A Project Report
Submitted for

Computer Aided Design & Analysis
(UME412)

Project 3

Design of Drive Mechanism and Support Frame for assembly of Force Pump driven by HONDA GX160 engine using Creo AFX

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Acknowledgement

This project would not have been possible without due support of my course instructor Dr. Bikramjit Sharma. His guidance, direction and methodology with which he taught us the subject was unparallel and unprecedented in every way. His guidance throughout the semester in classroom was the reason, I am in a position to bring this project to function. I would also like to thank my other course instructors who were always proactive in helping us and clarify our doubts whenever needed.

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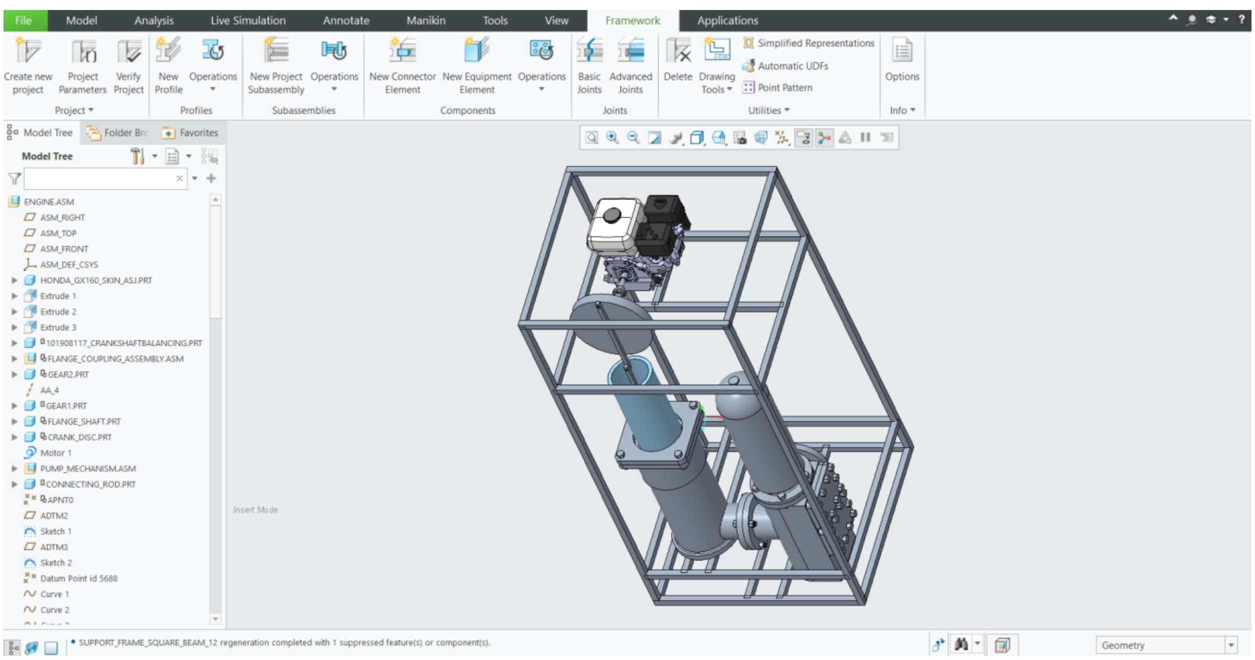
Introduction

The aim of this project is to drive the feed pump which was designed in the Online Test 1 using a HONDA GX160 5.5 HP Engine and support the whole assembly using AFX module of CREO. Assembly of the feed pump is exported from Onshape as a Parasolid, the assembly of the HONDA is provided along with the problem statement. Firstly, we have to assemble the Cranshaft that was modeled in Project-1 on CREO into the engine part. Then, we design a drive mechanism for the feed pump. We also connect the HONDA engine with the drive mechanism using appropriate shaft coupling and gearing to run the feed pump at 42 strokes per minute at maximum torque of the engine. The details of all the steps followed are included in this report.

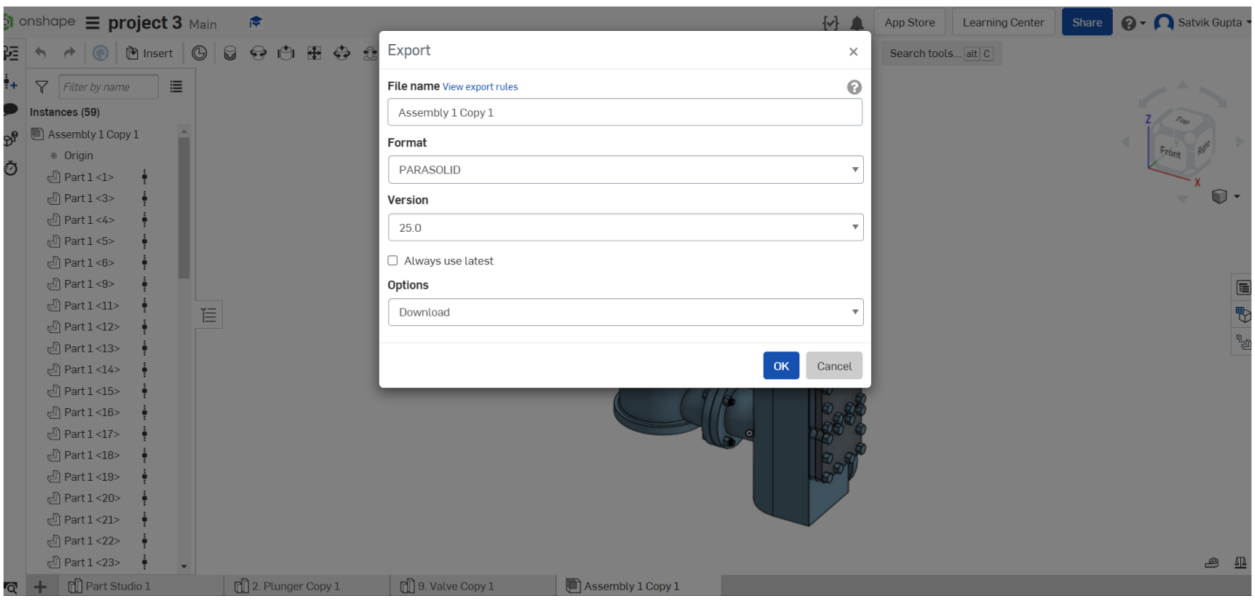


(Fig.1 Assembly of Engine with feed pump and support structure using AFX module)

Initial Steps of Design

a. Exporting the Feed Pump

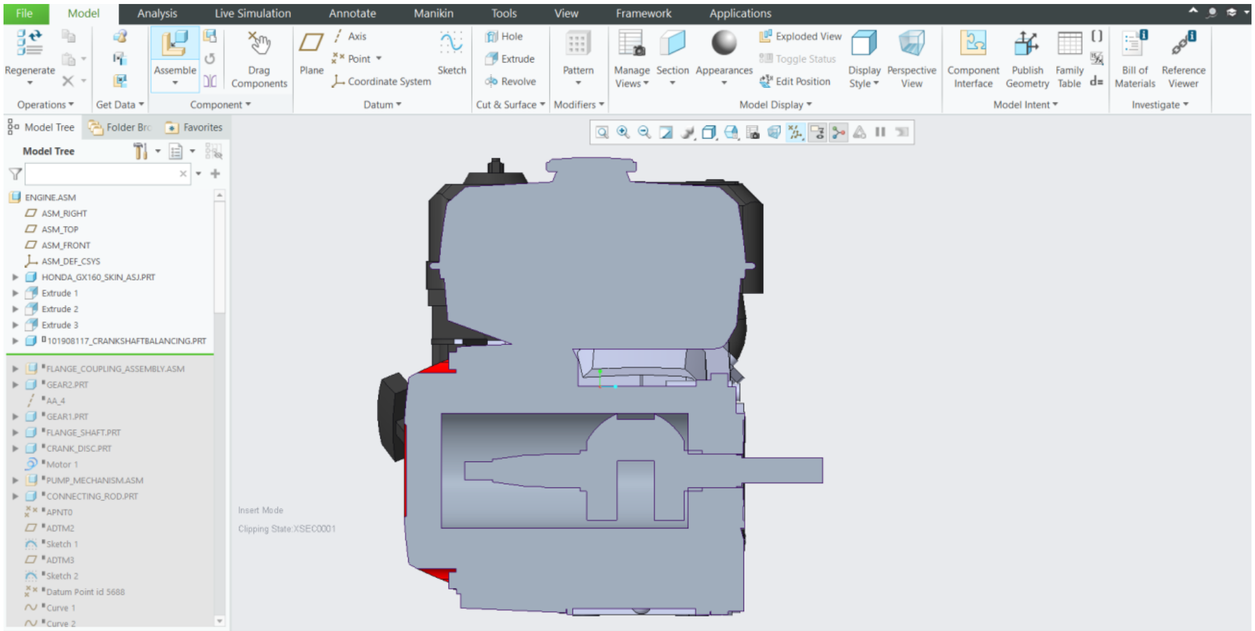
First step is to export the feed pump from online cloud based software Onshape to CREO PARAMETRIC 6.0. To do this, we make a copy of the feed pump in a new document in Onshape and then download the assembly file as Para-Solid version 25.0. The plunger and the valves are exported separately so as to assemble them in Creo to add assembly constraints.



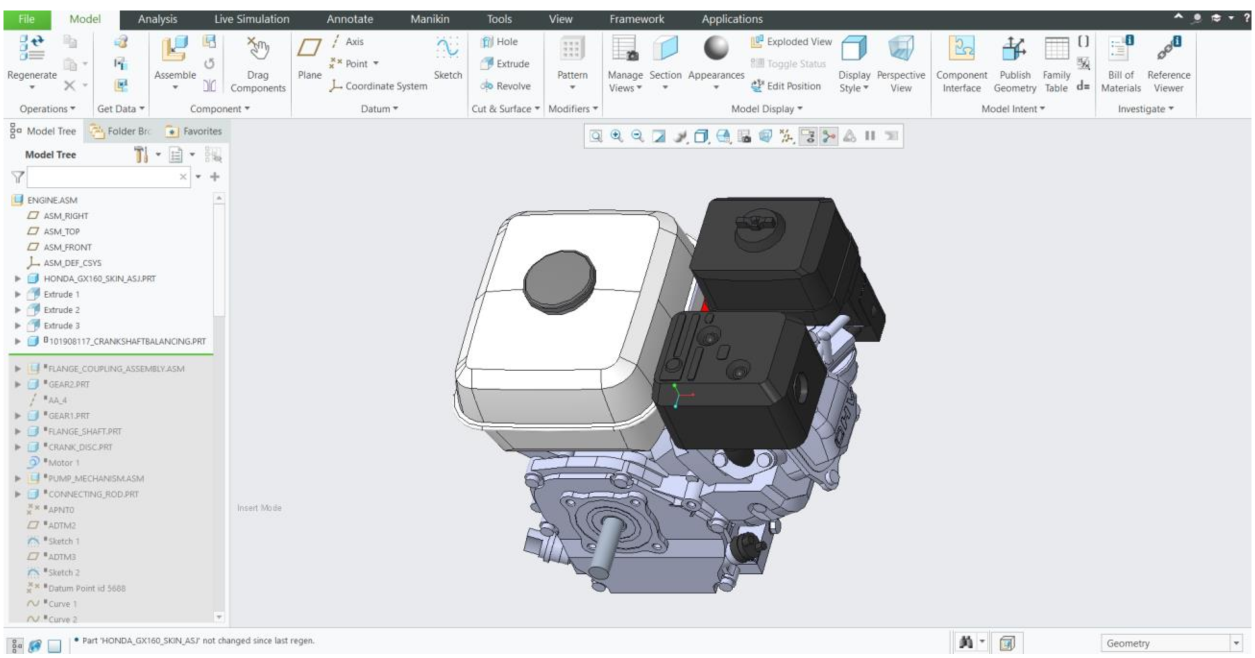
(Fig.2 Exporting feed pump assembly from ONSHAPE)

b. Crankshaft and Engine Assembly

Next step is to download and export the HONDA GX160 engine assembly provided to us in our working directory. We also have to make a copy of the initial crankshaft that was designed in the project 1 in the same working directory. The next steps are to make extrude cuts in the provided engine assembly so as to assemble the crankshaft in the engine. To assemble the crankshaft with the engine we use the constraint of a PIN joint.



