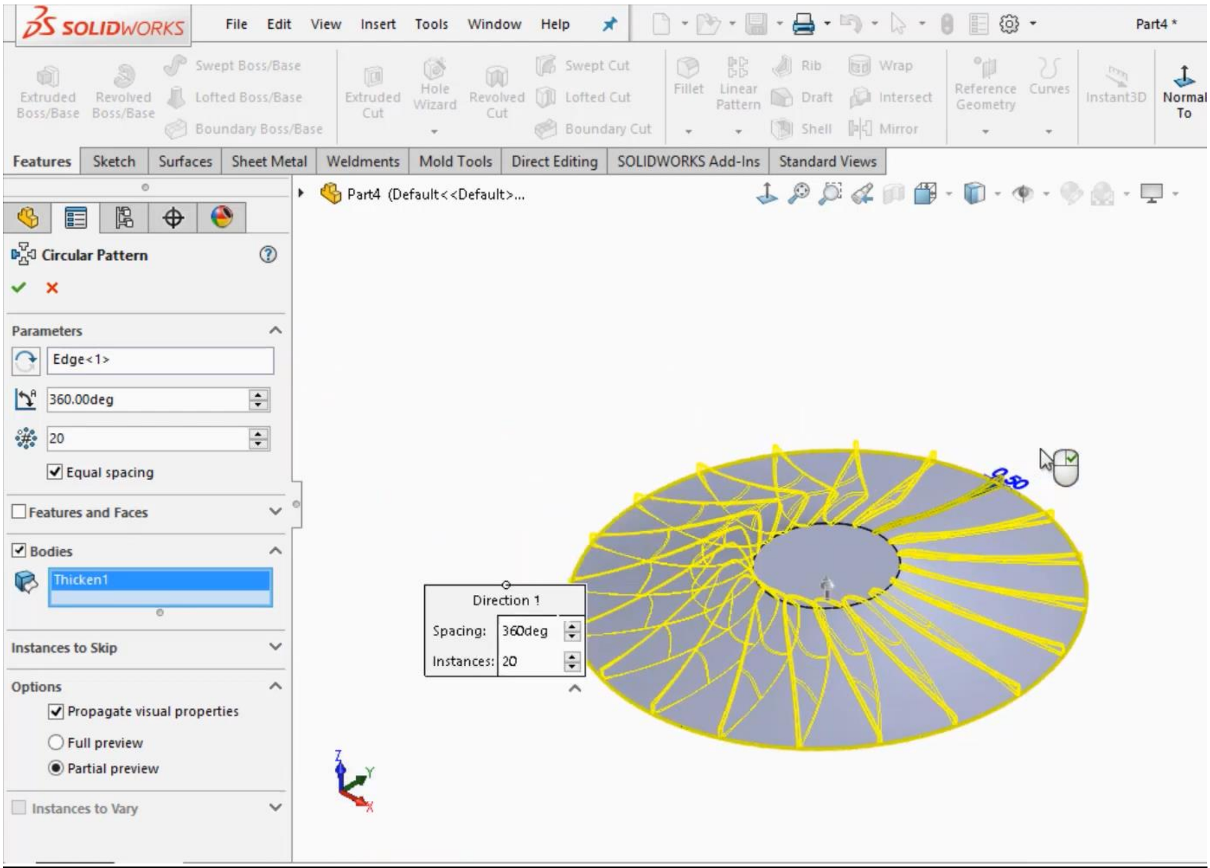


Fig-11: Complete Rod

COPLEPESS:



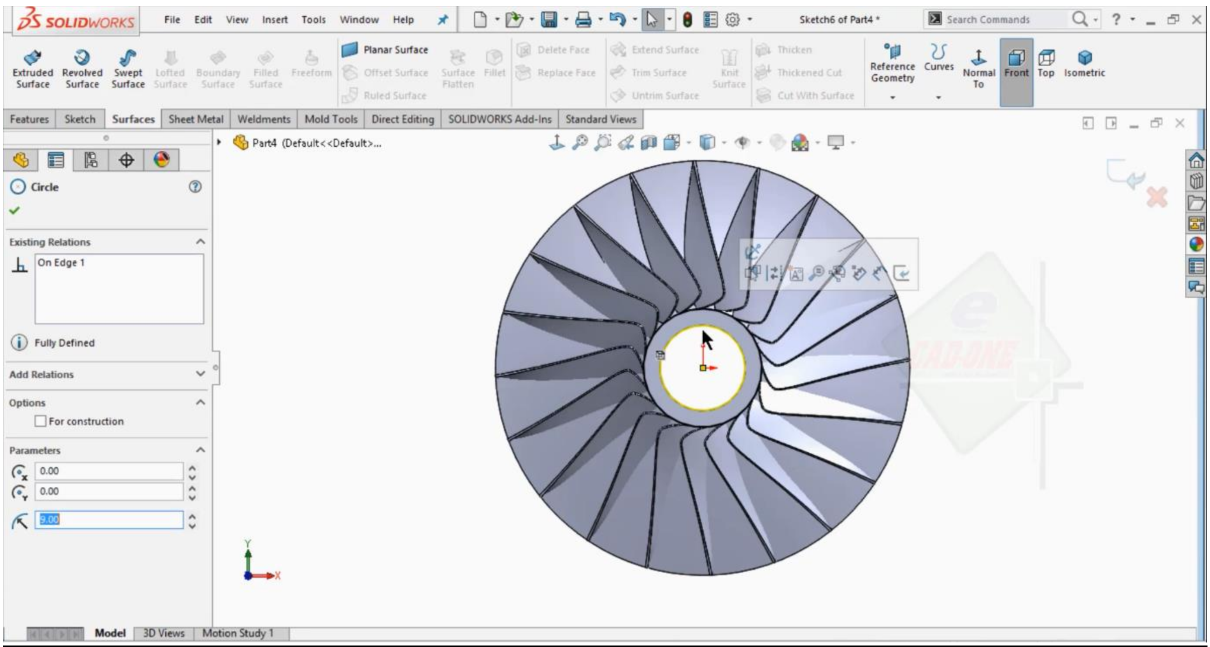
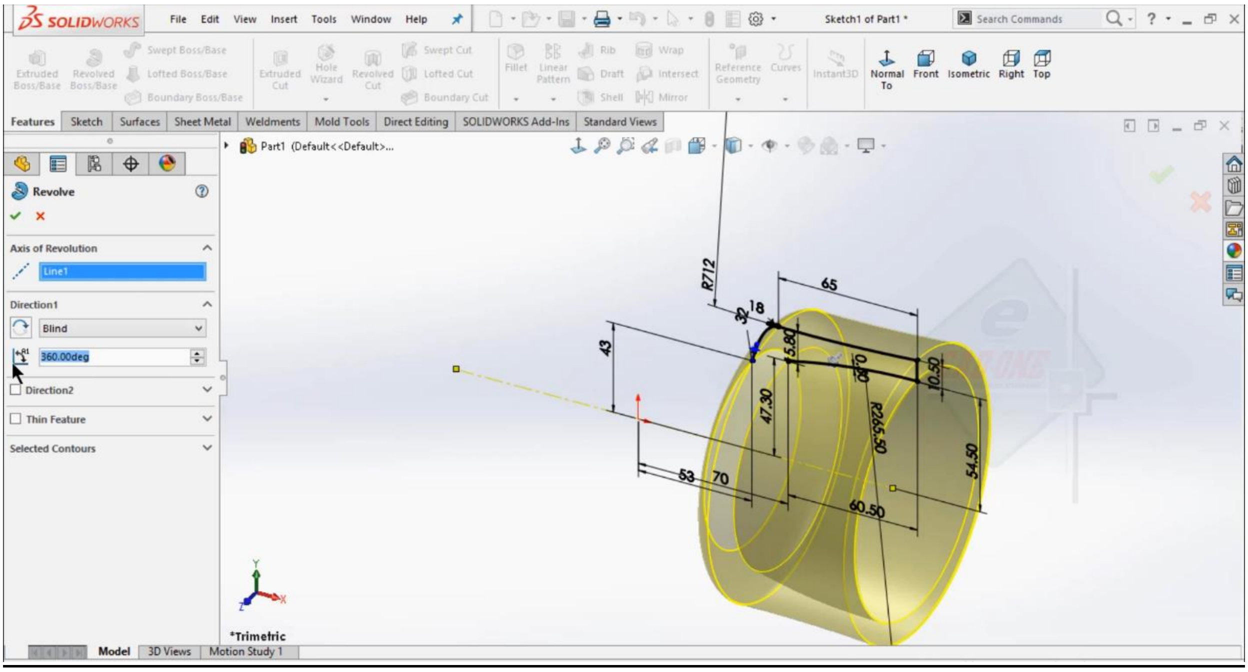


