A Project Report
Submitted for

Computer Aided Design & Analysis
(UME412)

Project 2
Project on Optimum Design of a Bottle

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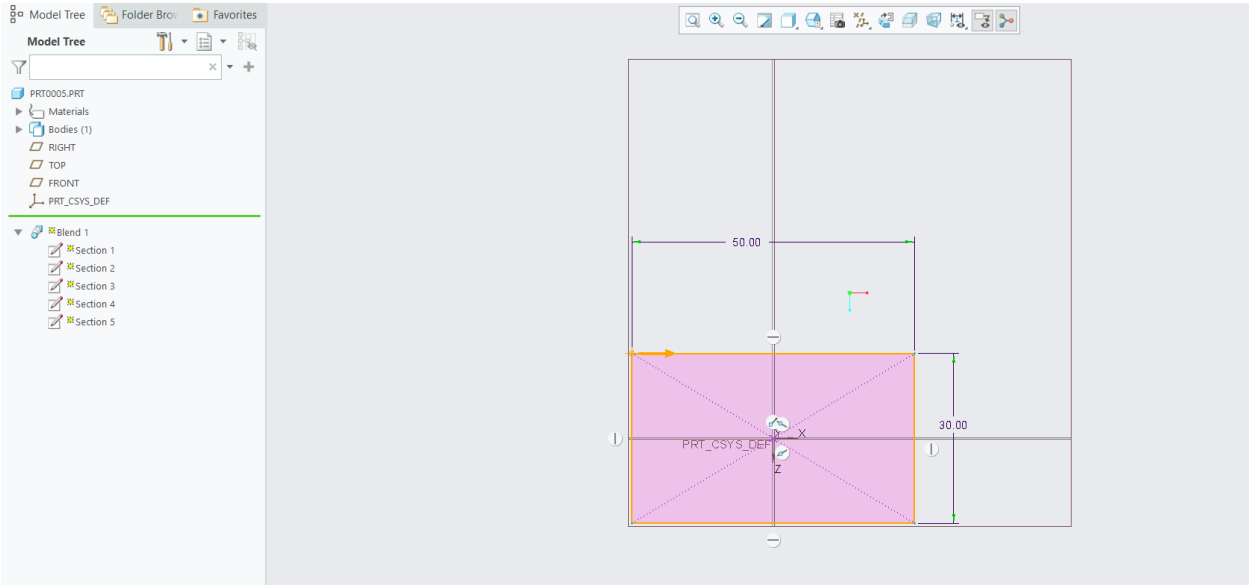
Introduction

The aim of this project is to create Optimum design of a Perfume Bottle using Creo Parametric SW –BMX and Simulation modules, with 550 ml of a liquid filling a total height of 200 mm, with a rectangular base of 50 x 30 mm inside the bottle, the corners of the rectangle have rounds of R5 mm. The cross-section of the bottle, which is variable, is made such that the top gradually reduces to the neck. The neck for attaching the spray assembly is 15 mm inner diameter. The shape of the surface of the bottle to be smooth (rounded where ever the geometry changes for die production and stress distribution with a minimum radius of 10 mm). We use an automated design study to find the value of two or more variable dimensions which gives the required volume of liquid.

The bottle is to be made such that when it is filled with perfume liquid it leaves a 15 mm clearance from the top of the bottle. The neck ID=15 mm and OD is ID+2*thickness of wall+1.5 mm. The neck of the bottle for attaching the spray assembly on the outside is 4 mm long along with the OD.