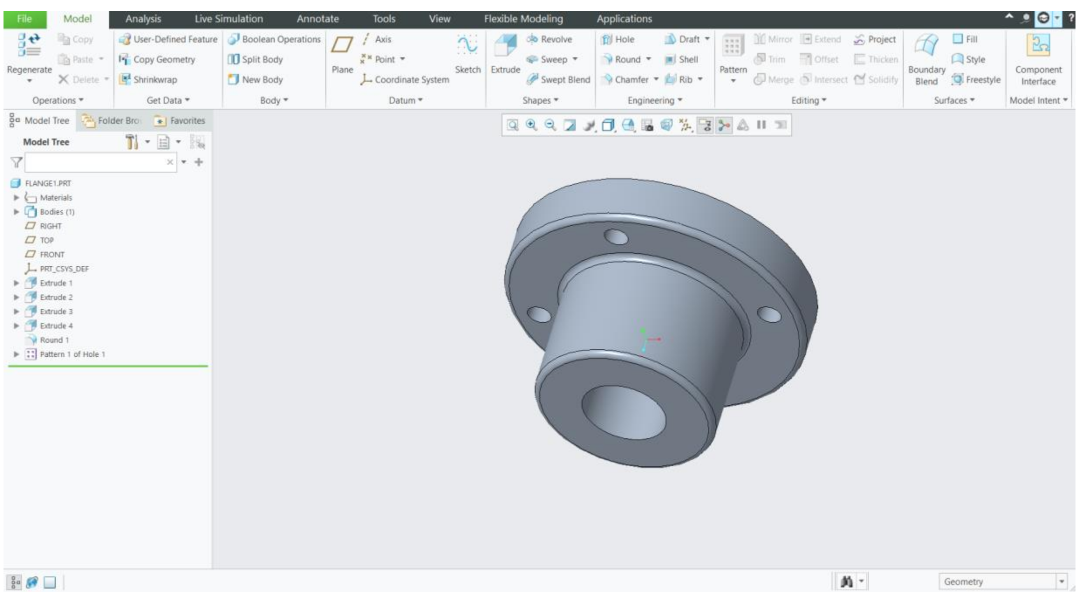
(Fig.3 Cranshaft and Engine Assembly- section view)



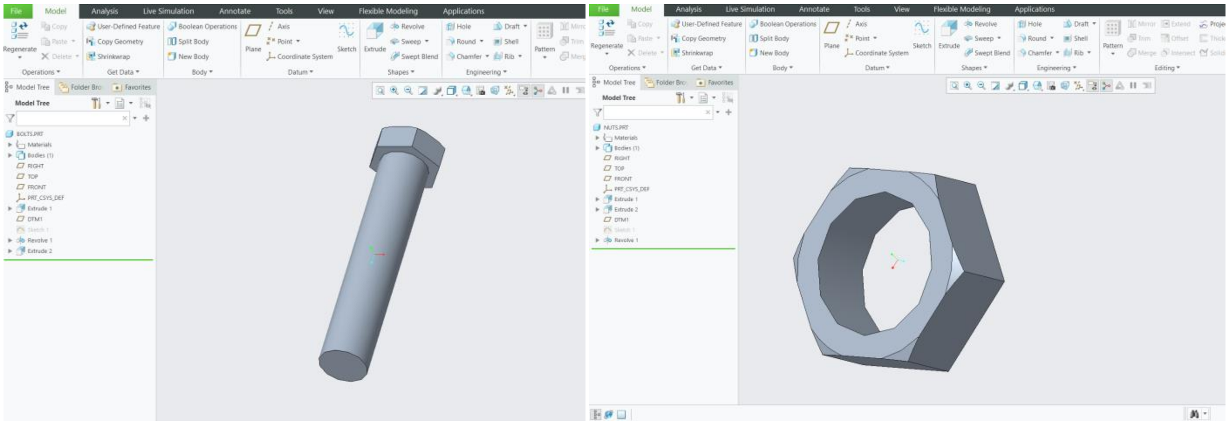
(Fig.3 Cranshaft and Engine Assembly- default view)

c. Drive Mechanism Design: of shaft coupling and gearing between the engine and pump mechanism

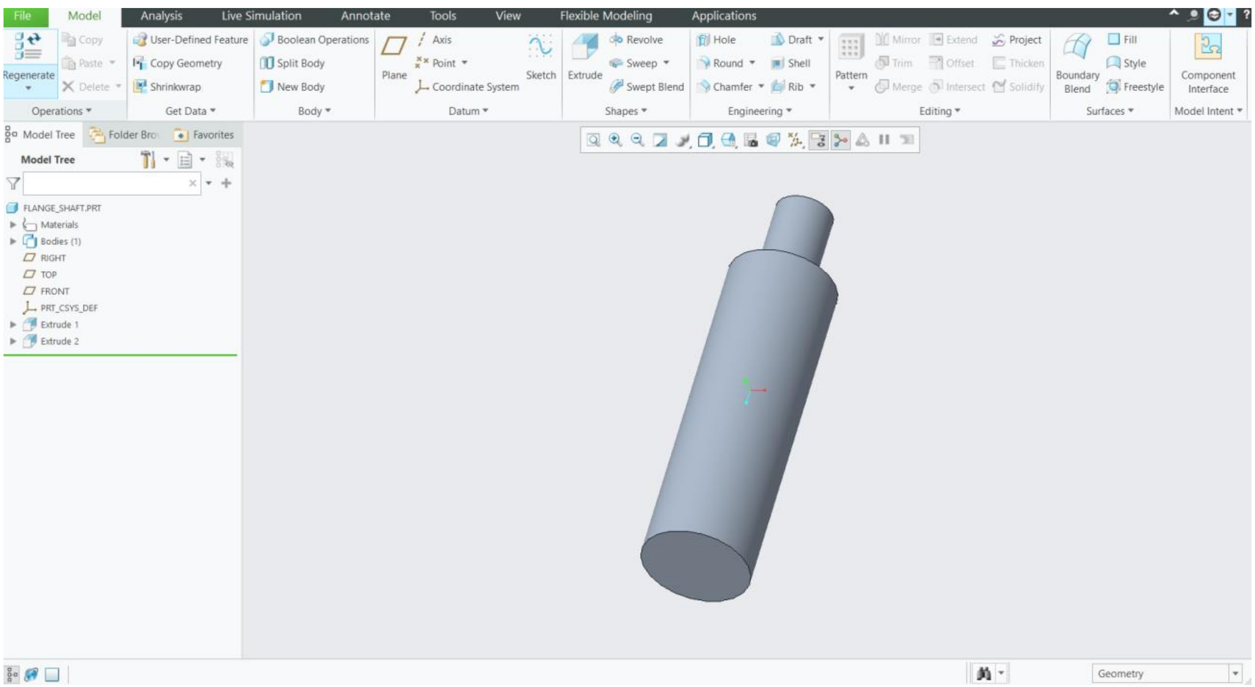
Once the Engine and Crankshaft are connected, next step is to make Shaft couplings and gears for the purpose of power transmission. Shaft couplings are mainly used to join two shafts to increase their lengths. Once the shaft couplings are designed we also assign the material as per the requirements. C.I is added to the flanges and M.S is added to nuts and bolts. To convert the high torque and RPM of the motor as per our requirements i.e. to run the feed pump with 42 strokes per minute, we use spur gears. Spur gears were designed keeping the specifications in mind and gear to RPM ratio was defined accordingly. Once all the parts of the coupling-gear mechanism are designed we assemble them with the help of PIN joint, coincident constraints, etc. Gearing is added with the help of gearing ratio and tool provided in the software.



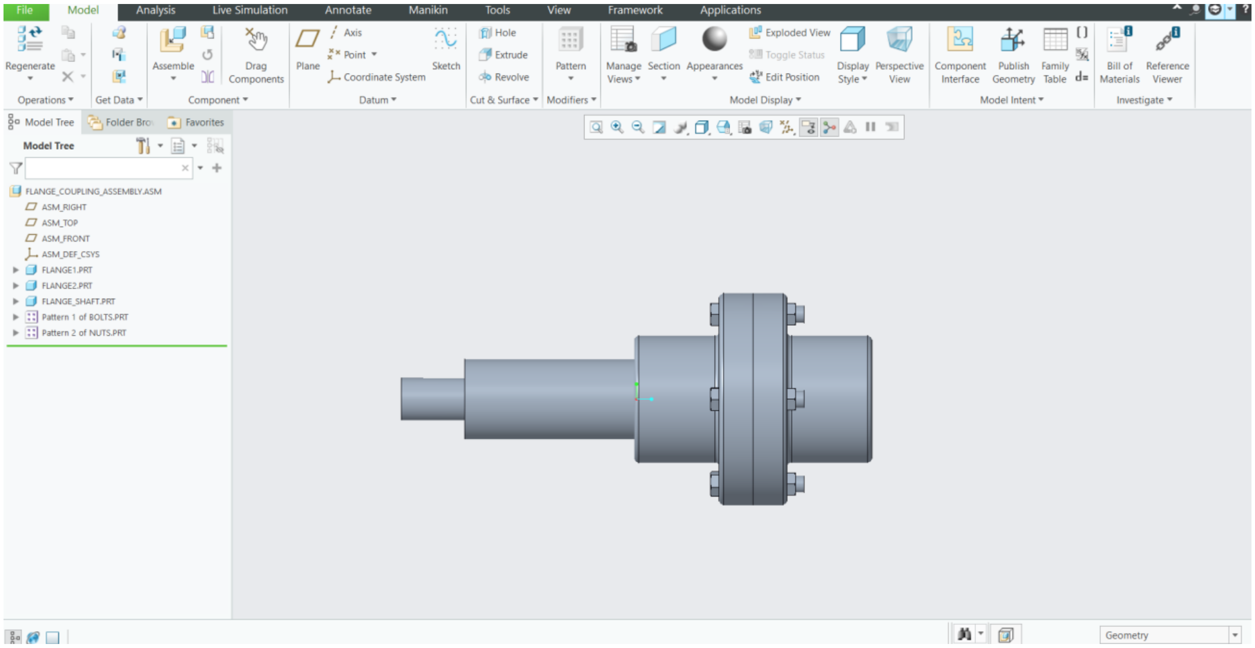
(Fig.4 Flanges)



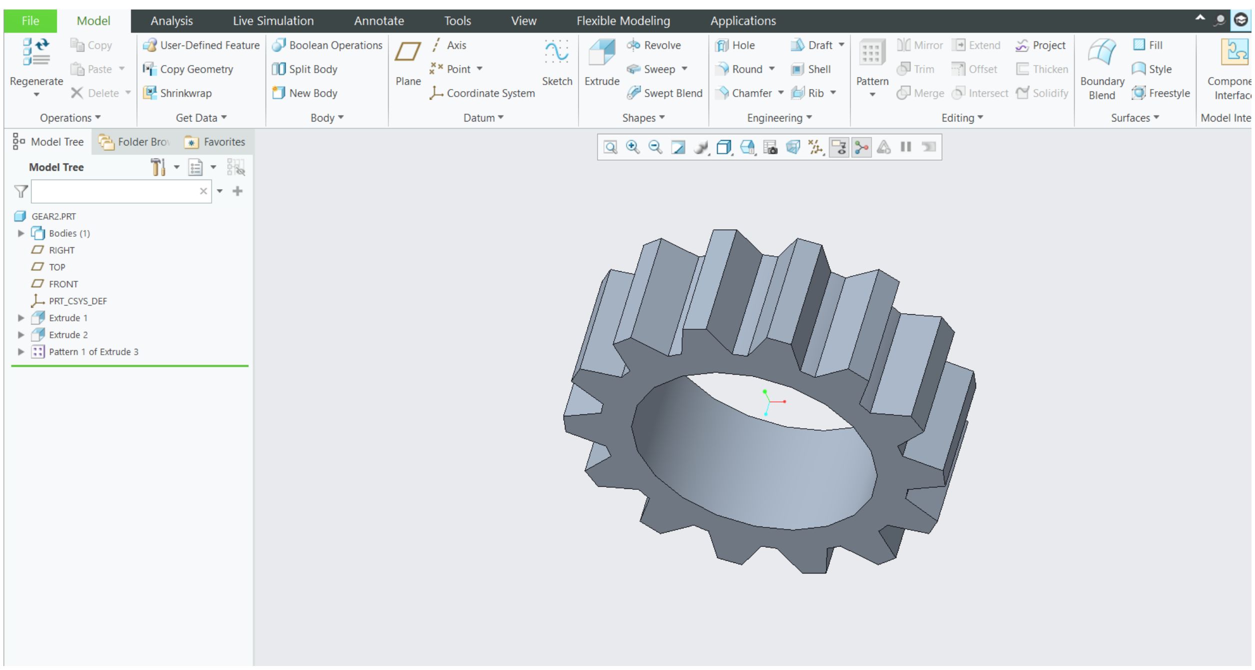
(Fig.5 Nuts and Bolts)



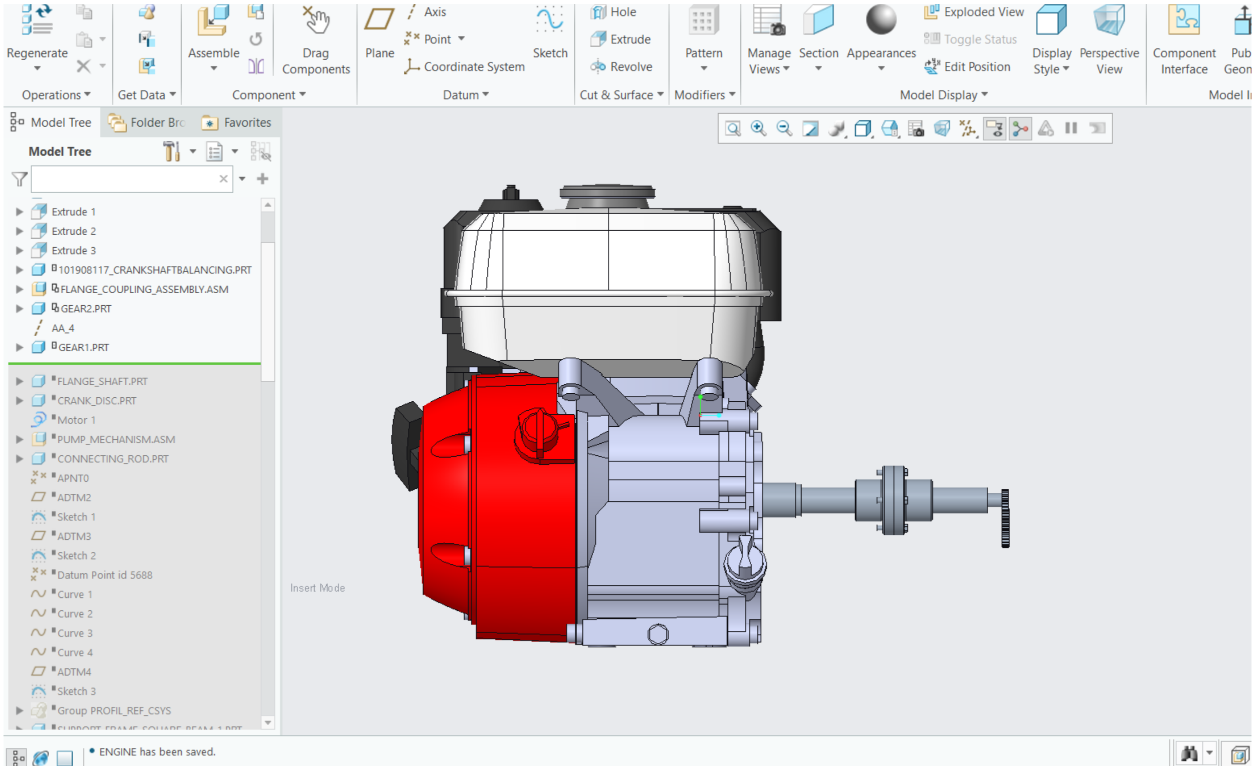
(Fig.6 Flange Shaft)