Fig-12: Modelling of Coplepess

GEAR HOUSING:



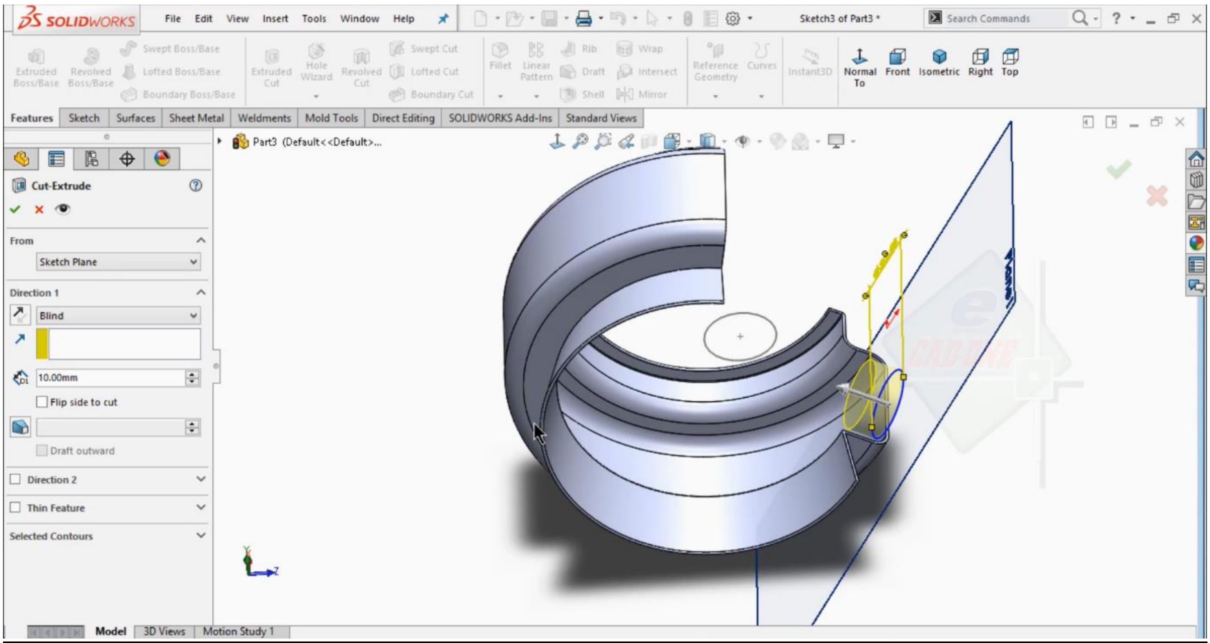


Fig-13: Modelling of Gear Housing

DRIVE TURBINE:

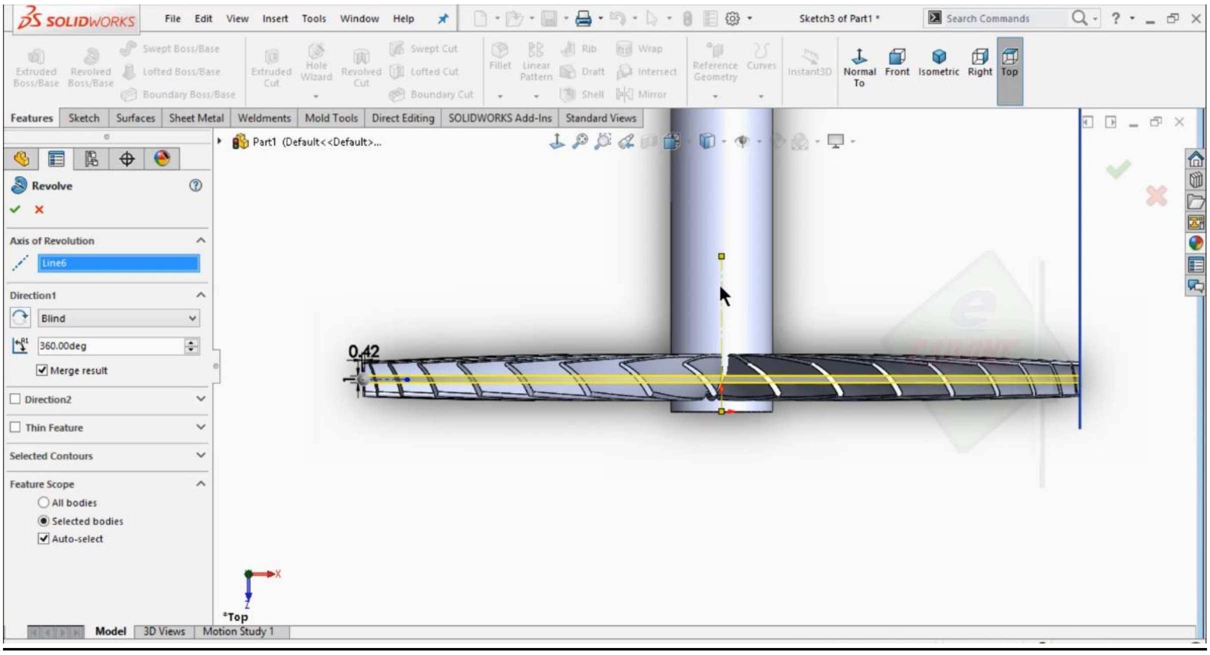


Fig-14: Front View Of Turbine

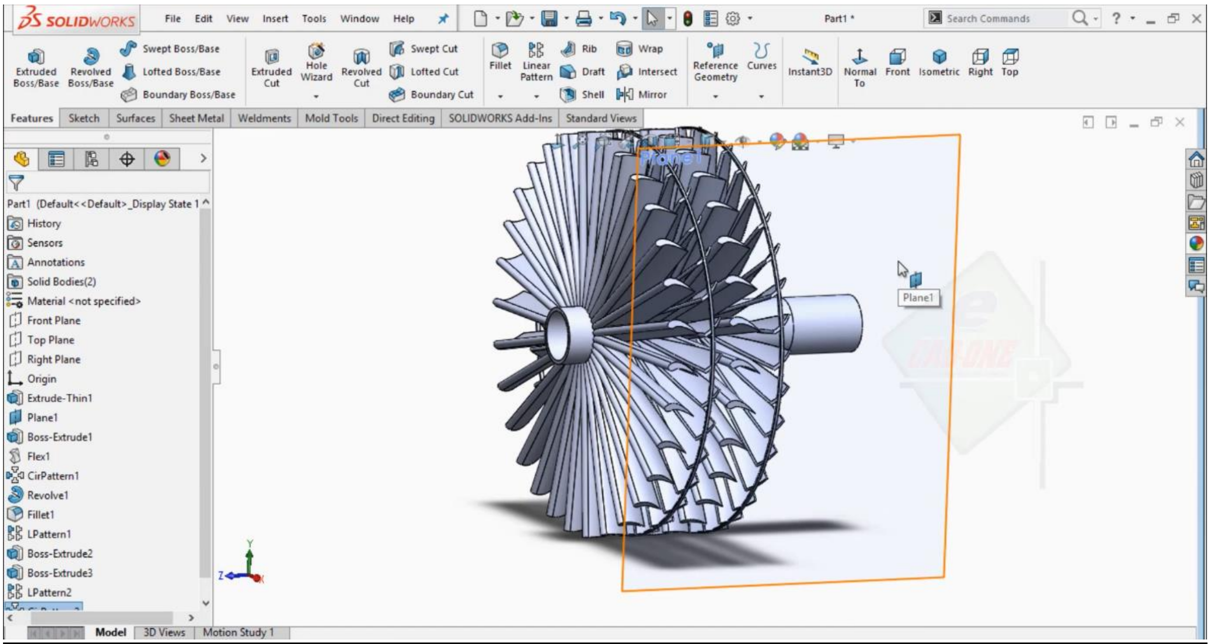


Fig-15: Double-Bleded Turbine

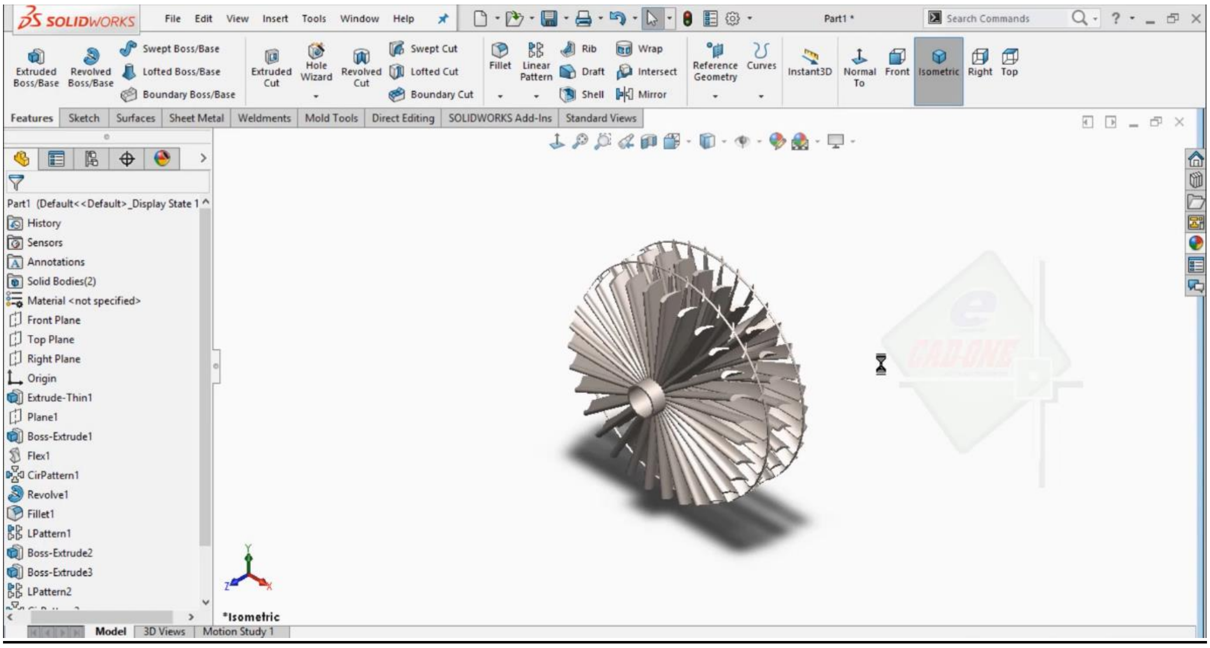
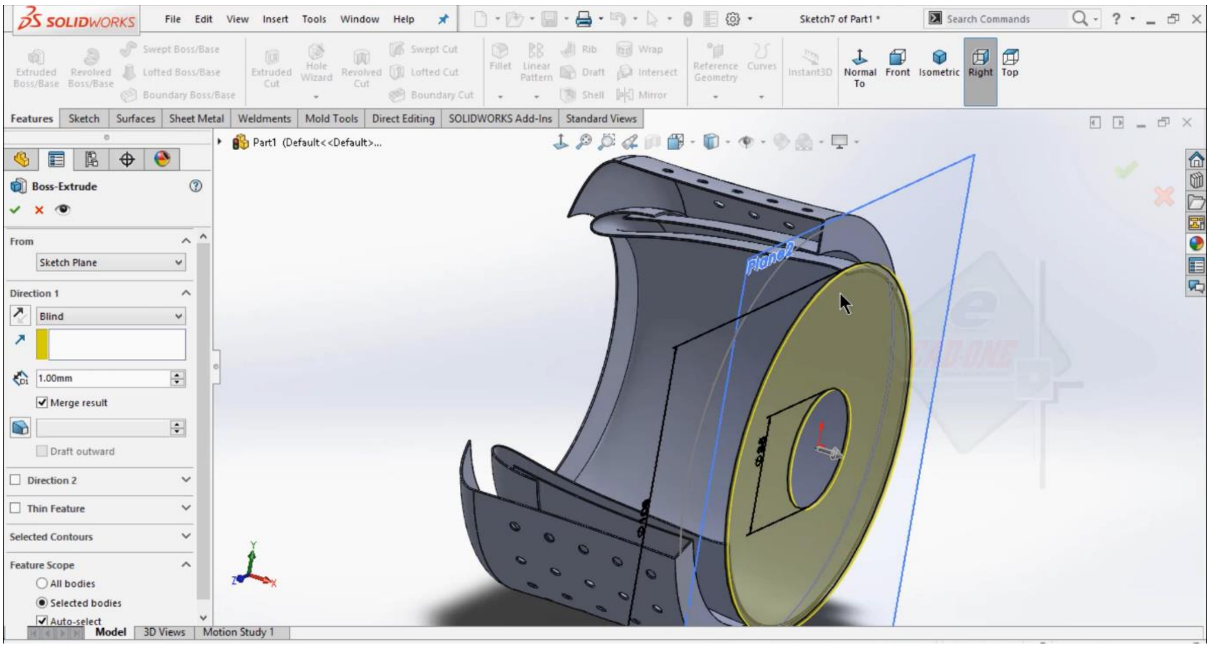
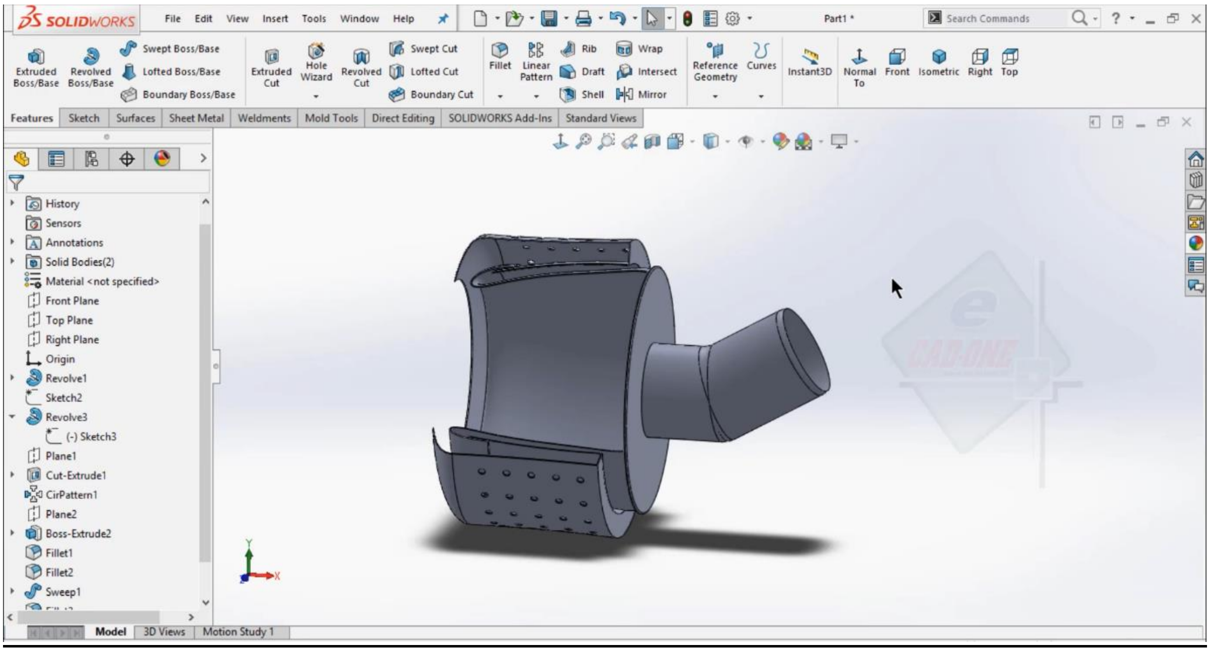


Fig-16:Complete Turbine

FIRING HOUSING:





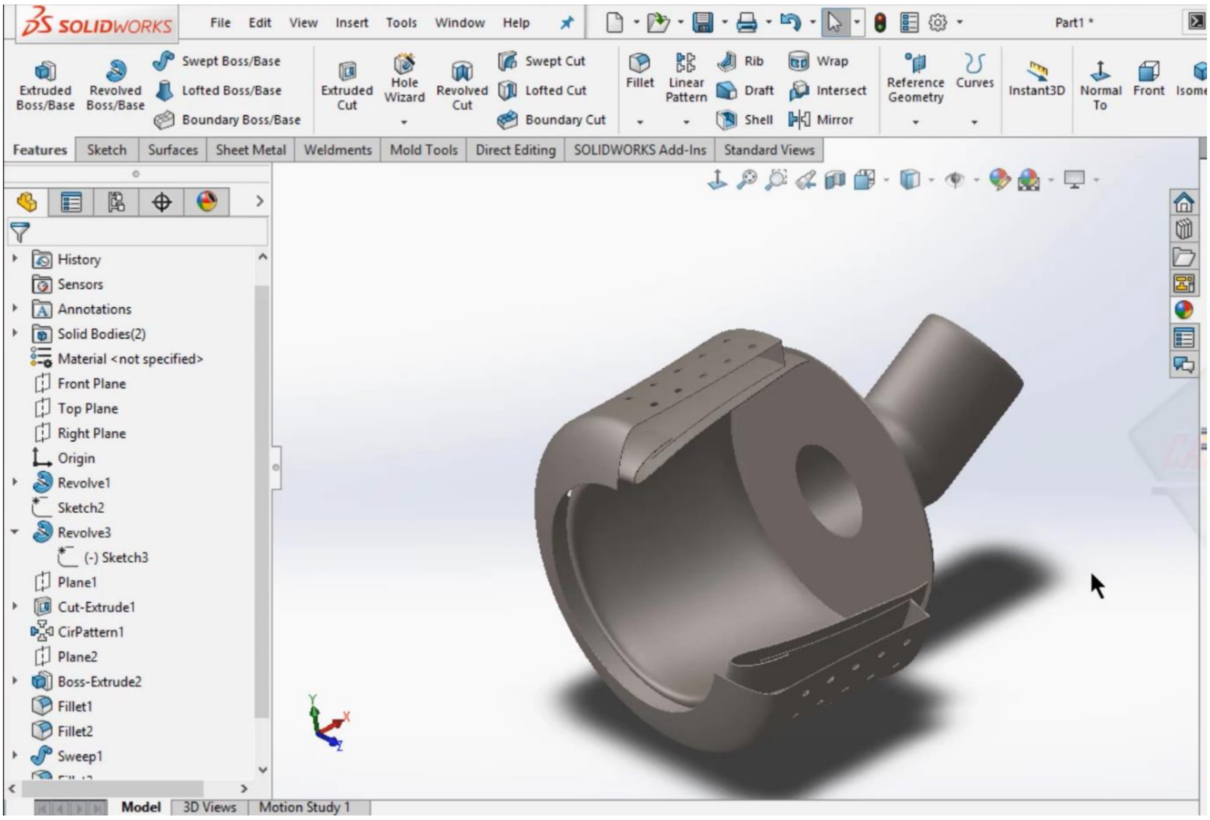


Fig-17: Complete Housing

ASSEMBLY:

The designed parts are now assembled together by mate relations to form the Jet Gas Turbine. The different views of the assembly are given below: -

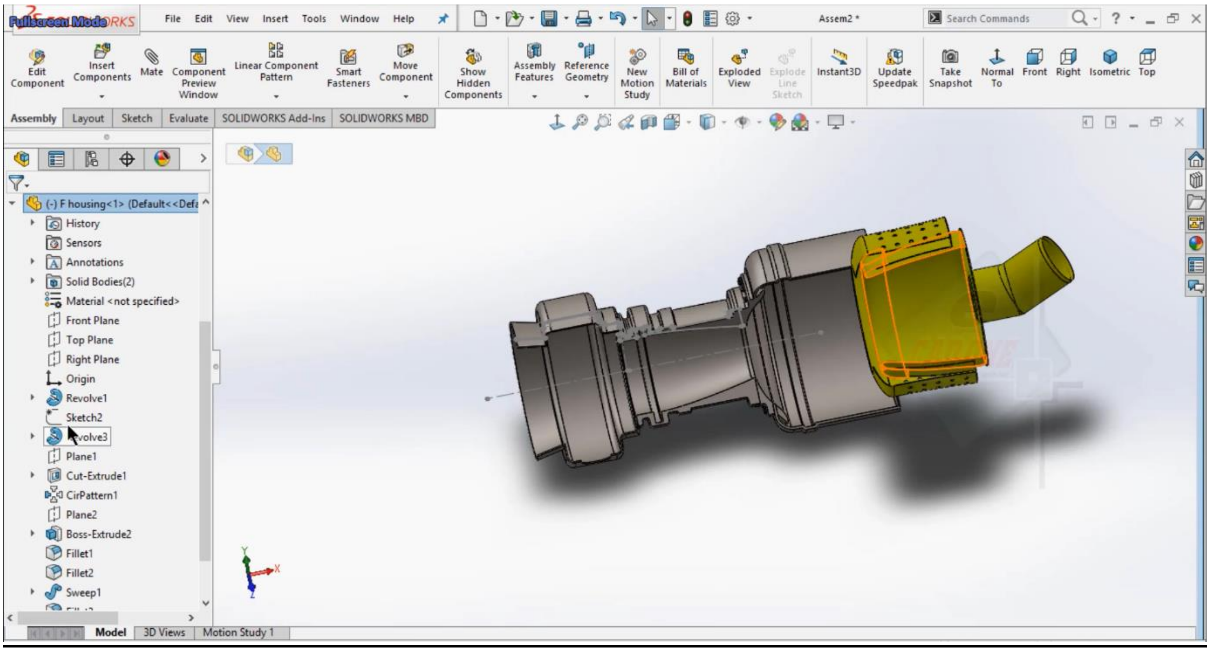


Fig-18

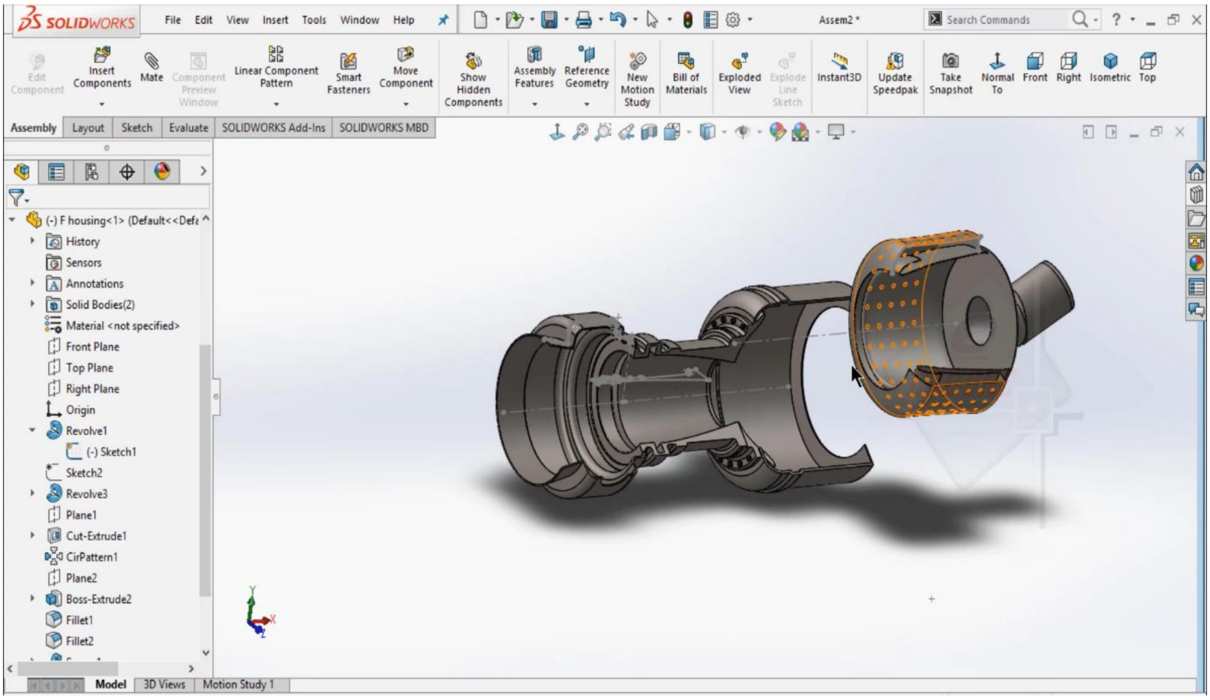
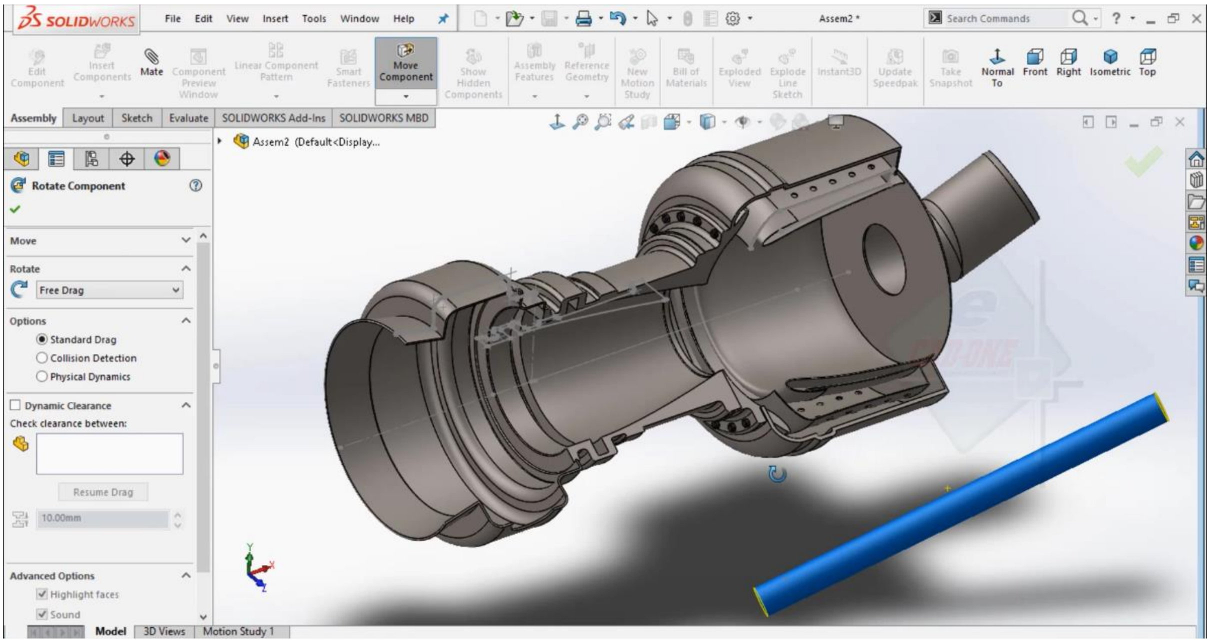


