A Project Report
Submitted for

Computer Aided Design & Analysis
(UME412)

Project 1

Project on Modeling, analysis, and optimization of Crankshaft part of HONDA GX160 5.5 Hp Engine, by Reverse Engineering using BMX module of CREO.

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Introduction

A crankshaft is a rotating shaft which converts reciprocating motion of the pistons into rotational motion. Crankshafts are commonly used in internal combustion engines and consist of a series of cranks and crankpins to which the connecting rods are attached. Crankshafts are usually made from metal, with most modern crankshafts being constructed using forged steel.

A three-dimensional CAD model of the crankshaft was created using PTC Creo, according to the two-dimensional drawing of the existing crankshaft. Optimization of the crankshaft was studied and the optimized crankshaft design should be replaced with existing crankshaft. The optimized crankshaft helps to increase the performance of the engine and causes reduction in weight. Reverse Engineering is just engineering applied in reverse order. In other word you just brake whole system in smaller pieces in order to get the understanding of whole system. The crank-shaft sample that is designed in this project is the one used in Honda GX-160 engine, using Behavior modeler Extension module on PTC-CREO.

(Fig. 1 Crank –shaft of Honda GX160)

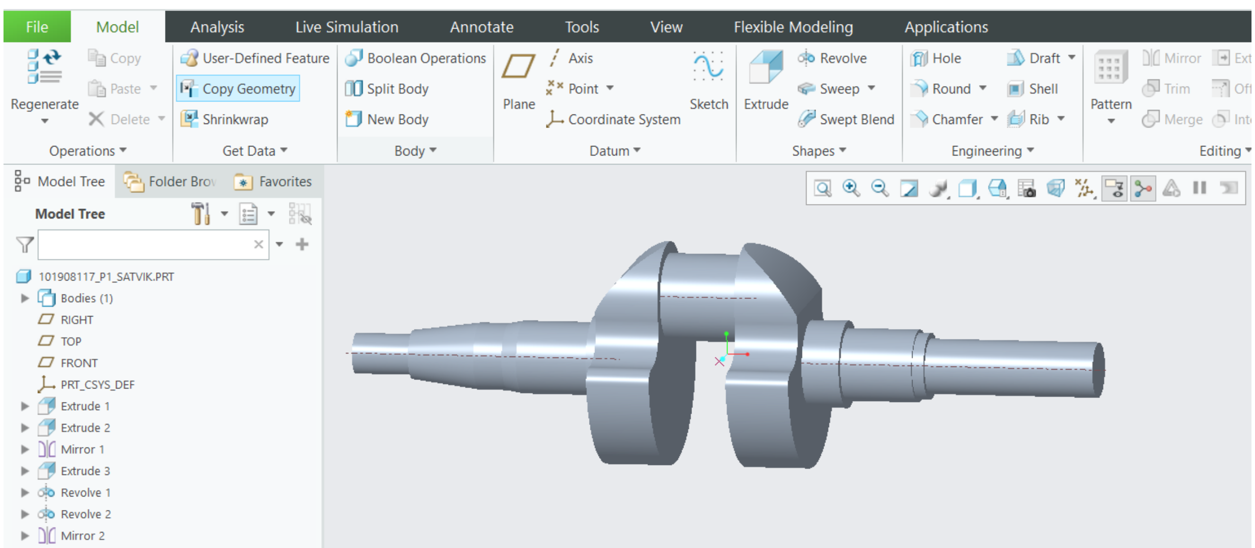
Initial modeling of crank-shaft

The crank-shaft of HONDA GX160 was successfully modeled on PTC CREO. The figure below shows the initial CAD model before optimization. PTC-CREO is a powerful 3-D modeling software with a wide variety of in-built features such as extrude, revolve, positioning, etc.

All the elements of the model were designed using different design features of CREO parametric software. The stepped shafts on either sides of the counter weights were designed using the revolve tool of the software.

Whereas, other features such as the counterweight was designed using the extrude feature of the software.

The features used in this model can be clearly seen in the fig. 2 below in the model tree section.