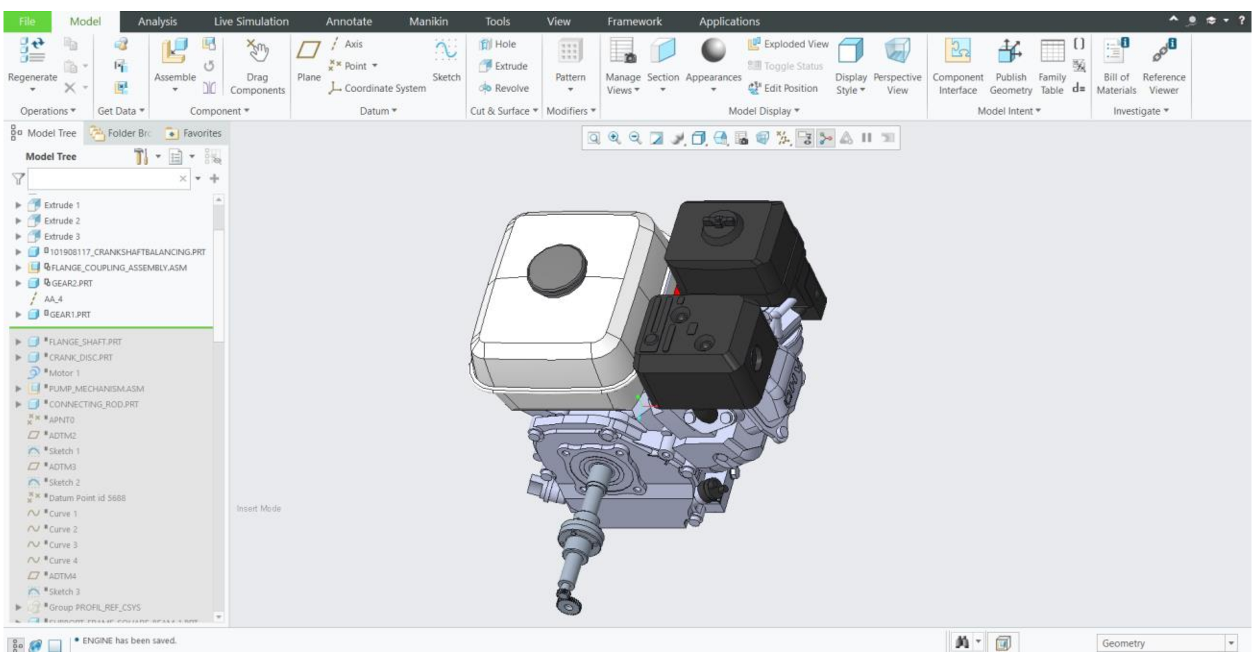
(Fig.7 Flange Shaft Assembly)



(Fig.8 Spur Gears)



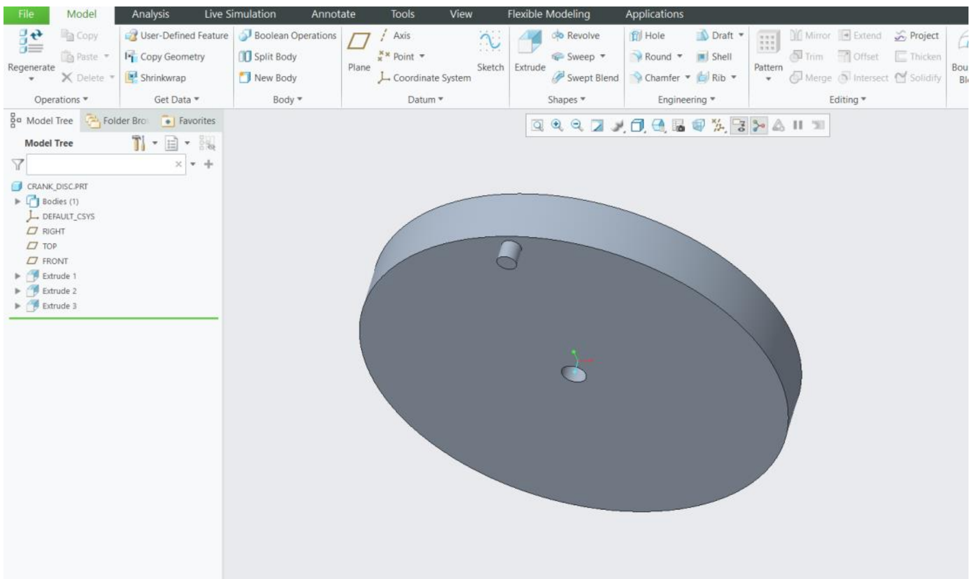
(Fig.9 Crankshaft coupling gear assembly- side view)



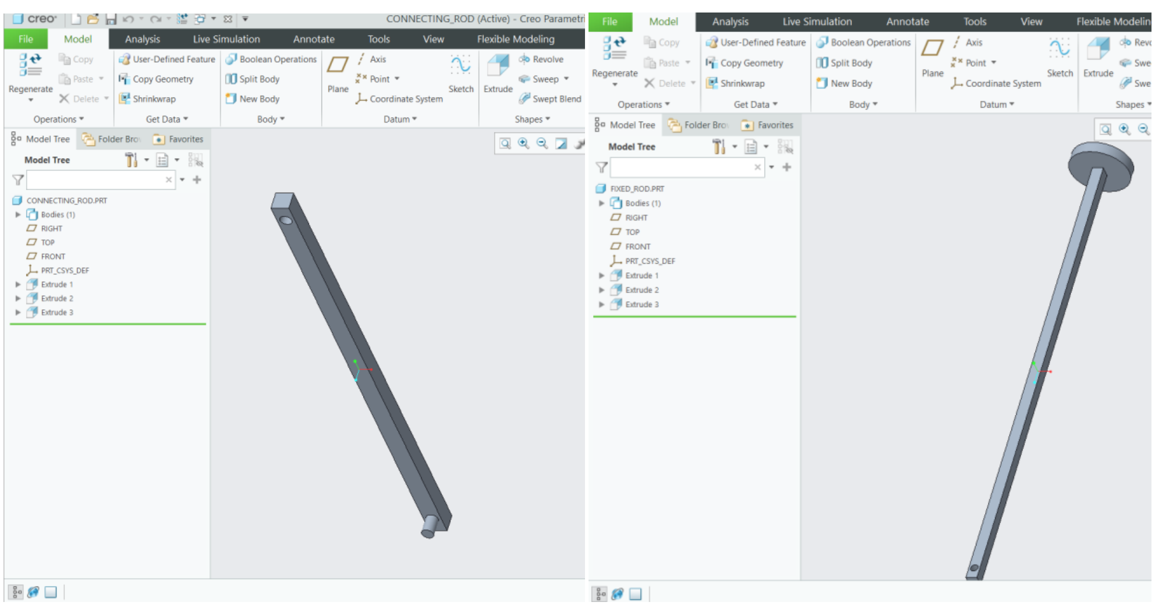
(Fig.10 Crankshaft coupling gear assembly- default view)

d. <u>Drive Mechanism Design: of Feed Pump</u>

The next step is to make the drive mechanism for the feed pump. The need of a drive mechanism is because we have to convert the rotary motion of the crankshaft to a reciprocating motion for the feed pump. The drive design mechanism that I chose for my assembly is a Single Slider Crank Mechanism. The main purpose of chosing a slider crank mechanism is because the less complexity to design, low cost, reduced number of parts and connections, reduced weight of the overall mechanism, etc.



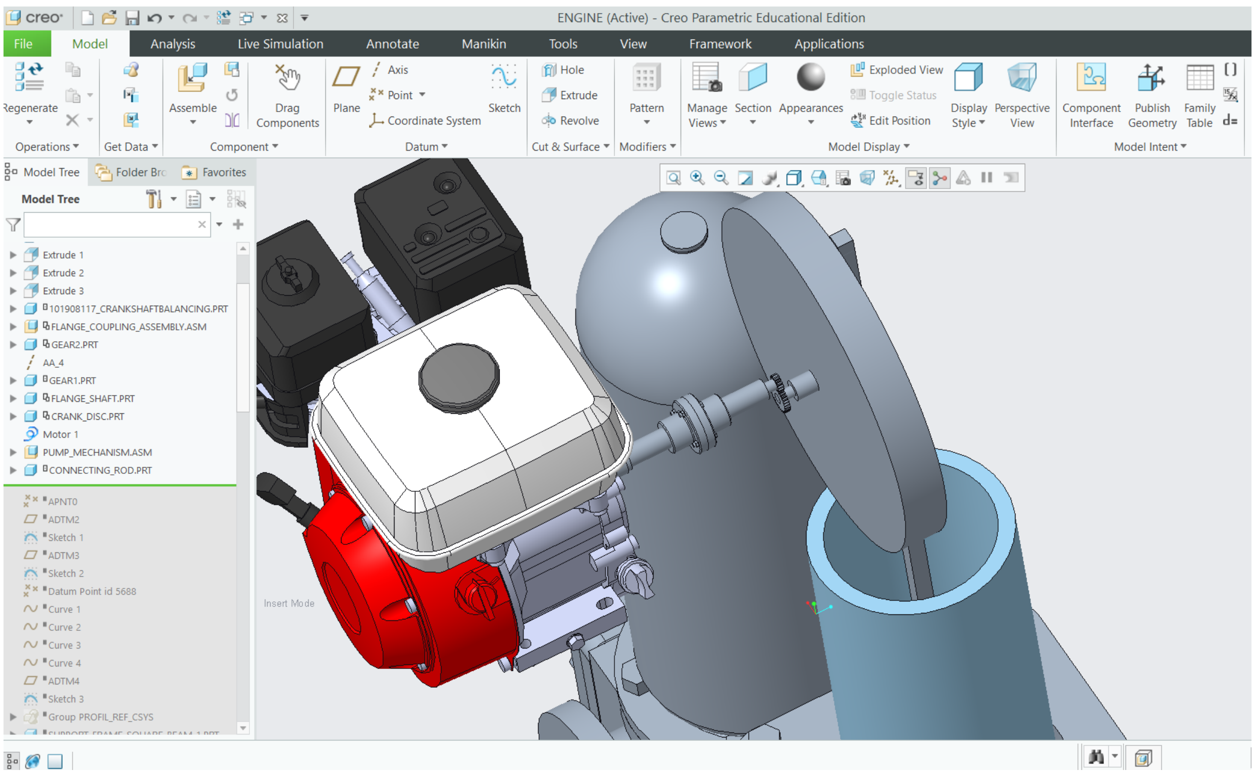
(Fig.11 Crank disc of slider crank mechanism)



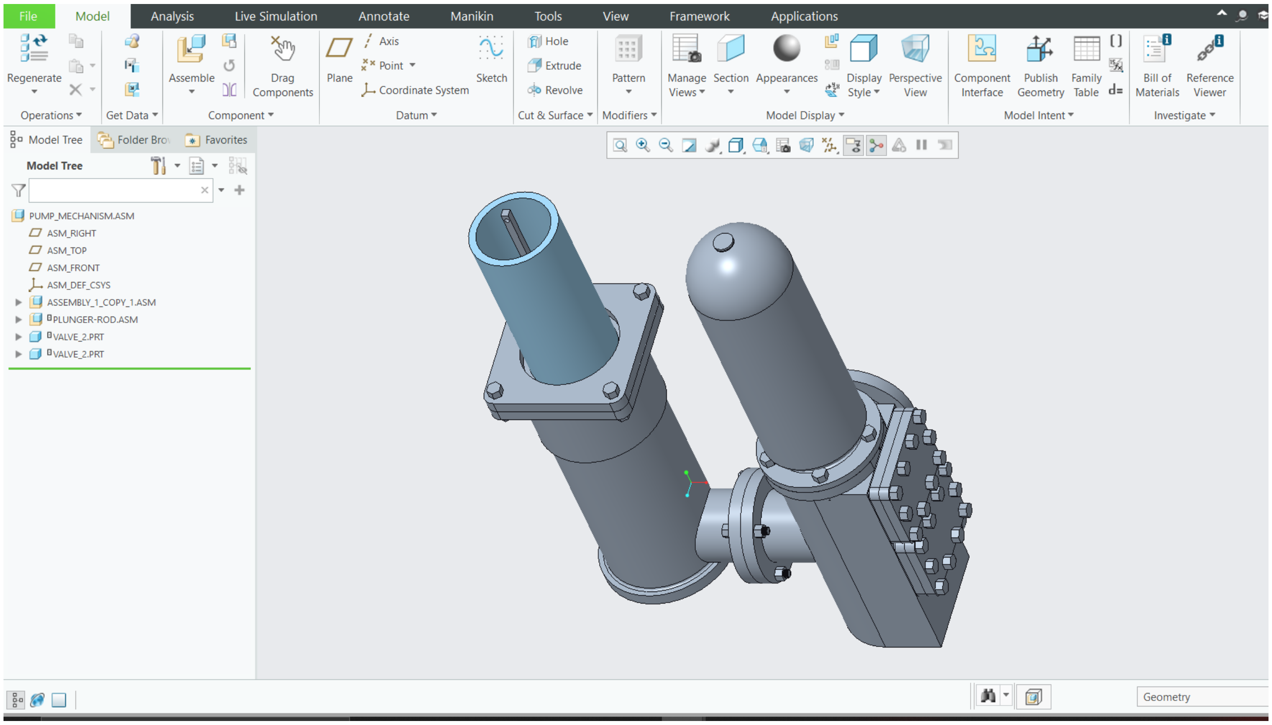
(Fig.12 Connecting rod and fixed rod of slider)