Fig-19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Insert Components
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Component Preview Window
Linear Component Pattern
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
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Explode Line Sketch
Instant3D
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Take Snapshot
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Standard Drag
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Dynamic Clearance
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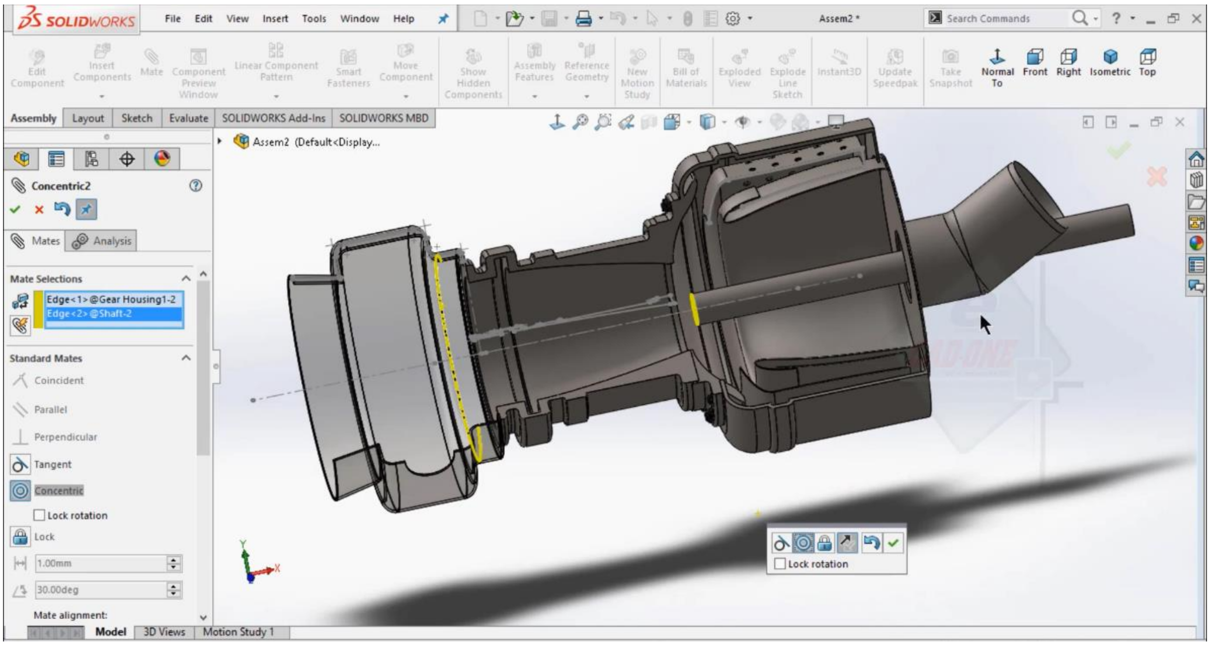
Advanced Options
Highlight faces
Sound
Model 3D Views Motion Study 1

Fig-20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Edge<2>@Shaft-2
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Tangent
Concentric
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30.00deg
Mate alignment:
Lock rotation
Model 3D Views Motion Study 1