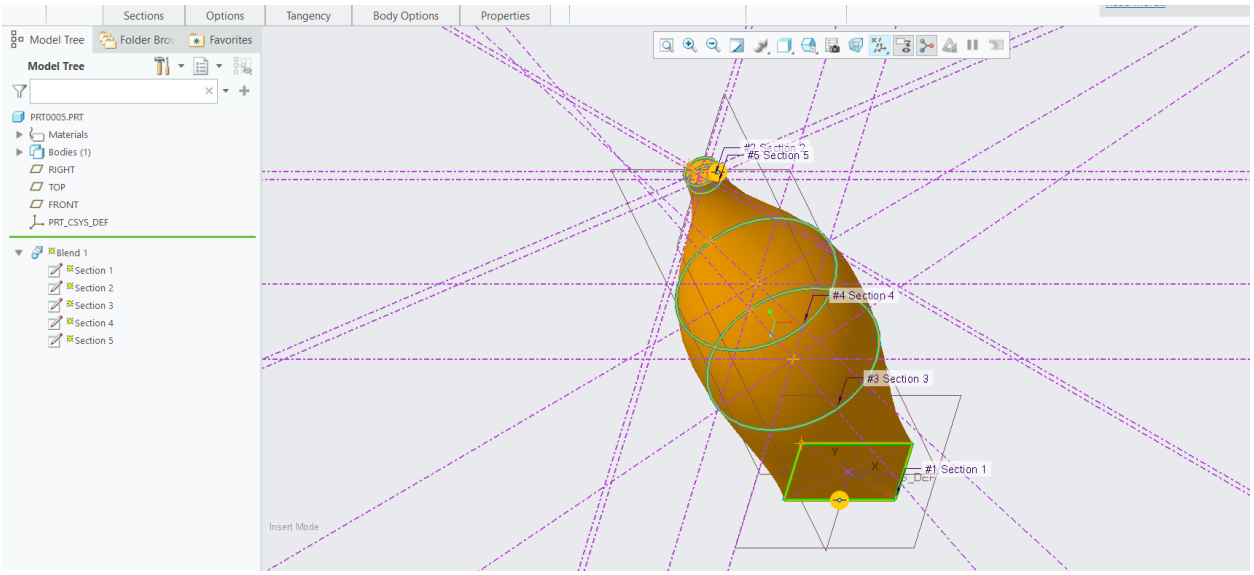
Initial Design of the Bottle

1. We first design the 50x30 rectangular base of the bottle.



(Fig. 1 Initial CAD base of bottle)

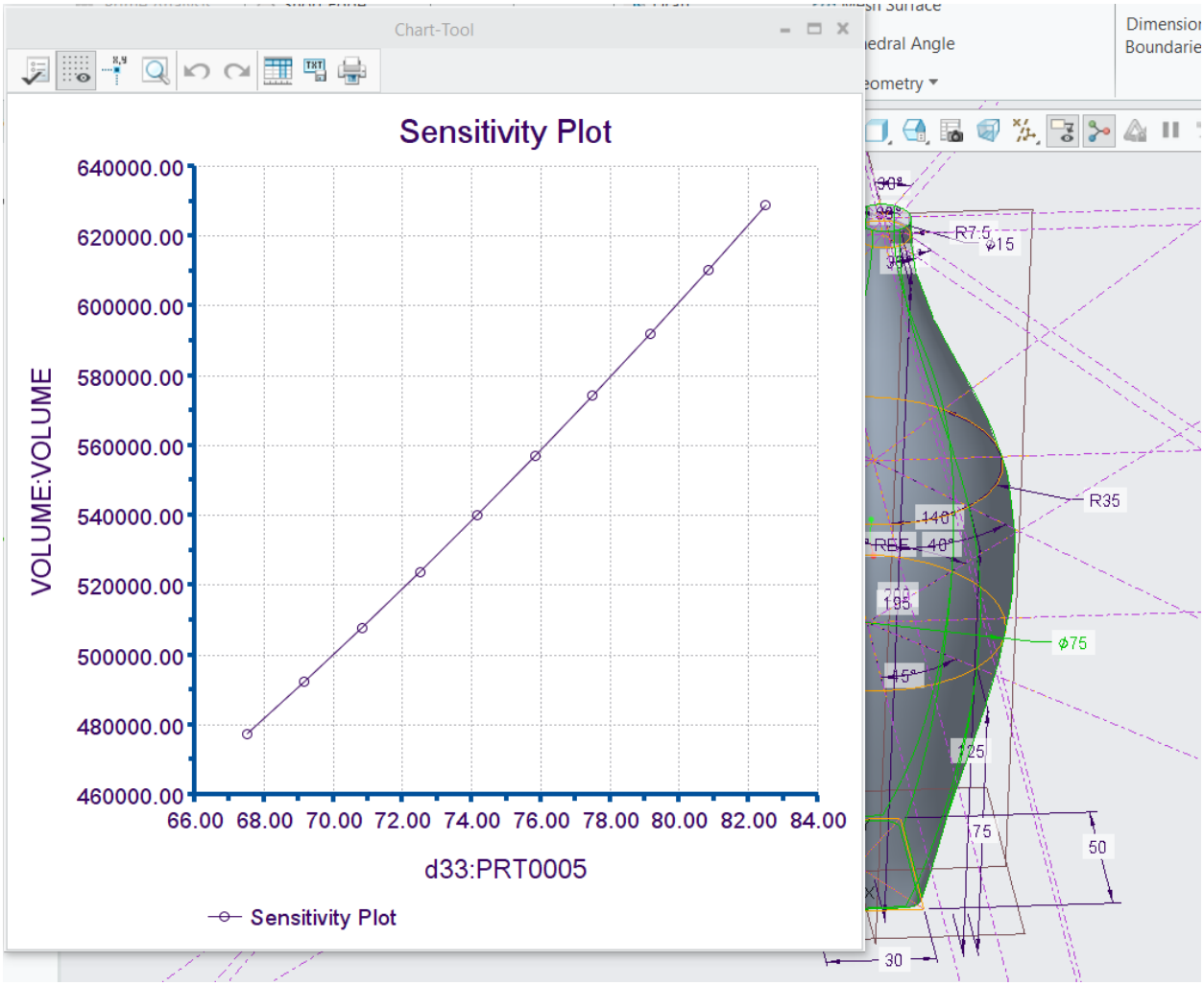
2. Using Blend tool, we create the variable shape of the bottle. Here I have used 5 sections to create the basic design of the bottle.