e. Assembly of Drive Mechanism to Crankshaft and Feed Pump

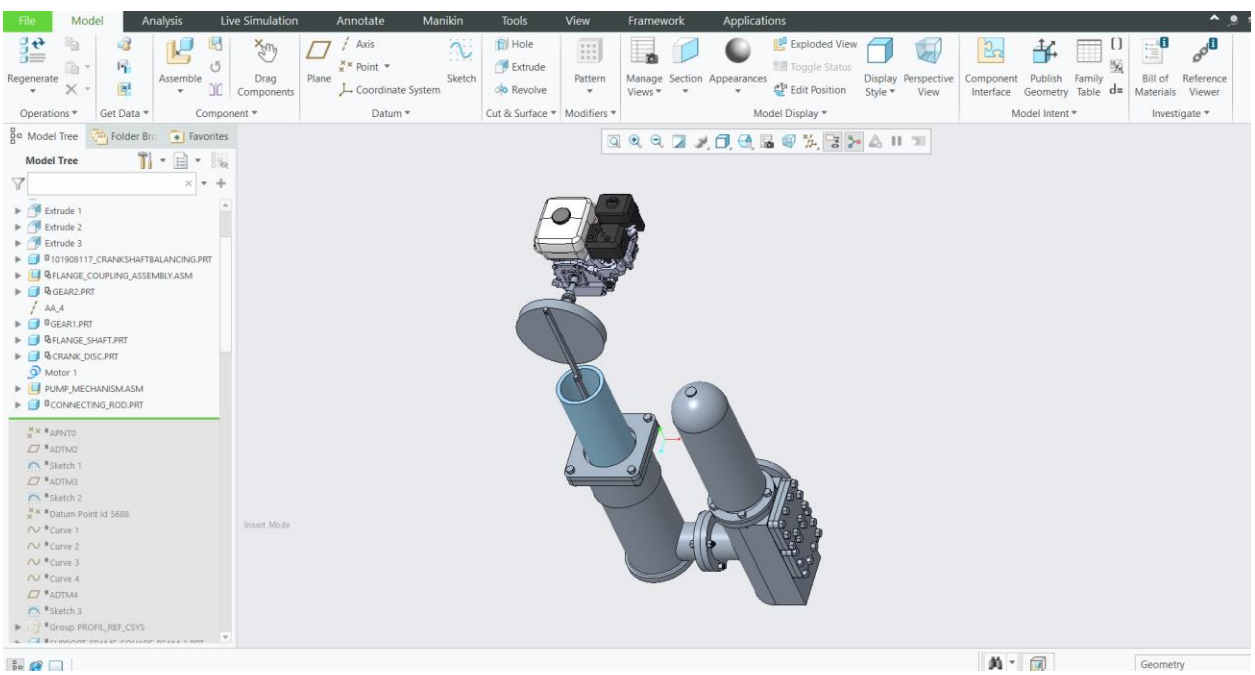
Once, all the parts of the slider crank mechanism are ready, the next step is to assemble the mechanism to the feed pump and the crankshaft-coupling-gearing assembly. To do this we first fix the feed pump in the assembly with the help of plane constraints and then attach the connecting rods with the help of PIN joints. We also use CYLINDRICAL type joint to fix the plunger with the feed pump.



(Fig.13 Gear mechanism mating with crank disc)



(Fig.14 Feed pump and plunger assembly)

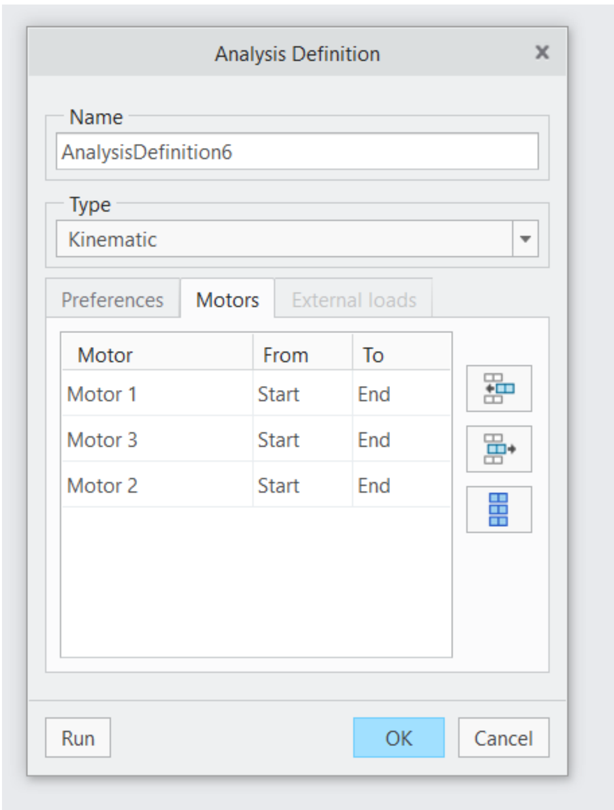


(Fig.15 Feed pump – Crankshaft assembly)

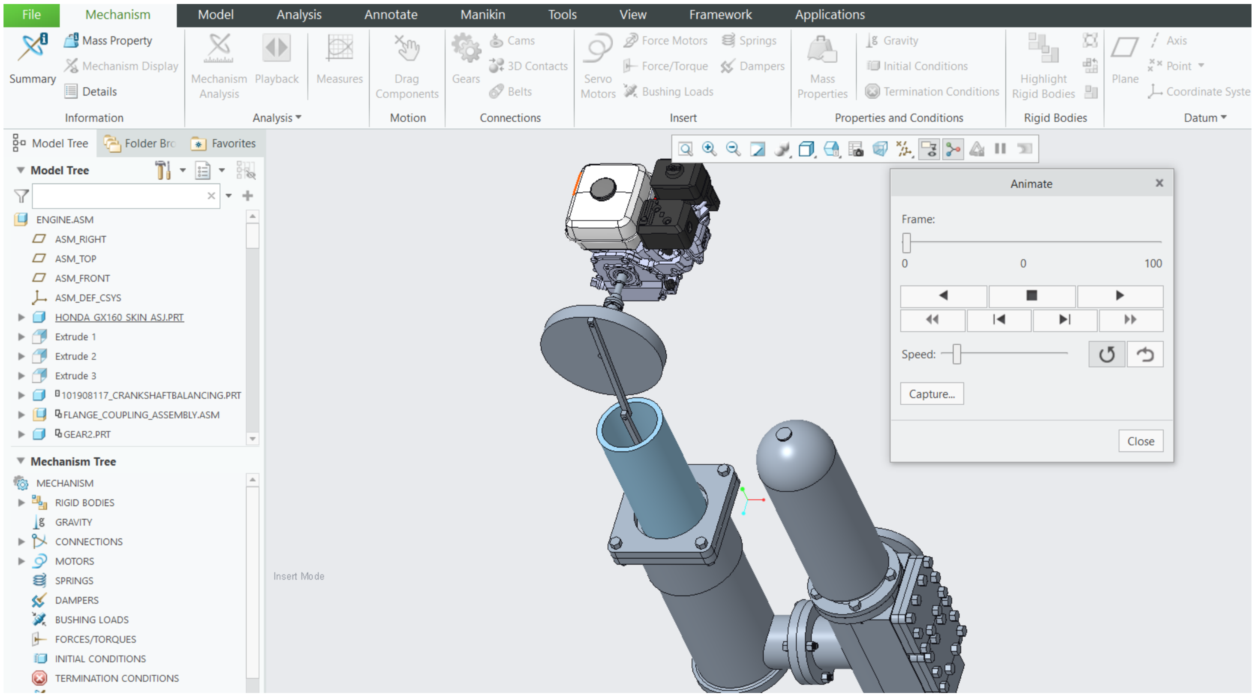
Motion Analysis

To test the Drive Design Mechanism, motion analysis is to be performed to check and get the desired outputs. To achieve this, the first step that we perform is by adding Servo Motors to the axis of rotations. In this project one servo motor has been added to the engine- aligned to the axis of rotation of the crankshaft with an angular velocity of 15000 deg/sec i.e. is the maximum angular velocity provided by the HONDA GX160 Engine. The other 2 motors are aligned with the axis of rotations of the valves in the feed pump. The animation of the motor analysis is attached along with this project report. The motion analysis was done for a duration of 10 seconds, where in the plunger made 3.5 strokes.

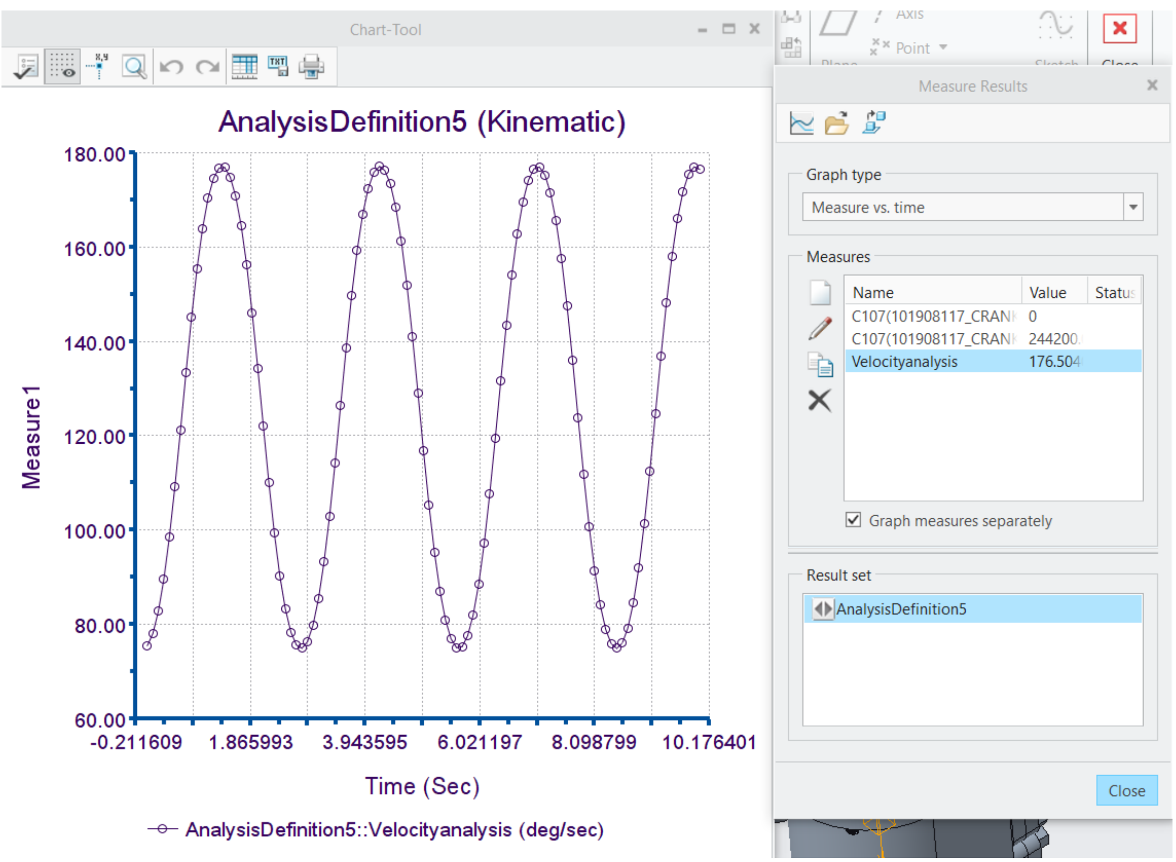
Link to the animation video-
https://drive.google.com/file/d/1mL4YmDyhfUn9wF_bwLDPP8EcD6uHOGa7/view?usp=sharing



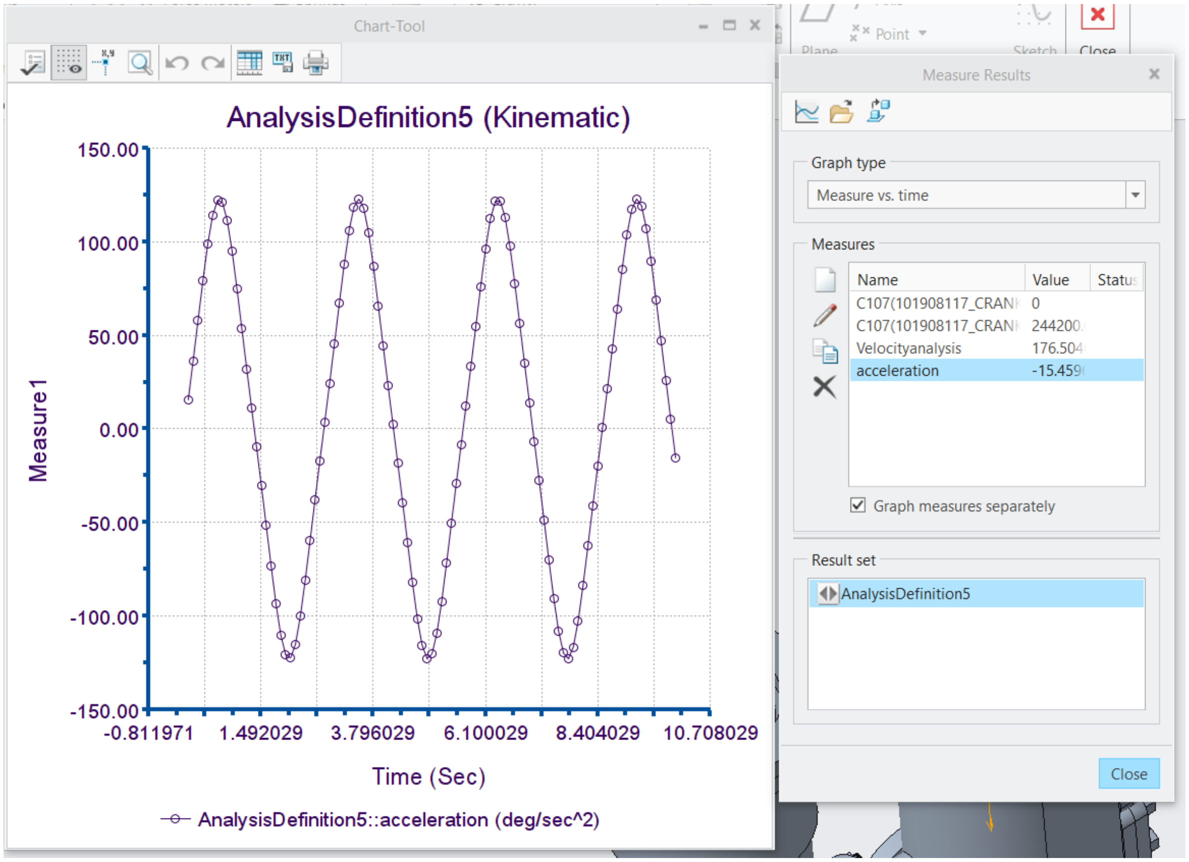
(Fig.16 Running the motion analysis)