Fig-21

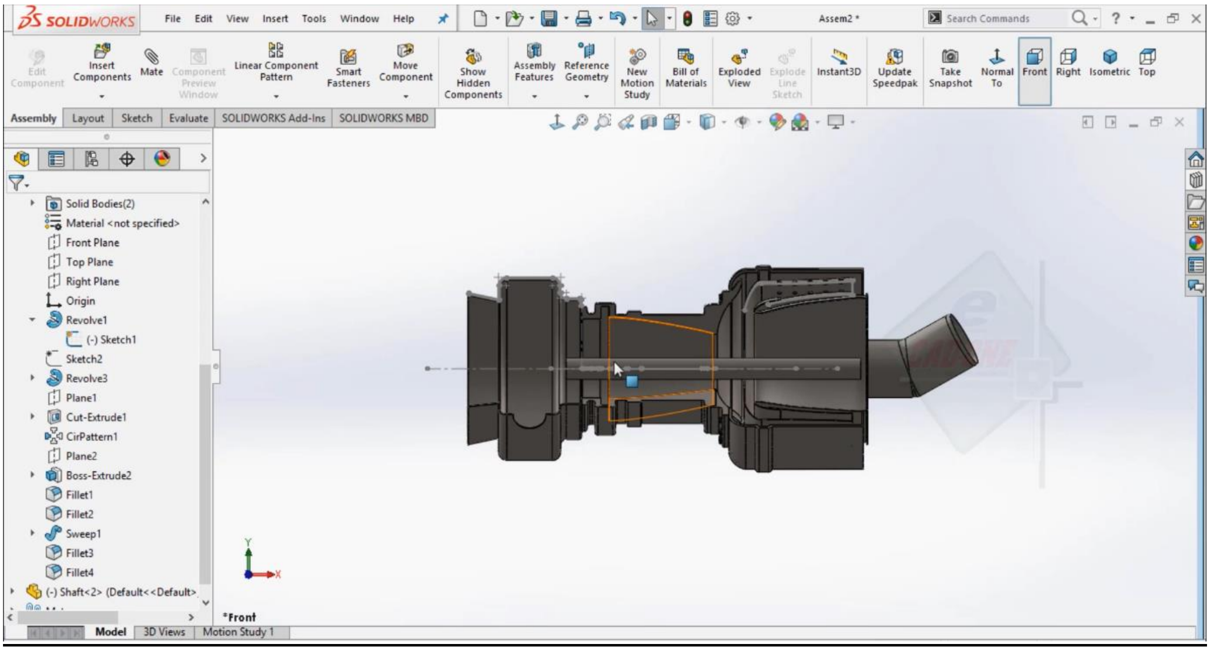

Fig-22

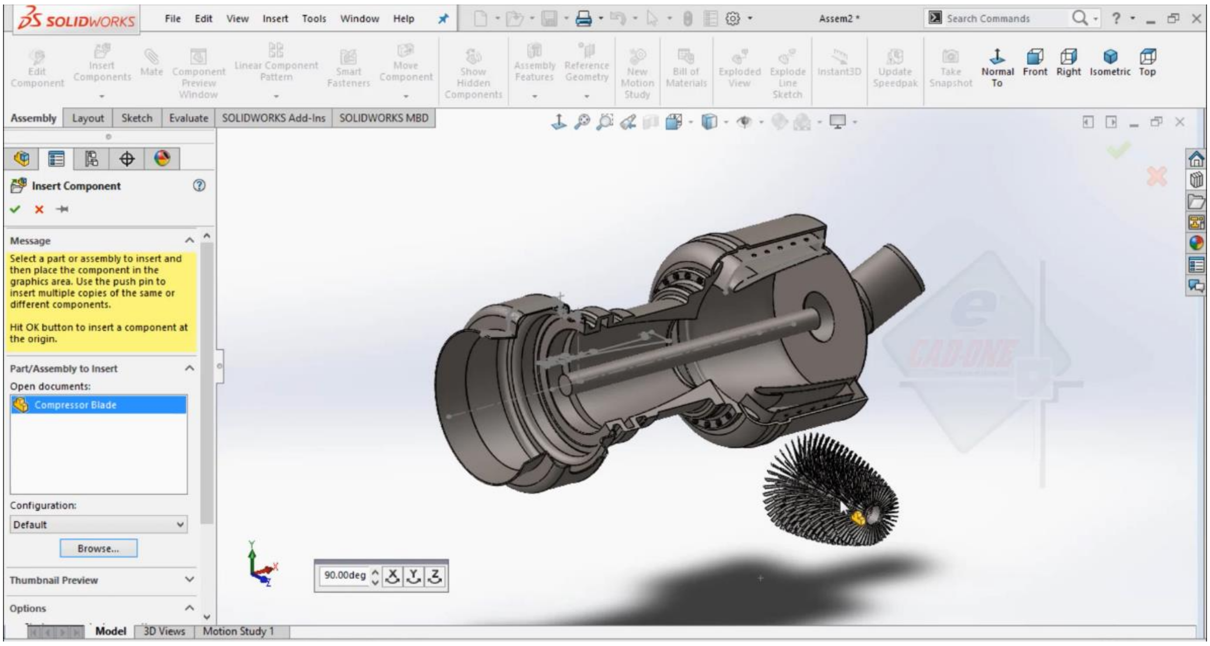

Fig-23

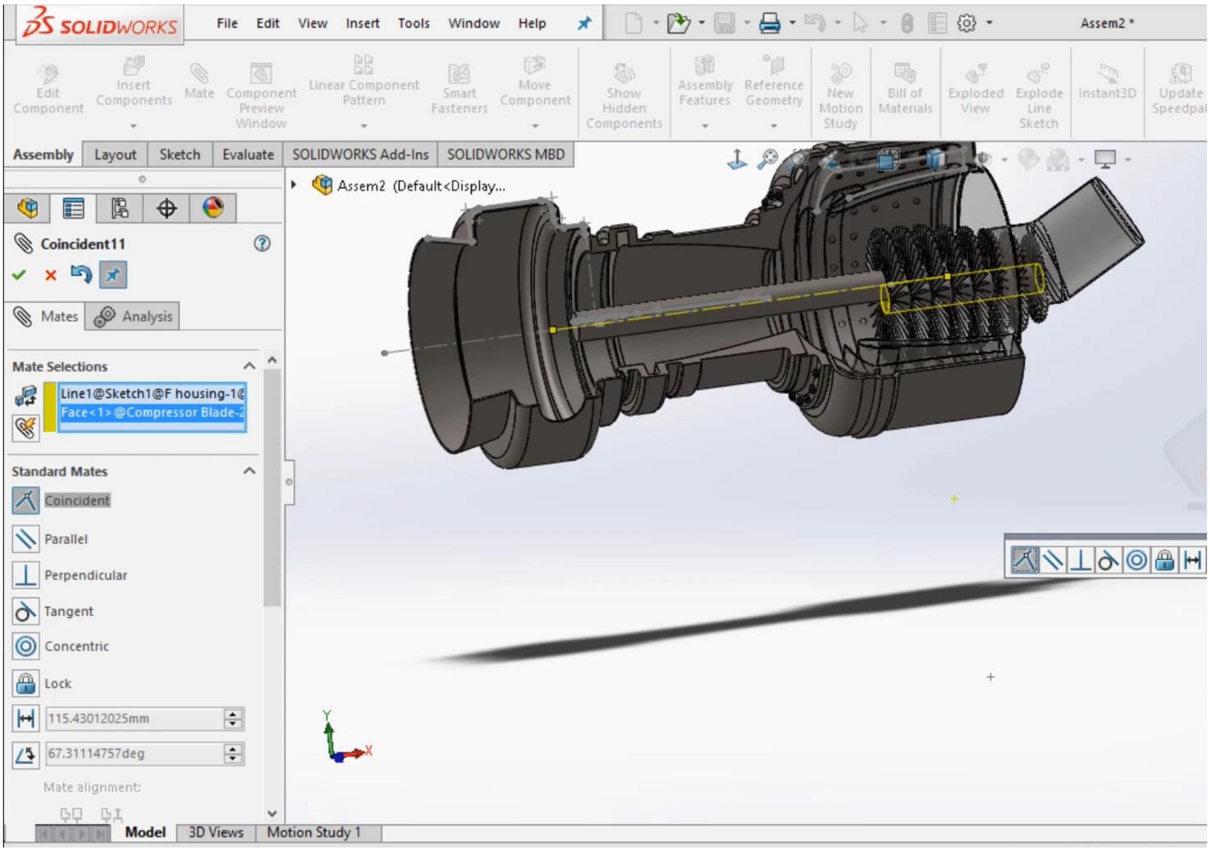

Fig-24

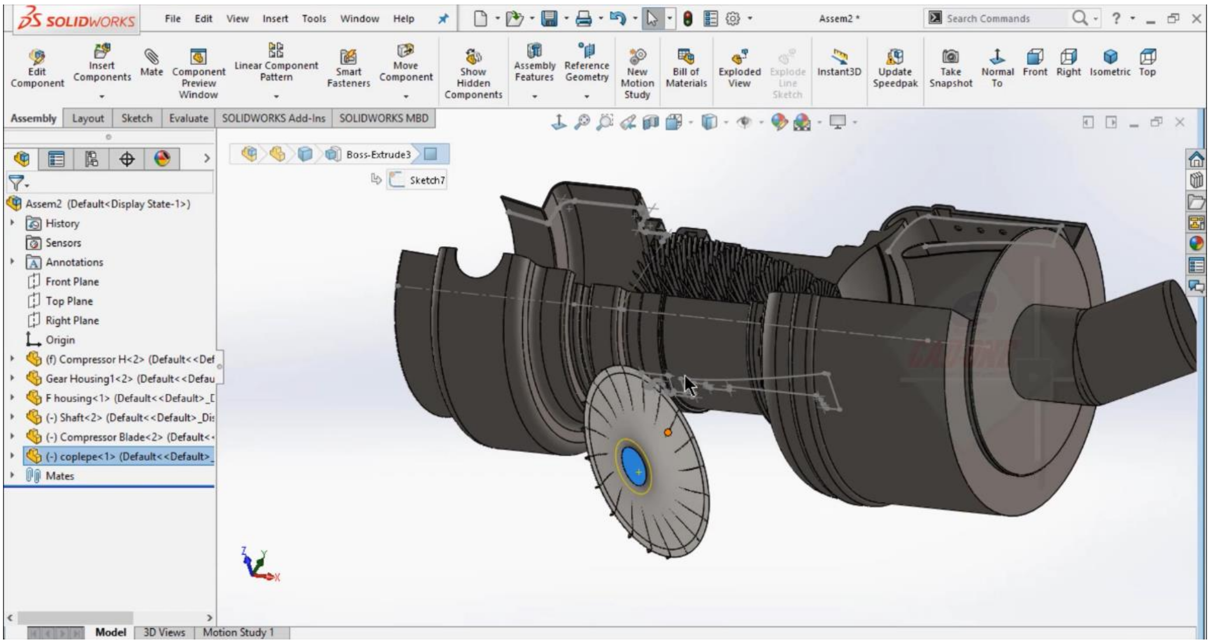