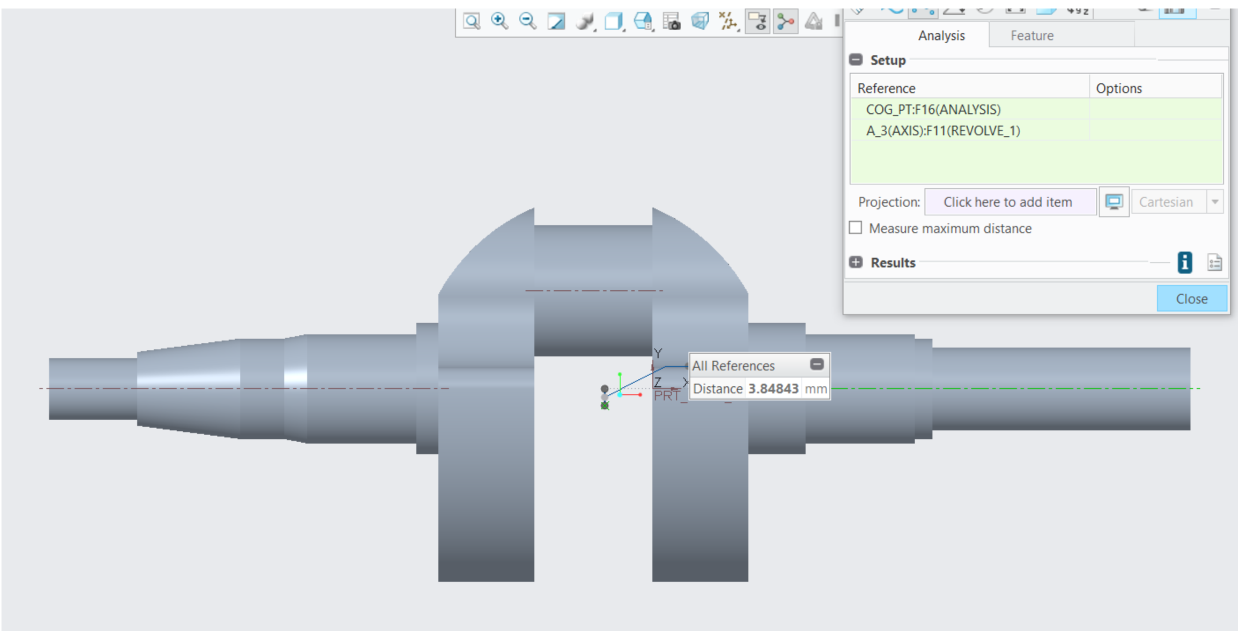


(Fig. 2 Initial CAD model of Crank –shaft of Honda GX160 designed on CREO software)

Modeling after effects

Once the CAD model of crank-shaft of HONDA GX160 was successfully made using the CREO parametric we still had some limitations to our design.
Even after designing the models with complete perfectness, it can still be unbalanced because of some offset distance between axis of rotation and centre of gravity (CG) or in other words, the axis of rotation and CG do not coincide with each other. This design is not a very optimum one and there will be a lot of challenges such as excessive vibrations and noise generation.

The centre of gravity (COG) position us offset by 3.84843mm from the axis of the shaft as shown in the fig. 3 below.



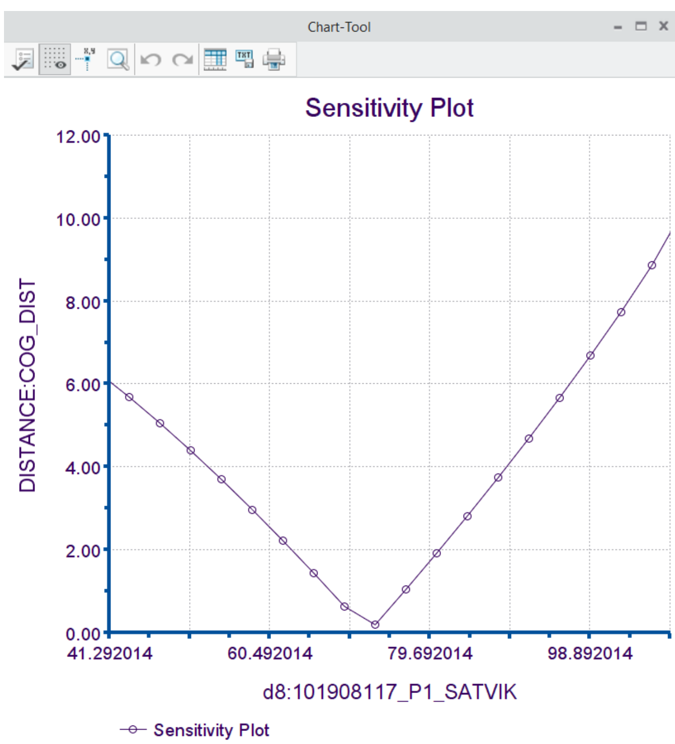
(Fig. 3 shows the distance between the axis and COG)