(Fig.17 Capturing the motion analysis)



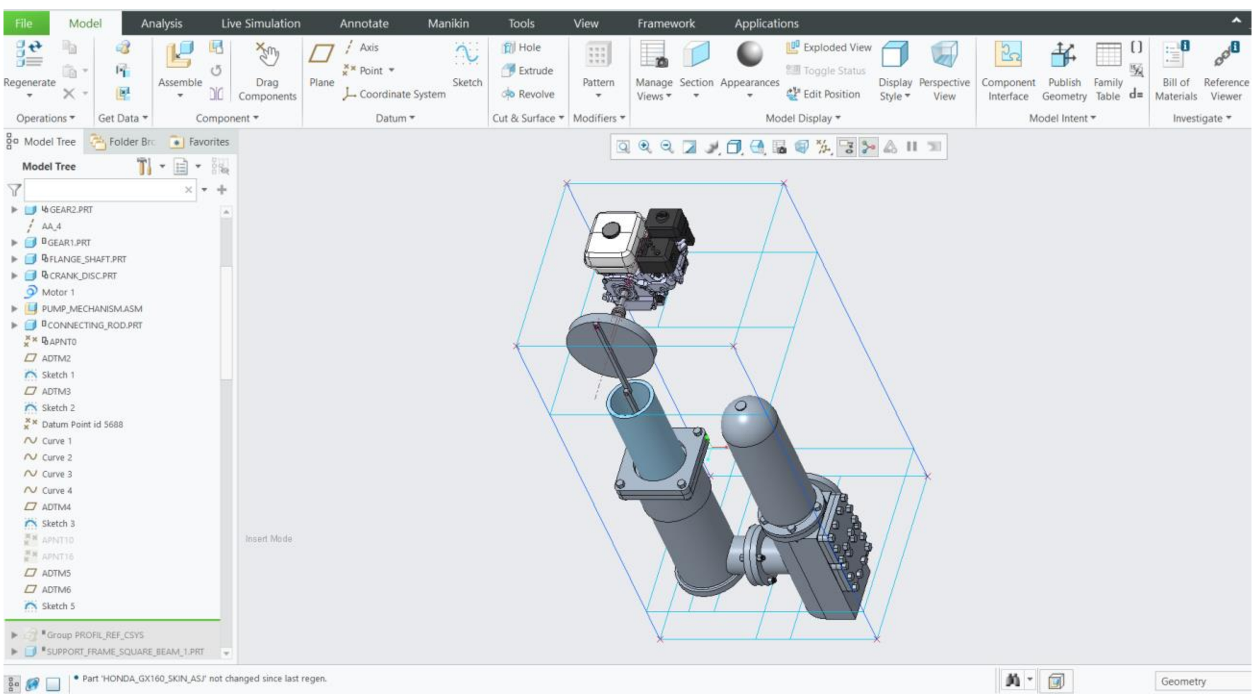
(Fig.18 Velocity-time graph)



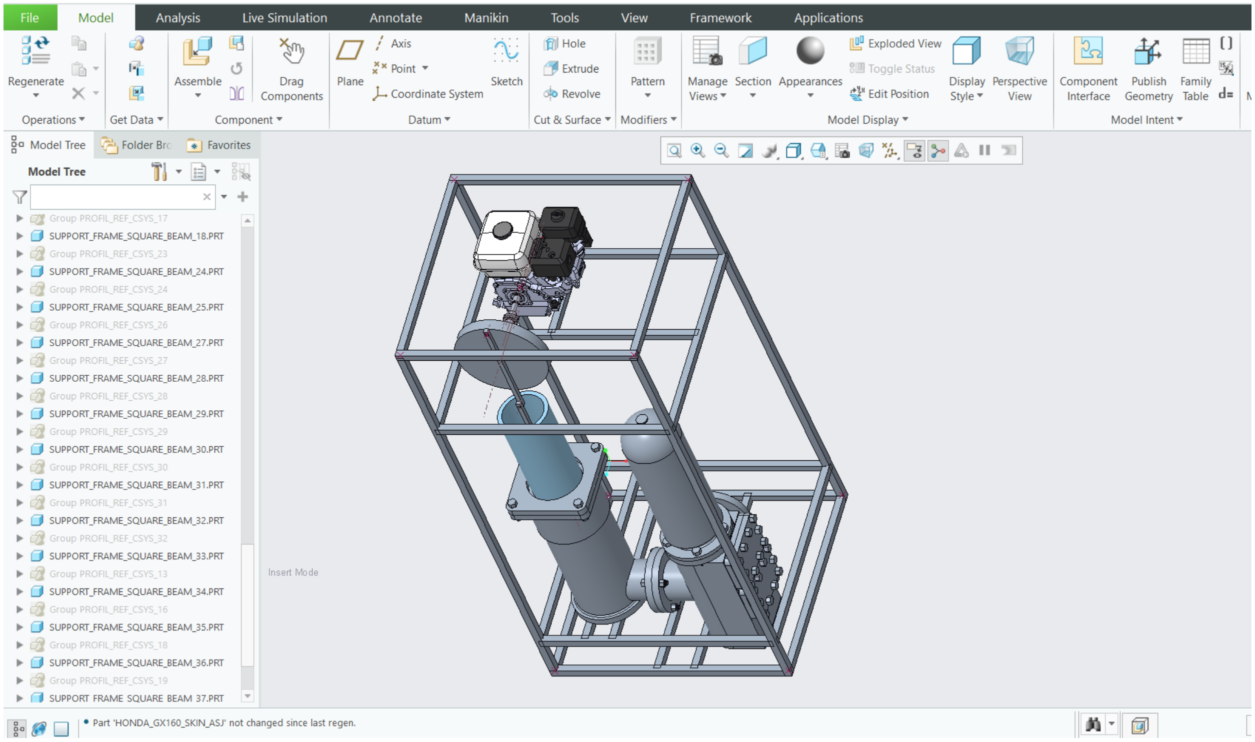
(Fig.19 Accelartion-time graph)

Support Structure Design using AFX

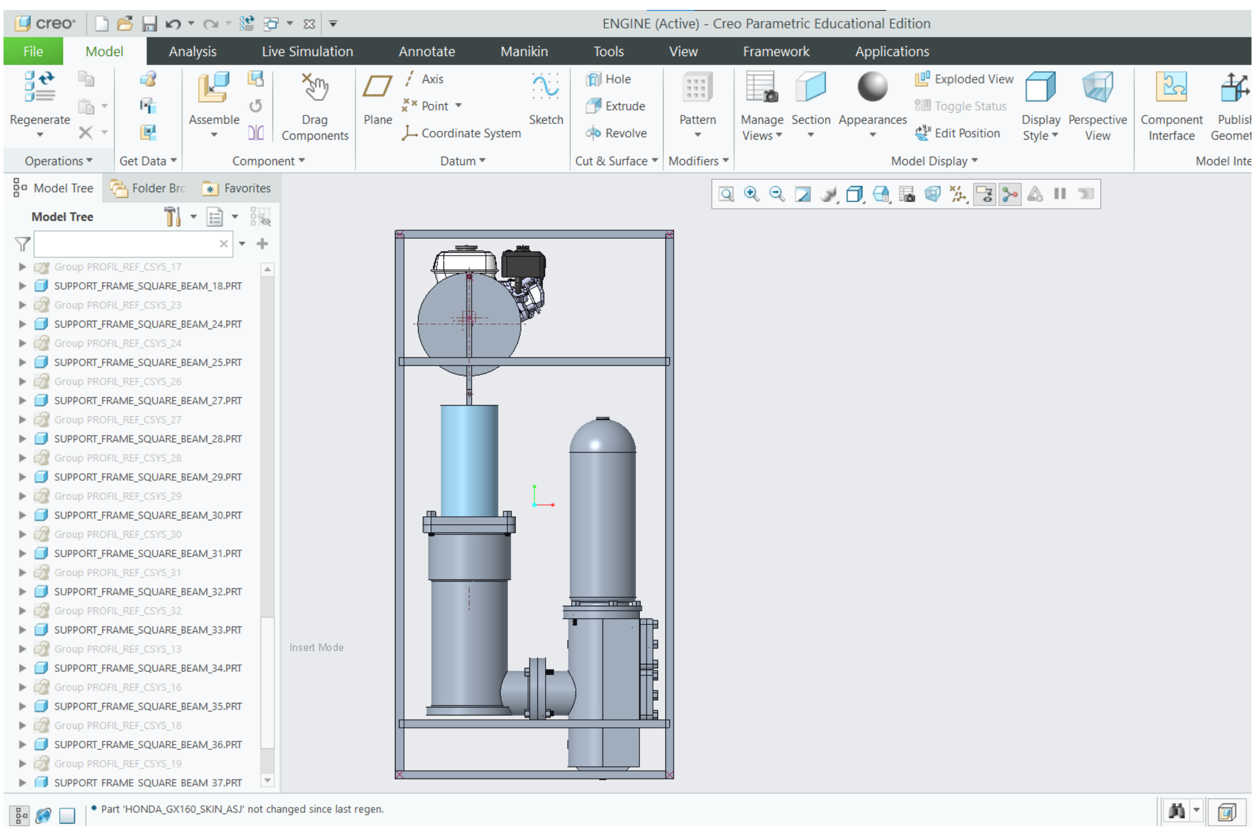
The support frame was designed using the AFX module of PRC CREO SW. The support structure was made using aluminium profiles for supporting all the above parts of the assembly of the feed pump, drive mechanism and the Engine. First we create datum planes and datum points. On these datum planes we make the required sketches for the support frame. In this project frame was designed in such a way that the support structure is easy to assemble, light weight, does not comes in between the nuts and bolts, making it easier for the technician while repairs. Using the tool of basic joints we give the edges a refined look. The support frame was designed in such a way that it easily supports the engine on which the engine will be placed, features were also created to support the feed pump and the mechanism.



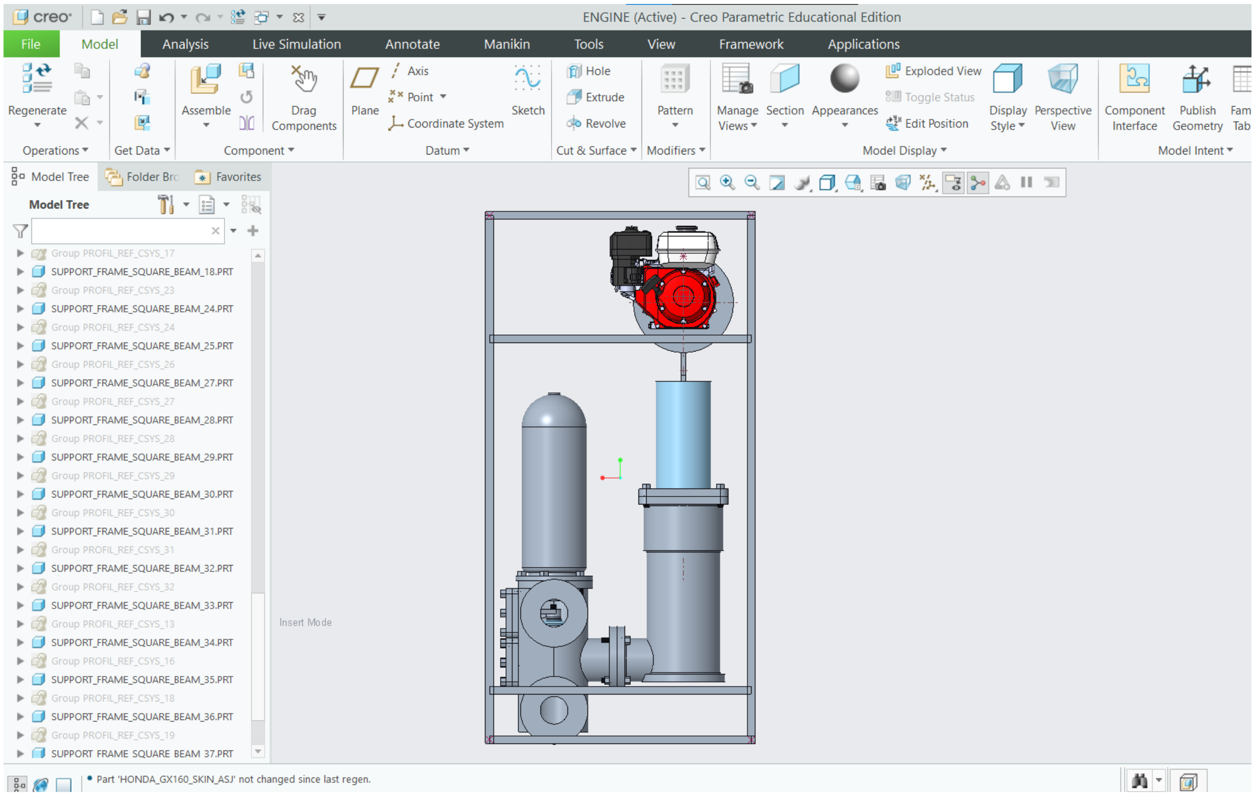
(Fig.20 Datum planes and sketches for support structure)