Fig-25

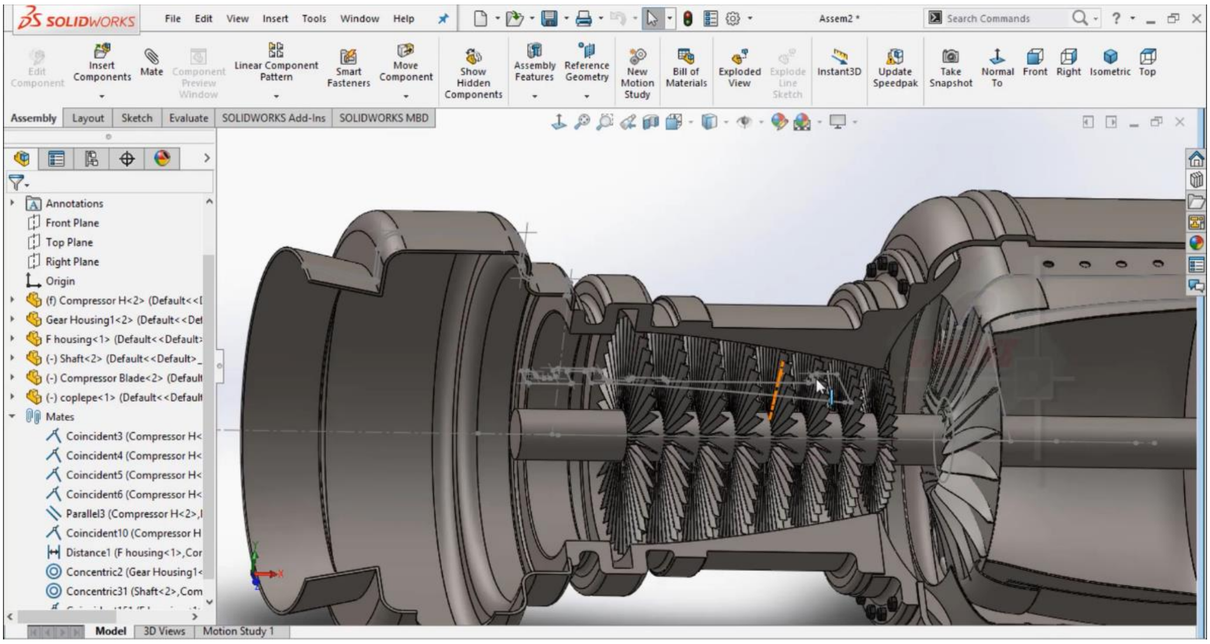

Fig-26

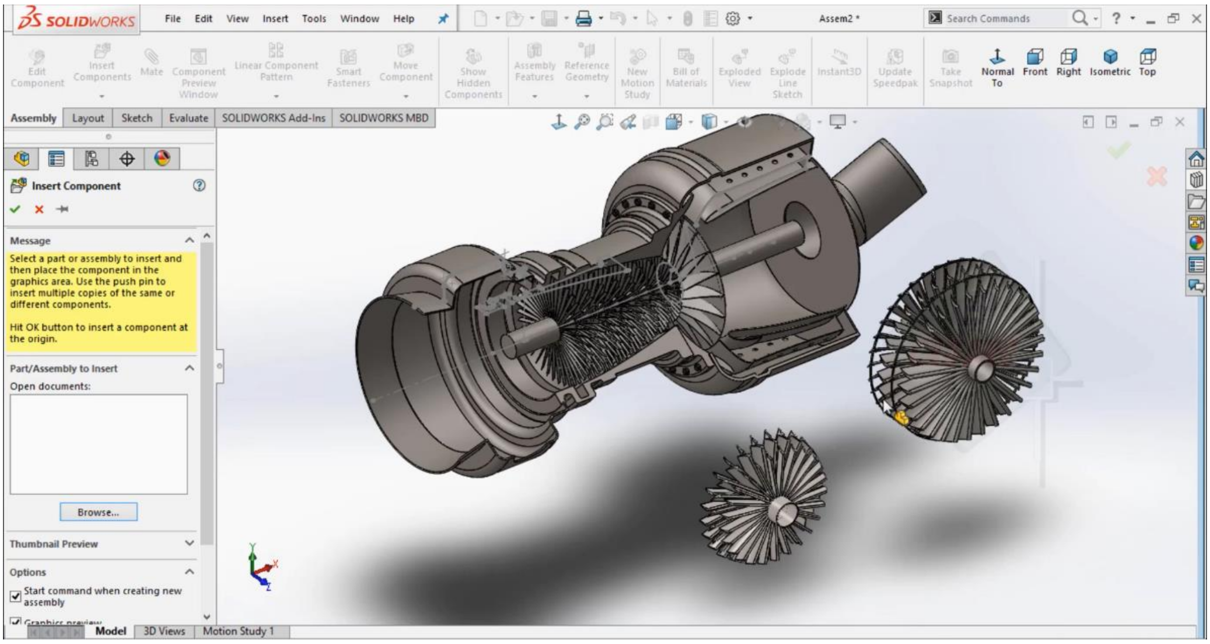

Fig-27

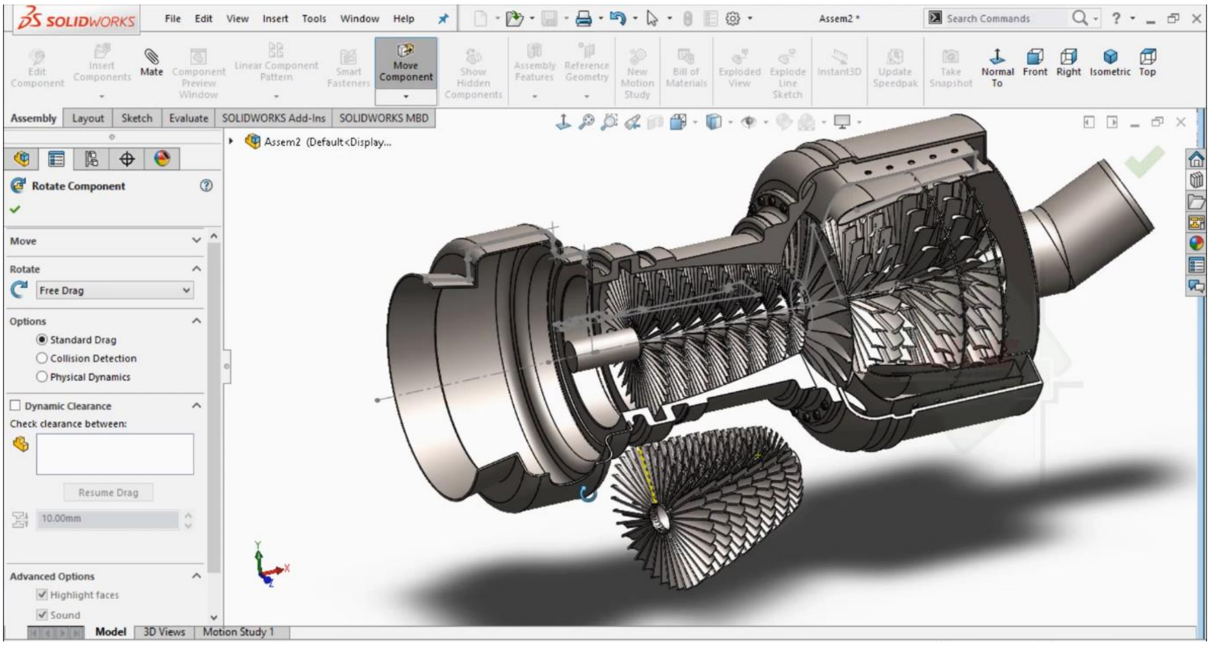

Fig-28(Frontal View of Project)