Analysis of Crank-shaft

By analyzing the CAD model of given part we can get the optimum model for a given set of parameters. It also helps us to understand the challenges and limitations one will face when the part/model will be used in real life. Analysis will help us to give the best possible model with the best set of parameters minimizing the errors. In this project we do the sensitivity analysis to find the range in which the constraints will lie. Once done with the sensitivity analysis, we perform the feasibility and optimization to get the feasible and optimum solution with minimum errors.

1. Sensitivity Analysis

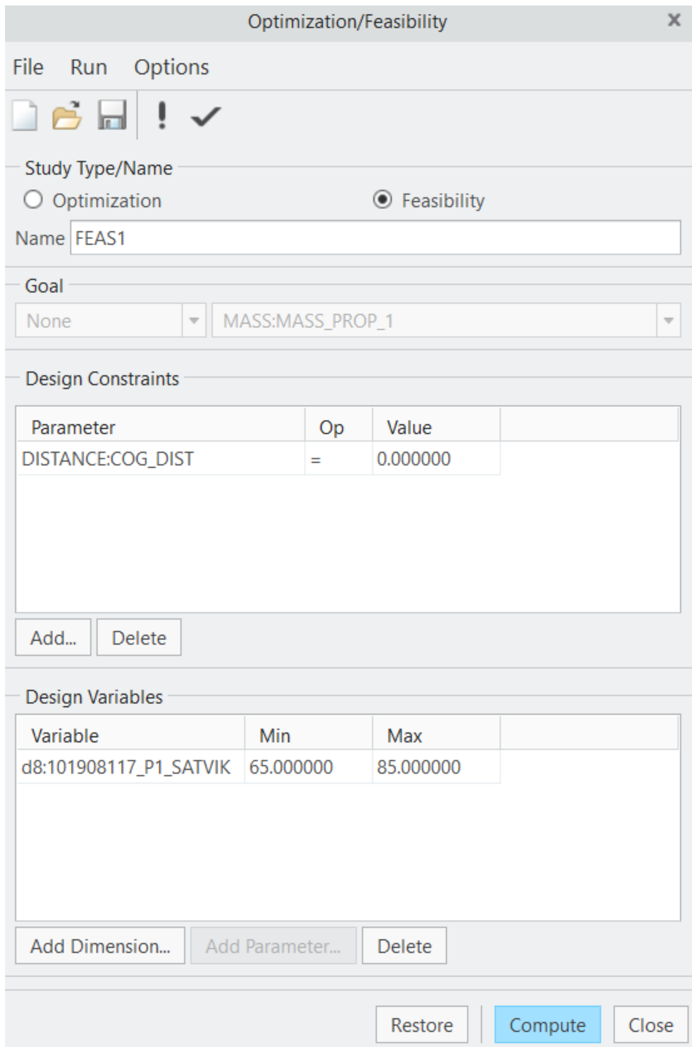
In order to balance the crankshaft or reducing the offset distance to zero sensitivity analysis is used. We plot a graph between the COG_DIST and the diameter of the counterweight. This will graph will help us know the desired range required for feasibility and optimization. There is a point on the graph on which offset distance is zero corresponding to a particular crank radius. At that crank radius shaft will be balanced.