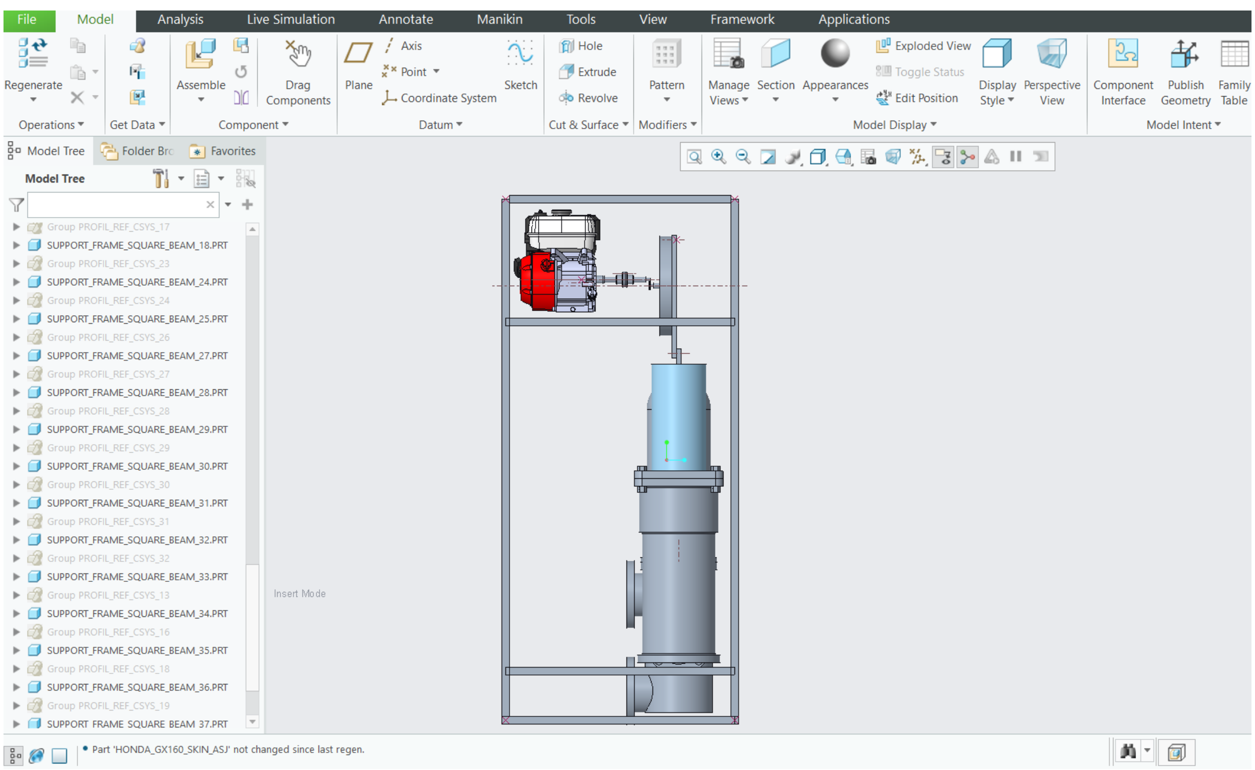
(Fig.21 Support structure using AFX module- default view)



(Fig.22 Support structure using AFX module- front view)



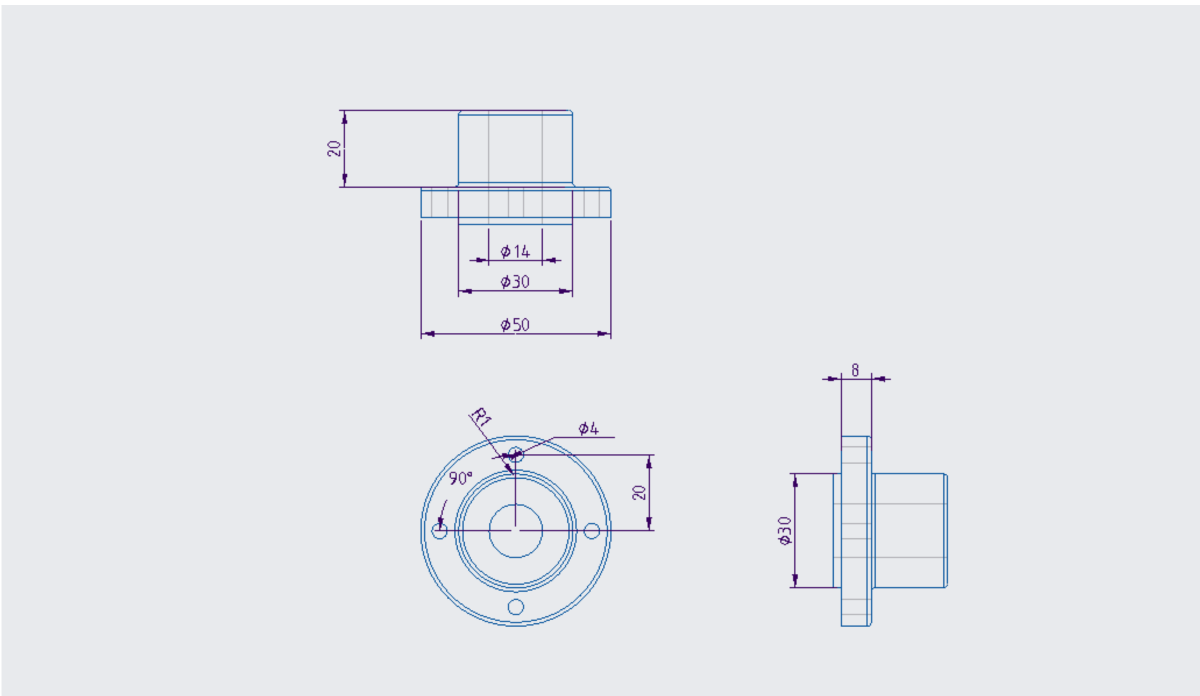
(Fig.22 Support structure using AFX module- back view)



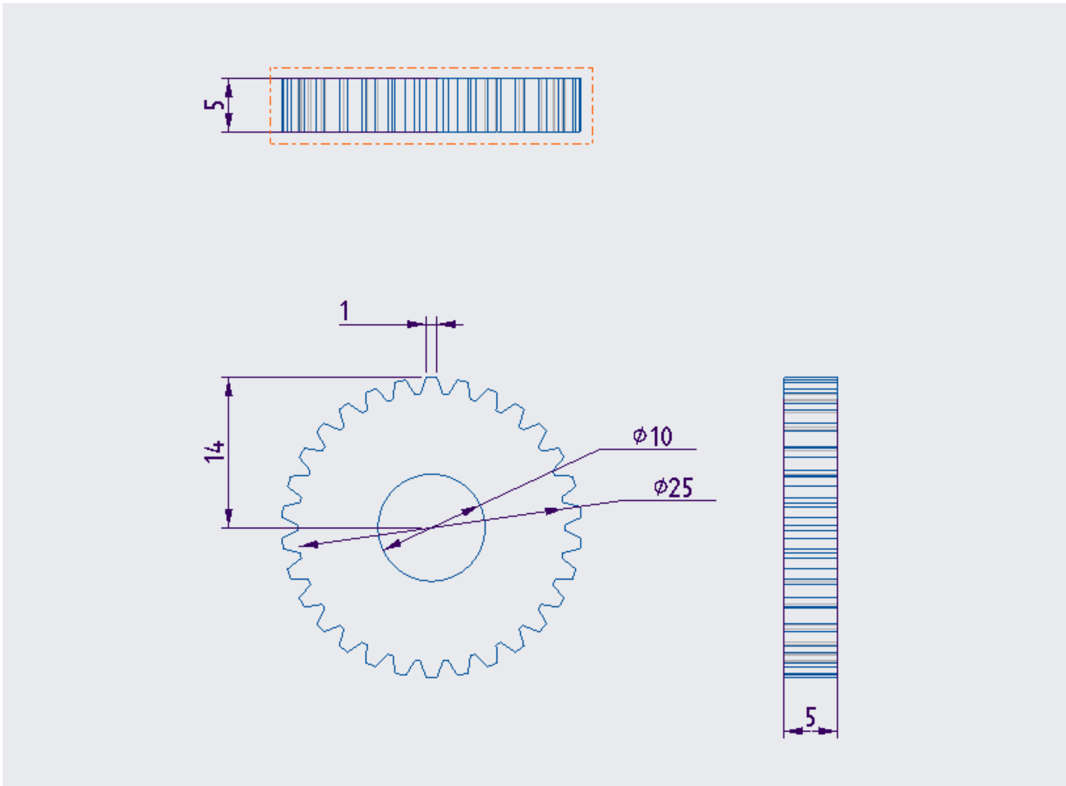
(Fig.23 Support structure using AFX module- side view)

Production Drawings and BOM

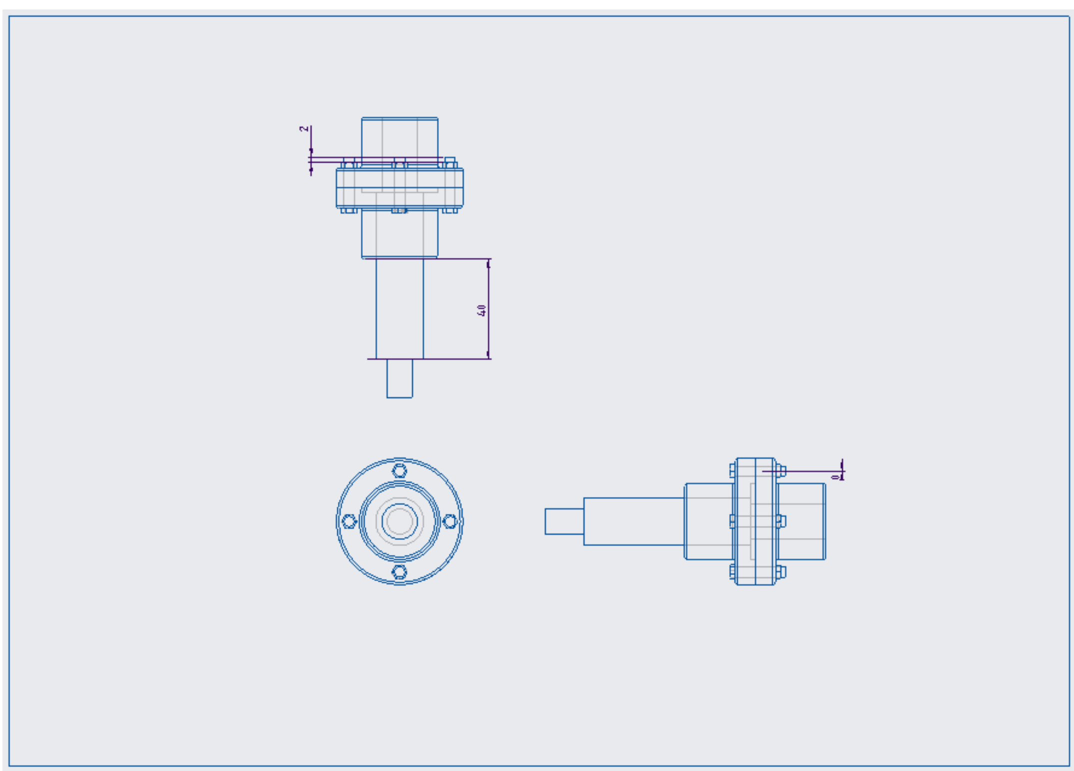
Production drawings were made keeping the industry standards in mind. Below are the attached screenshots of the drawings. All the drawings were made on standard A3 size of drawing sheet. BOM and ballooning was also done to the final assembly.