(Fig. 2 Initial CAD model of the bottle using blend tool/ sections of the bottle)

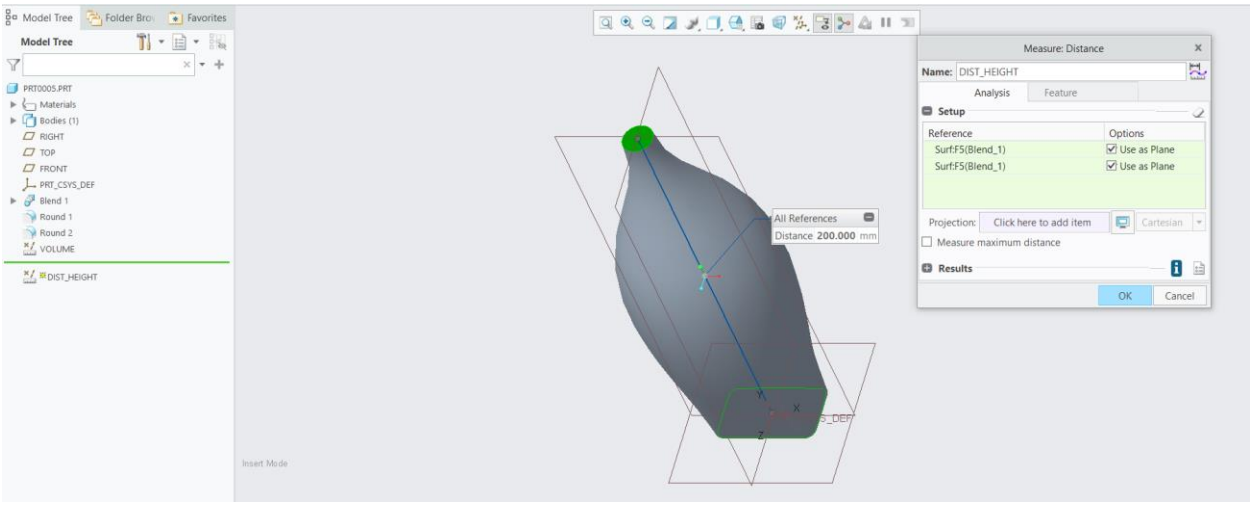
Steps of Design

1. We perform the sensitivity analysis to the initial design.

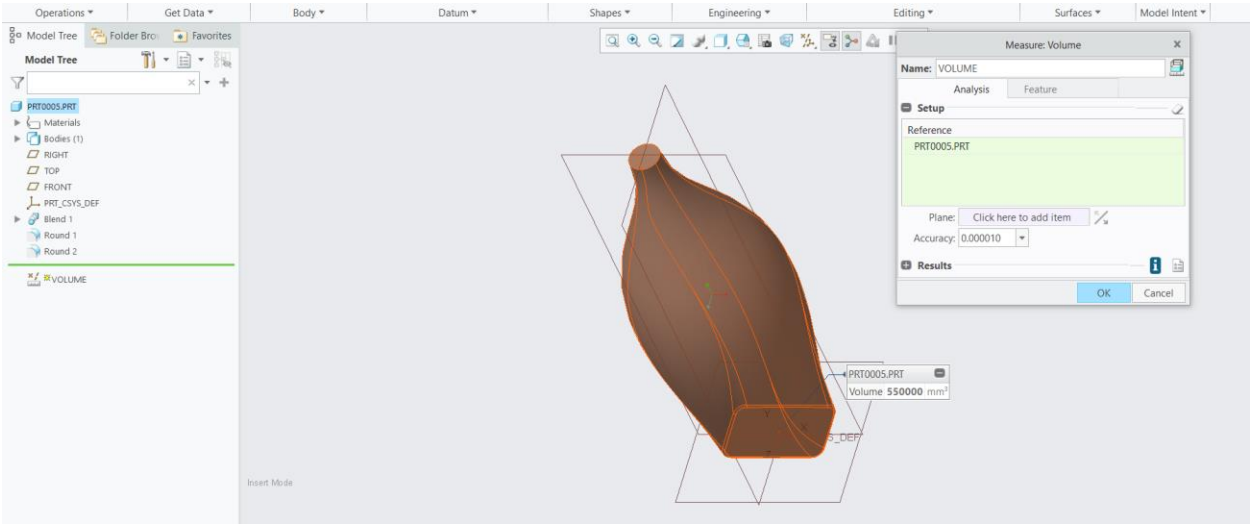