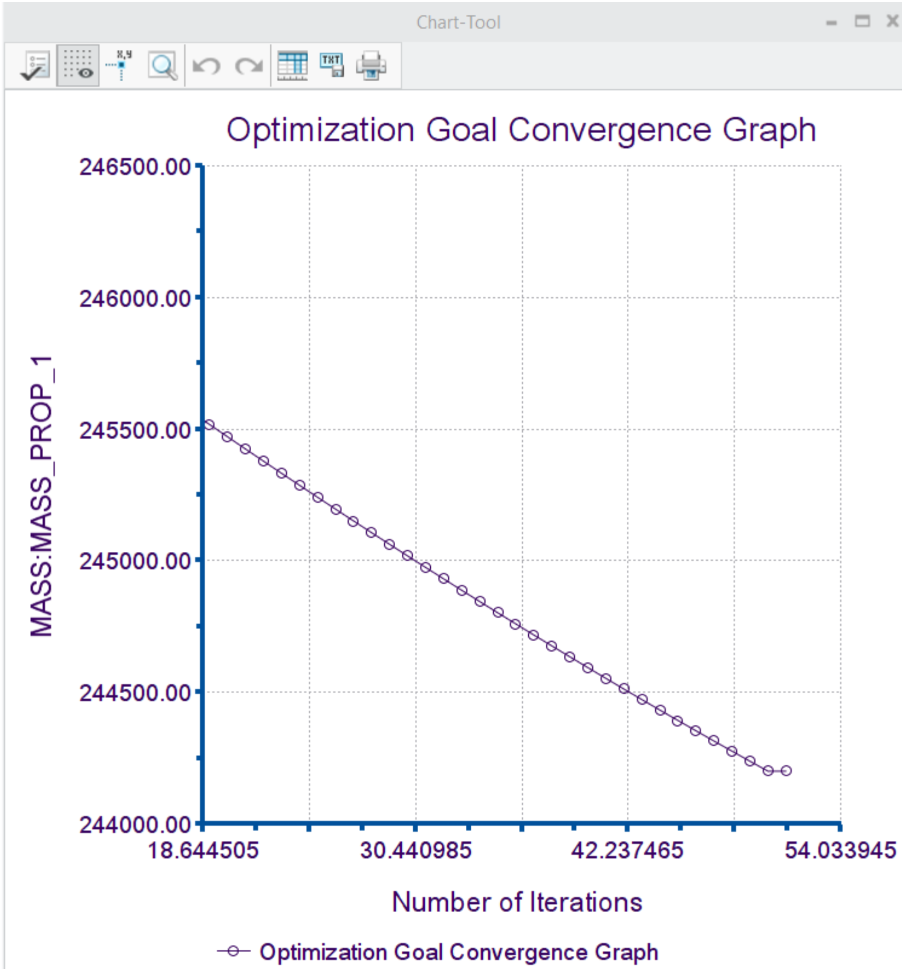
(Fig.4 sensitivity plot)

2. Optimization and feasibility

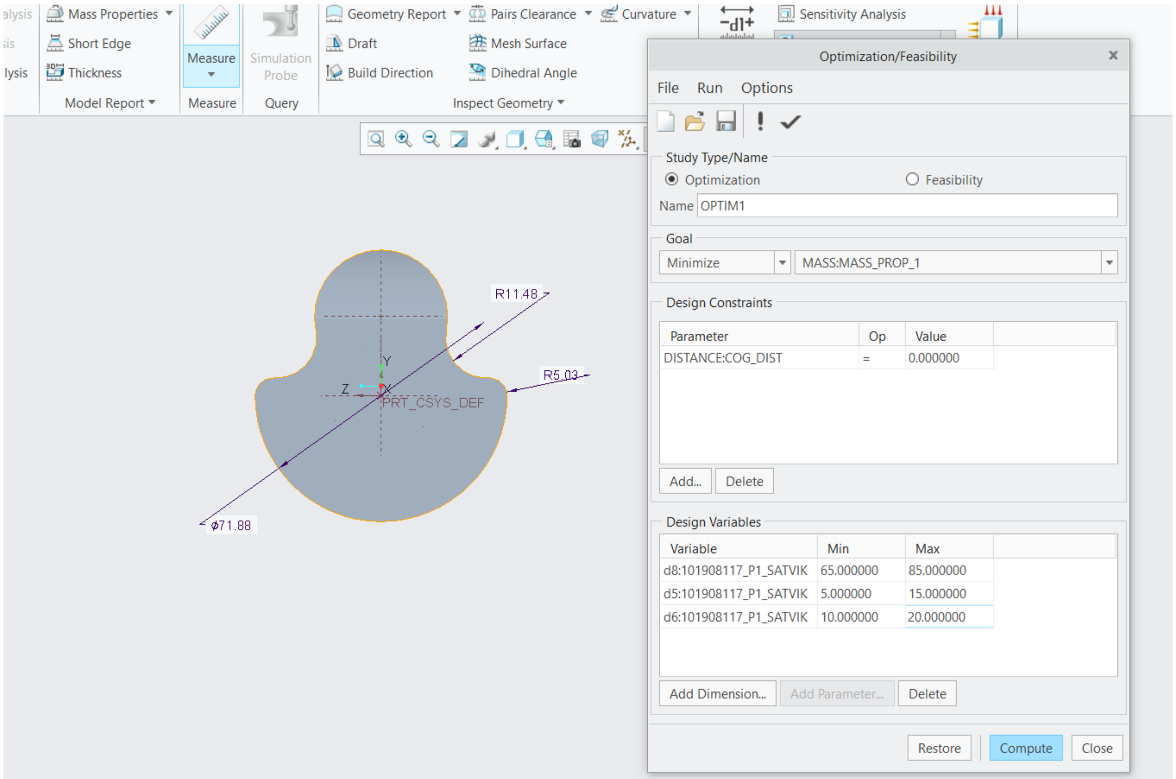
We can clearly see from the above (fig.4) graph that near 76-79 we get the least possible offset for COG. After that Feasibility/Optimization option is used for altering a particular dimension. This option will automatically produced a balanced design of crankshaft with an offset distance approximately equals to zero.