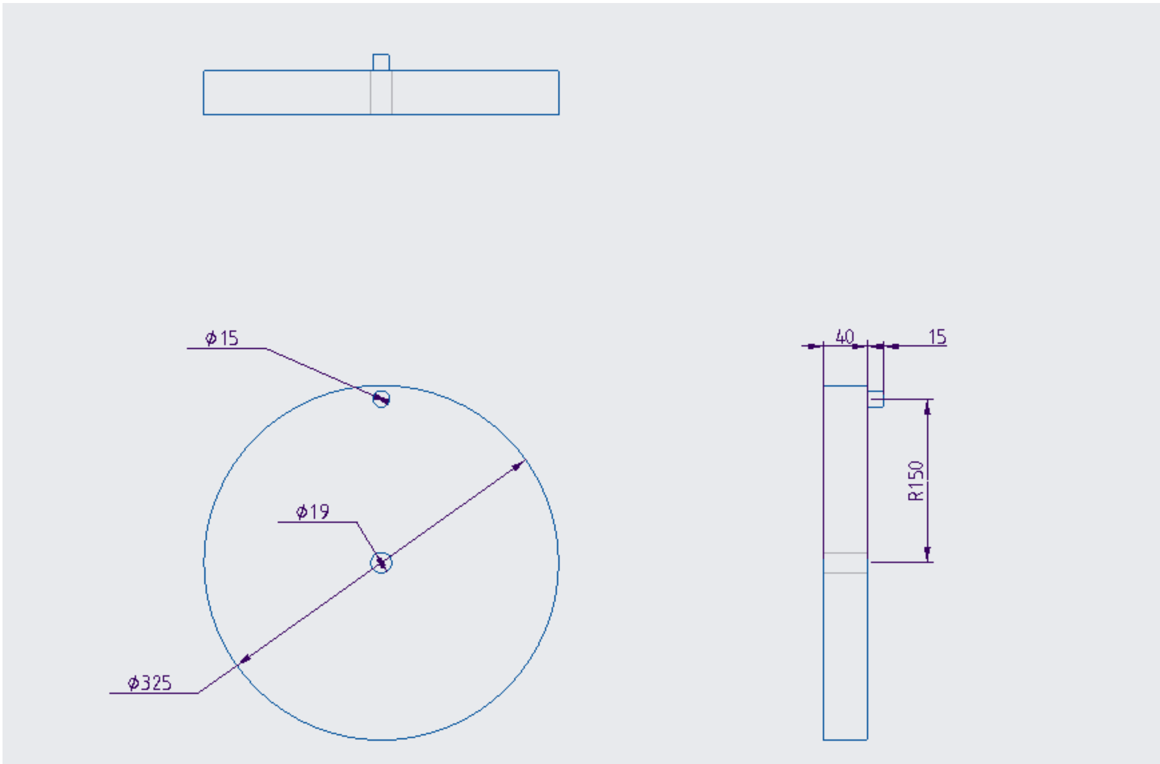
(Fig.24 Production drawing of the flange)



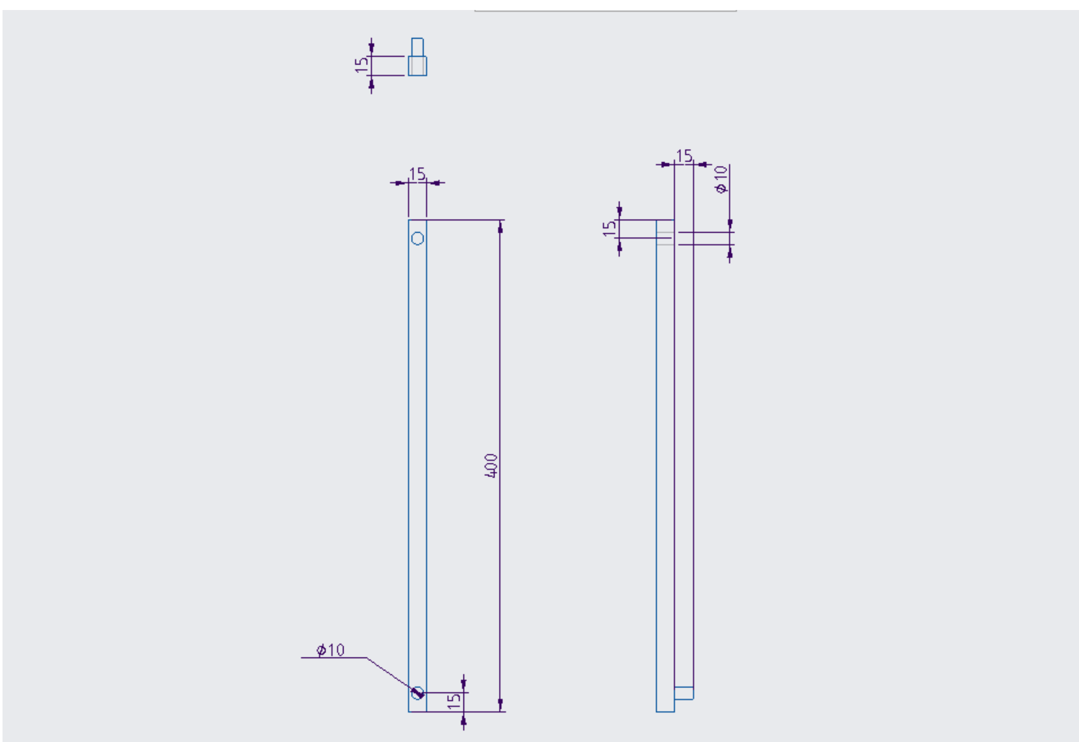
(Fig.25 Production drawing of gear)



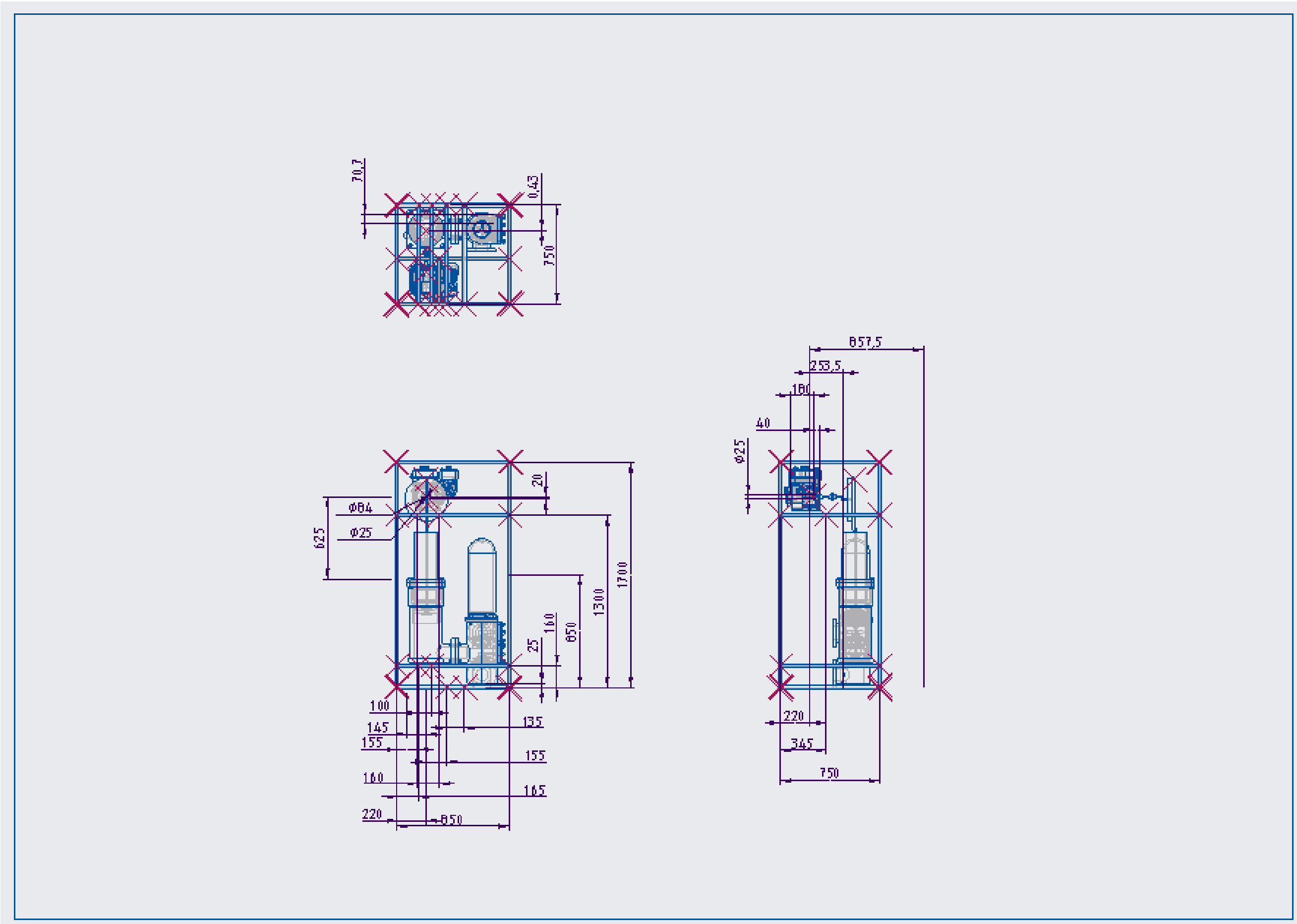
(Fig.26 Production drawing of couple assembly)



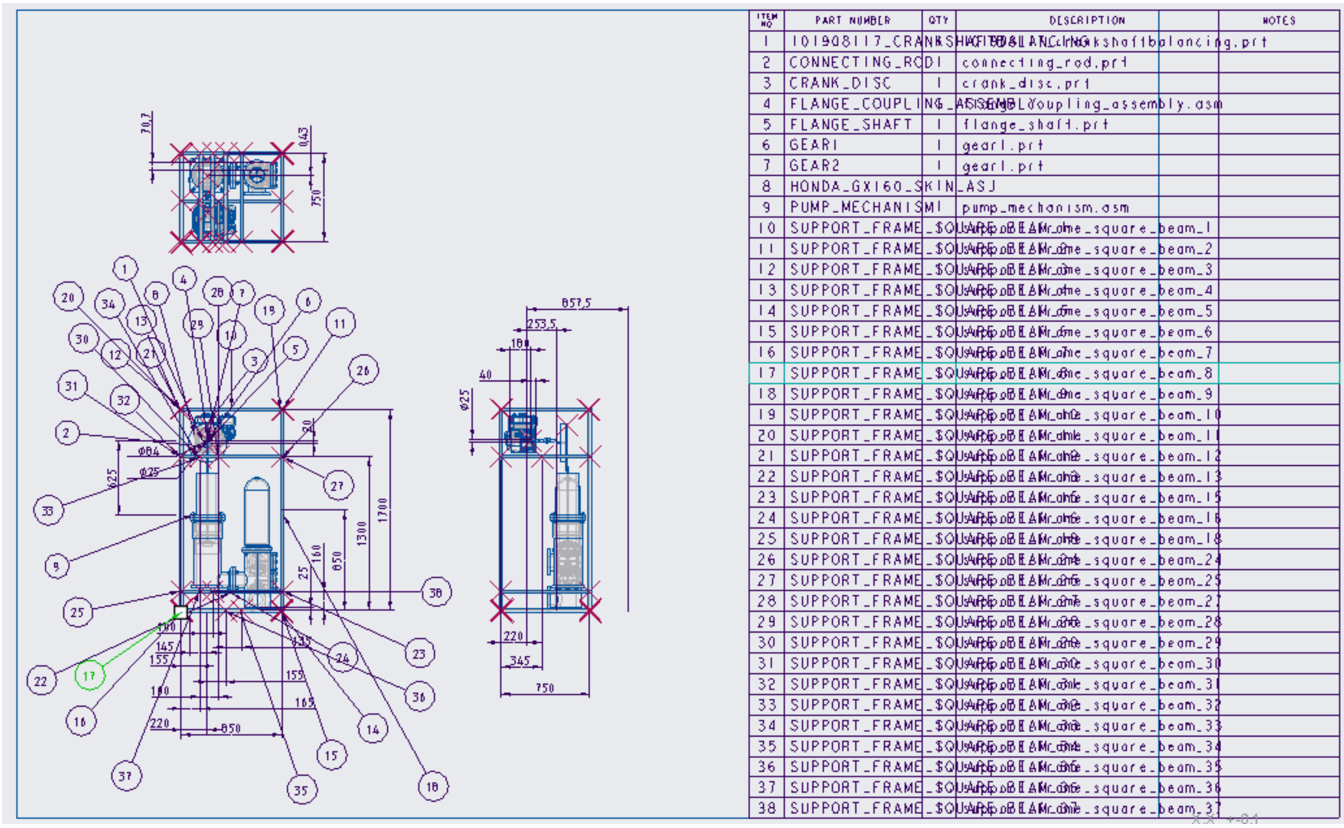
(Fig.27 Production drawing of crank disc)



(Fig.28 Production drawing of connecting rod)



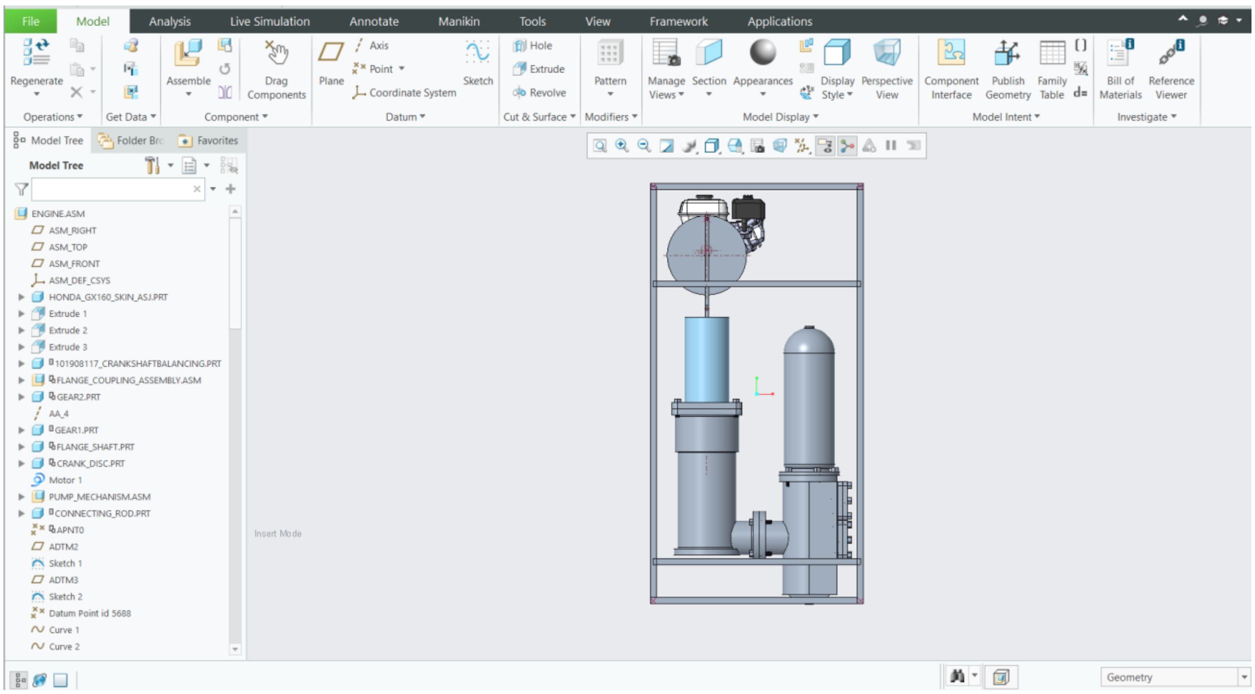
(Fig.29 Final production of the assembly)