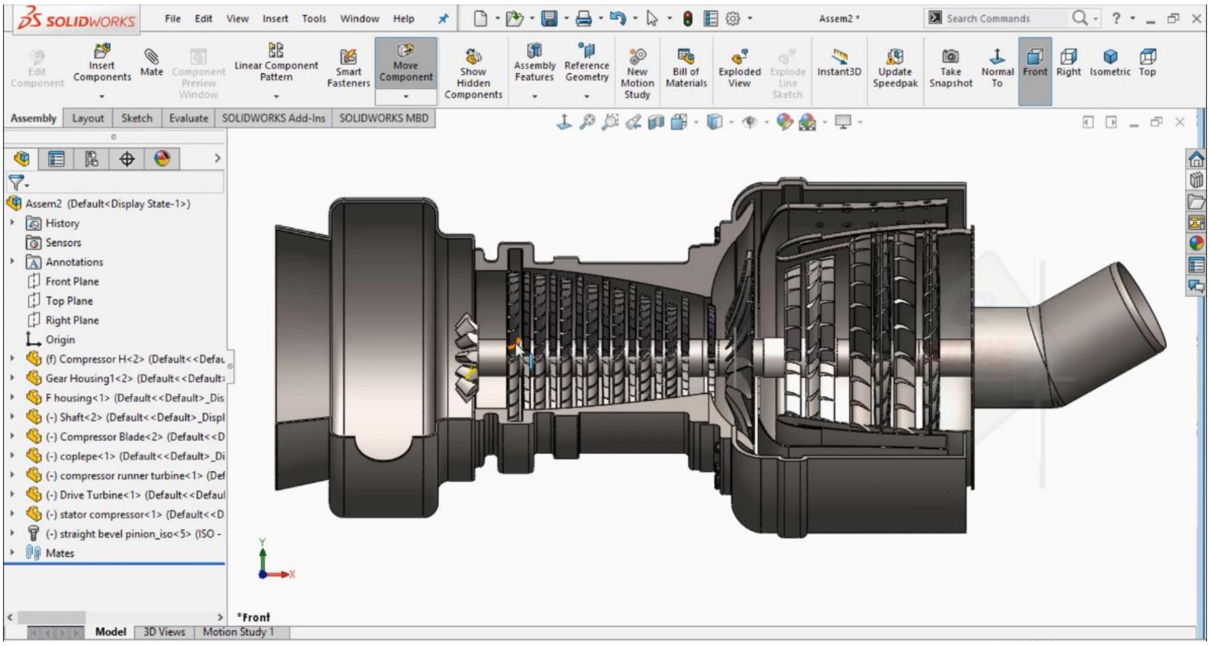

Fig-29(Cross Sectional View of Project)

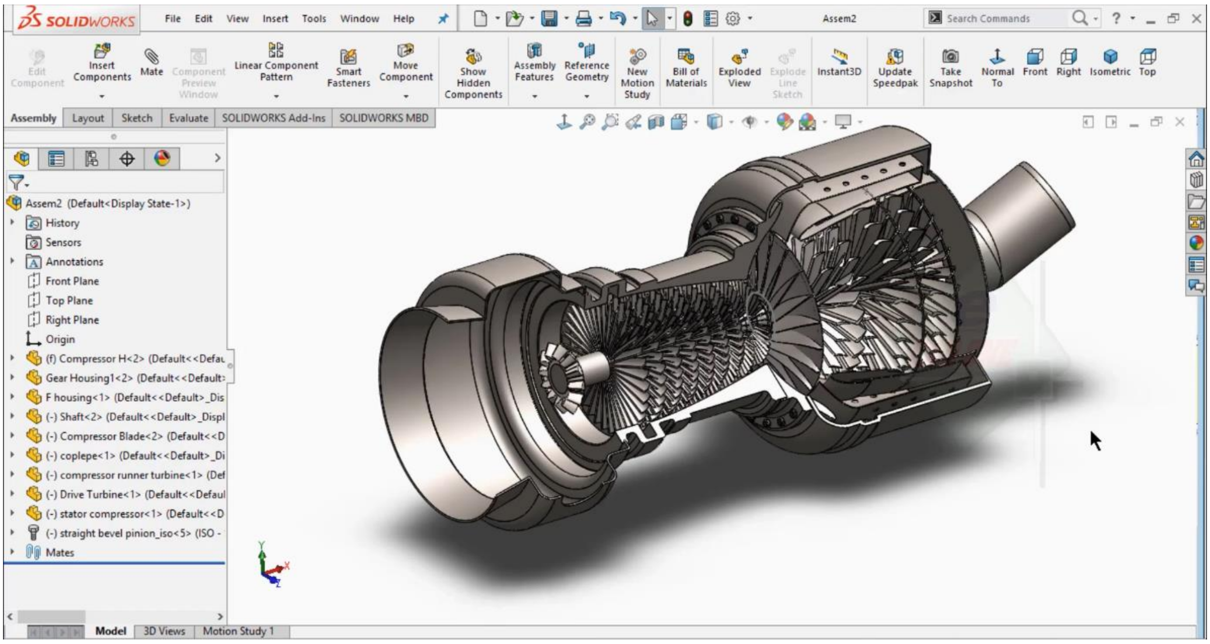

Fig-30(Full View of Modelling of The Jet Turbine)

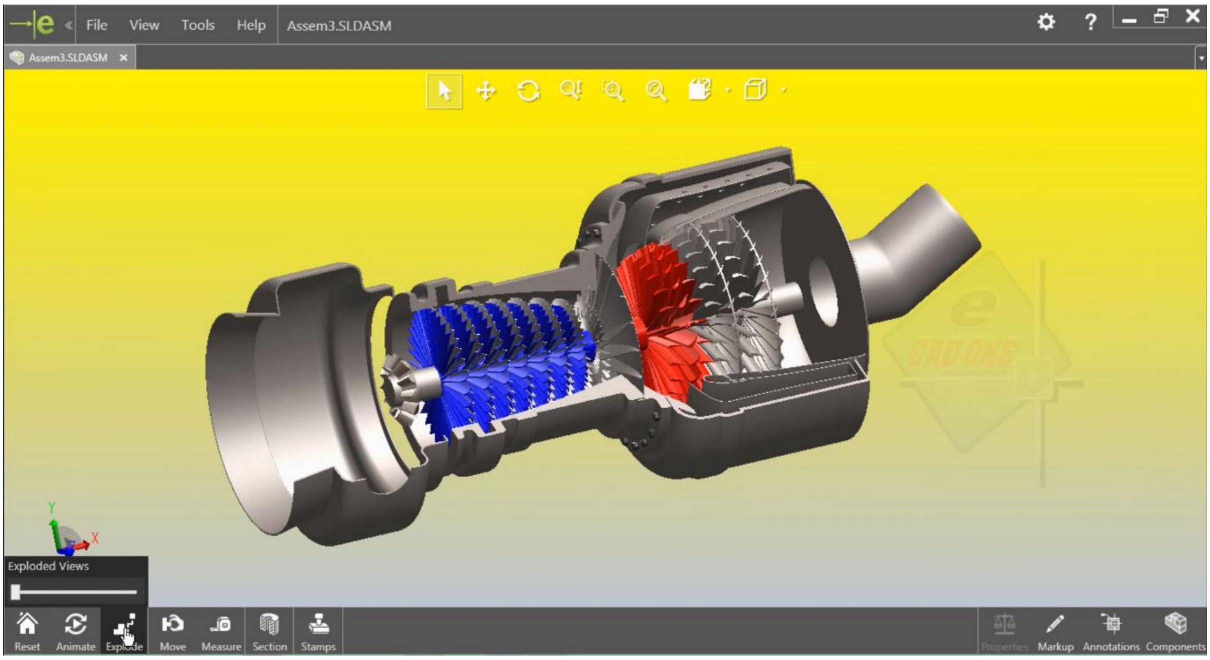

Fig-31(Animated View of Jet Gas Turbine)

CONCLUSION

In The Above project we see How We Can Design A Jet Gas Turbine Using Only 3D Solid works. It has shown the advantages, benefits, characteristics, and applications of gas turbine engines.It clearly states the superiority of gas turbine engines over reciprocating engines. We have taken a neutral view of the topic. This project is replica of actual working of the jet engine on a small scale level. The turbocharger serves as an integrated compressor & turbine assembly which is suitably manipulated (carefully converted) in to an open cycle constant pressure gas turbine. Its basic working is explained here. The incoming air is captured by the engine inlet. Some of the incoming air passes through the fan and continues on into the core compressor and then the burner, where it is mixed with fuel and combustion accurs. The hot exhaust passes through the core and fan turbines and then out the nozzle, as in a basic turbojet. The rest of the incoming air passes through the fan and bypasses, or goes around the engine, just like the air through a propeller. The air that goes through the fan has a velocity that is slightly increased from free stream. So a turbofan gets some of its thrust from the core and some of its thrustThe project mainly involves complex modelling, designing and analysis in SolidWorks.