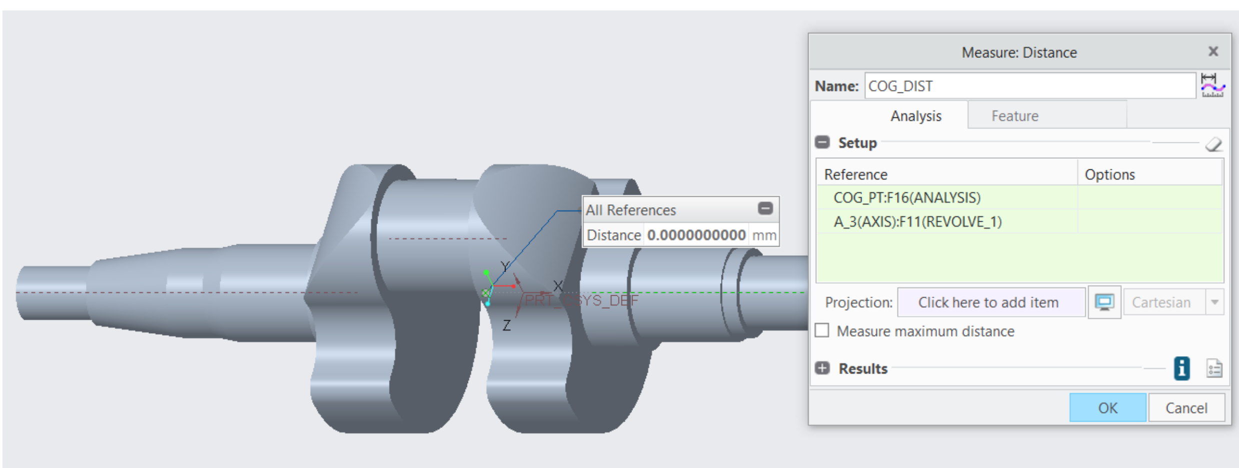
(Fig. 5 Feasibility to set the COG_DIST = 0)



(Fig. 6 Optimization goal convergence plot)



(Fig. 6 Optimized diameters for balanced weight of counterweight)



(Fig. 7 Figure shows the offset distance between the axis of rotation and COG is 0)

Reflections

1. **Is this project relevant to the contemporary knowledge and skills required for your branch of engineering?**
   A- Yes, this project gives me in depth knowledge of CREO software and I got to know how to OPTIMIZE the part and also about SENSITIVITY ANALYSIS which will really help me in my future projects as a mechanical engineer

2. **What are the main learning from this project?**

A- 1) How to OPTIMIZE the MODEL.
   2) Learned about FEASIBILITY.
   3) By using the right method, we made our project feasible.

3. **How would you assess the usefulness of this project to your future career as an engineer?**

A- This project really helped me in learning OPTIMIZATION, FEASIBILITY and this project has improved my basic knowledge of designing which will help me a lot in my upcoming projects and also in my future projects as an engineer.

4. **How would you suggest improving the project problem to make it better for your learning?**

A- 1)Should have given the Strain Deformation.
   2)Should have given Equivalent Stress analysis for better understanding.

5. **Reflect and write a note on the further design of the crank shaft balancing mass required to balance the added effect of connecting rod, piston pin and piston when the engine is working.**

A- We should design components separately then balance them and we will assemble them because it will be difficult to balance the assembly in one turn.

Conclusion

As an engineering student we learned many things but one of the most important things which we learn is to design a material. By practicing we enhance our performance in making our drawing quickly and with no extra dimensions which are given in the figure. We learn to optimize the distance and also feasibility of the material which thus help in our future projects.