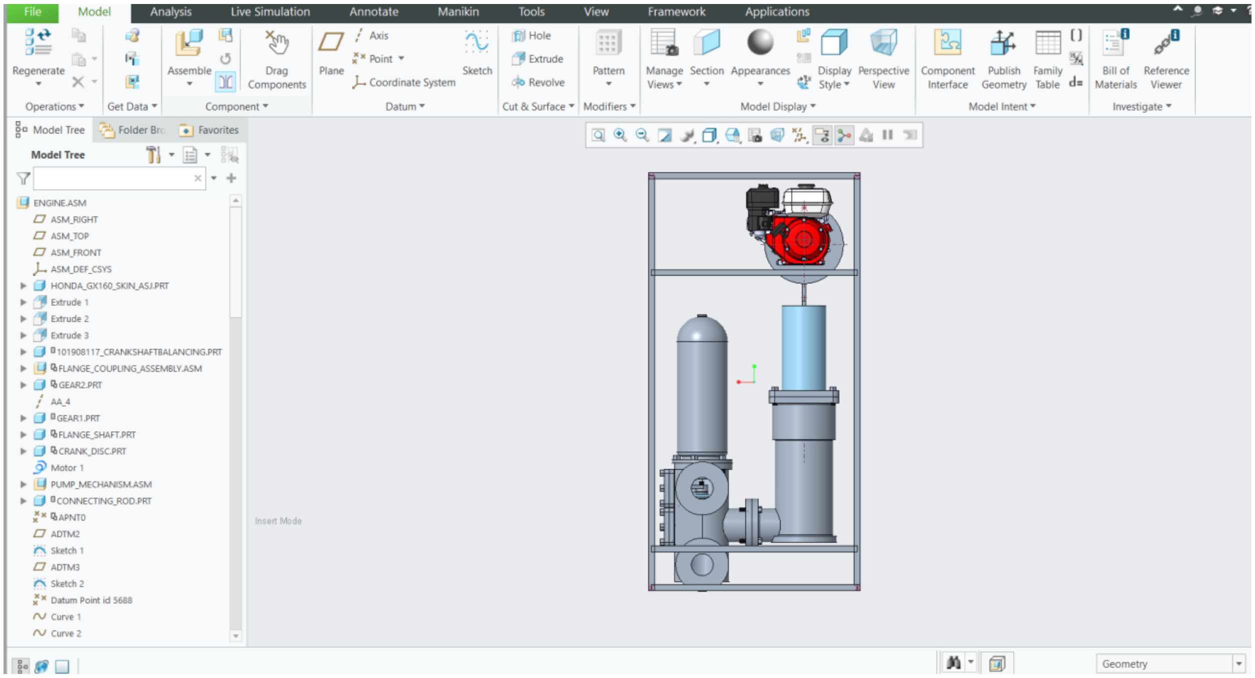
(Fig.29 Final production of the assembly with BOM and ballooning)

Final Design/ Conclusion

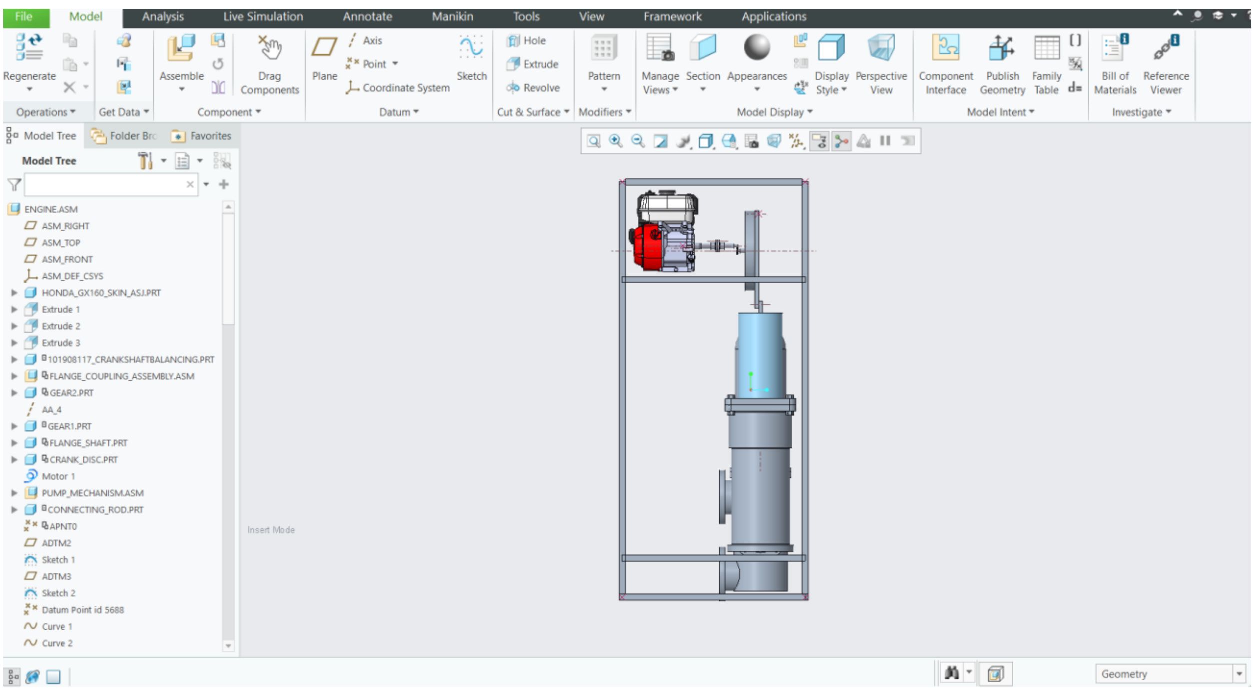
We were successfully able to assemble the engine, crankshaft, and the feed pump. The gear mechanism and the drive mechanism for the feed pump along with the motion analysis was completed. We were also able to create production drawings along with BOM and ballooning.



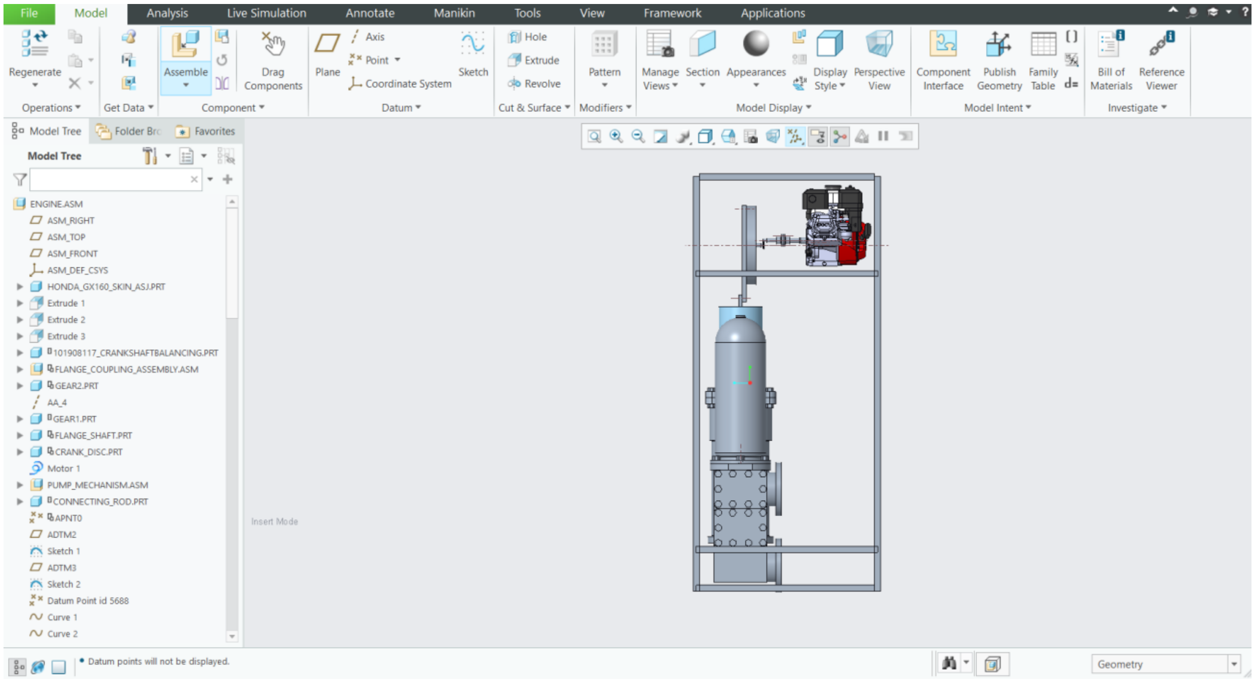
(Fig.30 Final Assembly- front view)



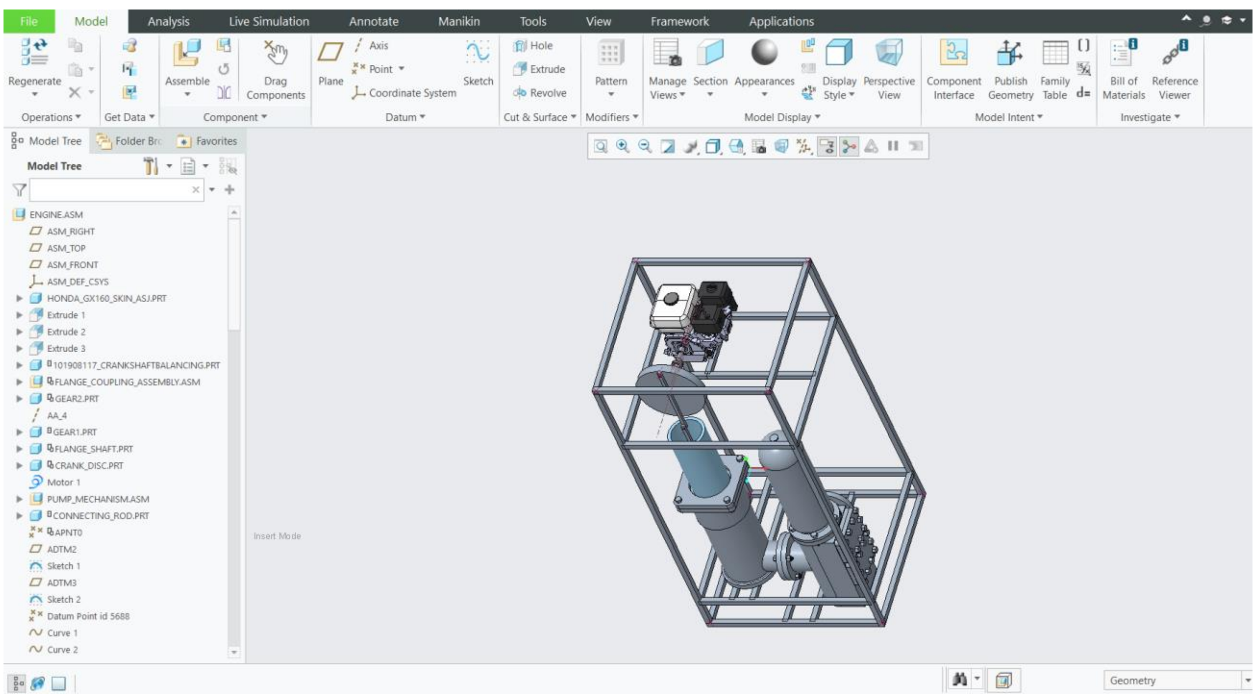
(Fig.31 Final Assembly- back view)



(Fig.32 Final Assembly- left side view)



(Fig.33 Final Assembly- right side view)



(Fig.34 Final Assembly- default view)

Reflections

1. Assumptions in design

There were few assumptions that were taken into consideration while completing this project. The complete AFX structure was made with dimensional assumptions. The upper and lower limit of the plunger movement were taken by assumption, hence the dimensions of the slider crank mechanism were also an assumption according to the plunger. There is an assumption that the engine is working but in reality we are only rotating the crankshaft in this project.

2. Limitations and scope of improvement

A few limitations in this project are that no vibrational, gravitational, etc. forces are not considered. The optimization and feasibility analysis of all the parts was not done. We performed structural analysis only for the crankshaft. In the motion analysis the video which is captured does not come out to be of the exact time limit as required. A lot of improvements can be done to this particular project including the above mentioned limitations.

3. Learning’s

There are a lot of learning’s from this particular project. The overall projects that were involved in the successful completion of this course not only taught us the skills of CAD-CAM but also gave us an overview as to what are the industry expectations. The modeling, analysis, assembly, drawing part of the project help us to grow in terms of our technical skills required in the industry. The project helped us to get the feel of real engineering that we are missing out on due to the pandemic. As hands-on experience is very important being a mechanical engineer, this project helps us to achieve that and once the project is completed along with the report, there’s a sense of satisfaction and achievement. I would like to thank all the course instructors for making this project based learing experience a great one and helping us make better DESIGN ENGINEERS.

References

1. PTC CREO online support and resource materials
   http://support.ptc.com/help/creo/creo_pma/usascii/index.html#page/detail%2FAbout_BOM_Balloons.html%23

2. Online lecture recordings
   https://www.youtube.com/playlist?list=PLkuV1FW8dkSN0PEX5ielFY4UslWDABZZu

3. Online recorded lectures and e-content LMS
   https://www.youtube.com/playlist?list=PLkuV1FW8dkSN0PEX5ielFY4UslWDABZZu

4. Coupling resource material provided

5. Engine dissection and assembly- ELC activity videos
   https://www.youtube.com/watch?v=eU3xChPCmBQ&t=1s