(Fig. 3 Sensitivity plot)

2. Now we perform the feasibility check in order to get the required volume and height of the bottle.

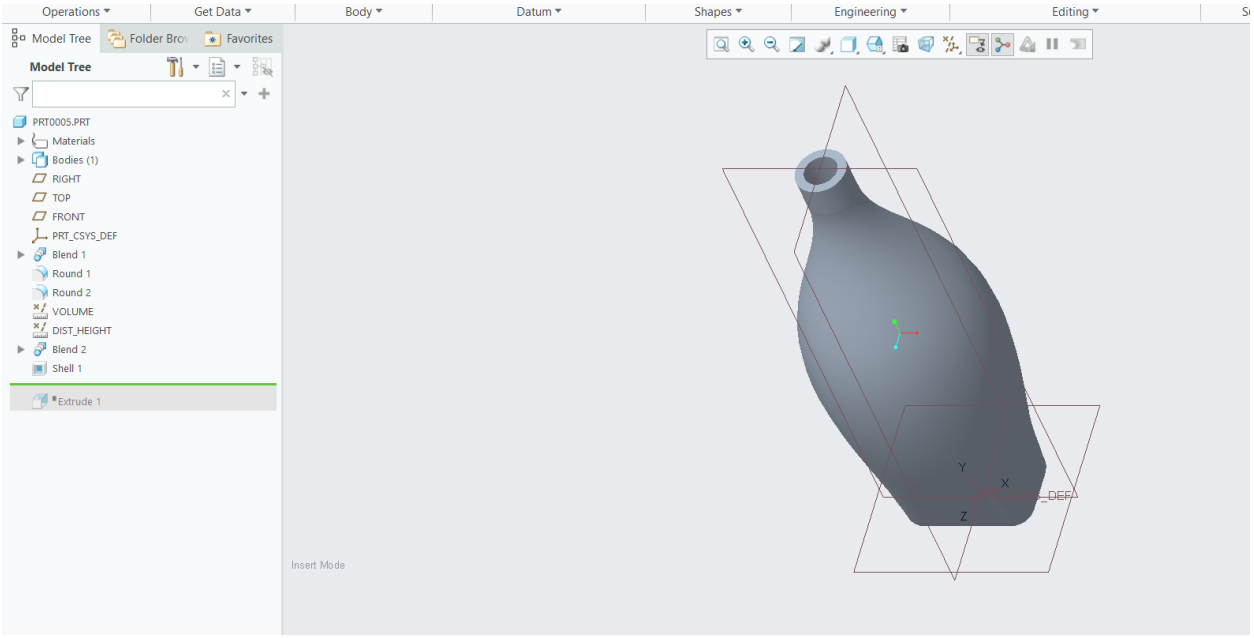


(Fig. 4 measuring the height of the bottle after performing the feasibility analysis)



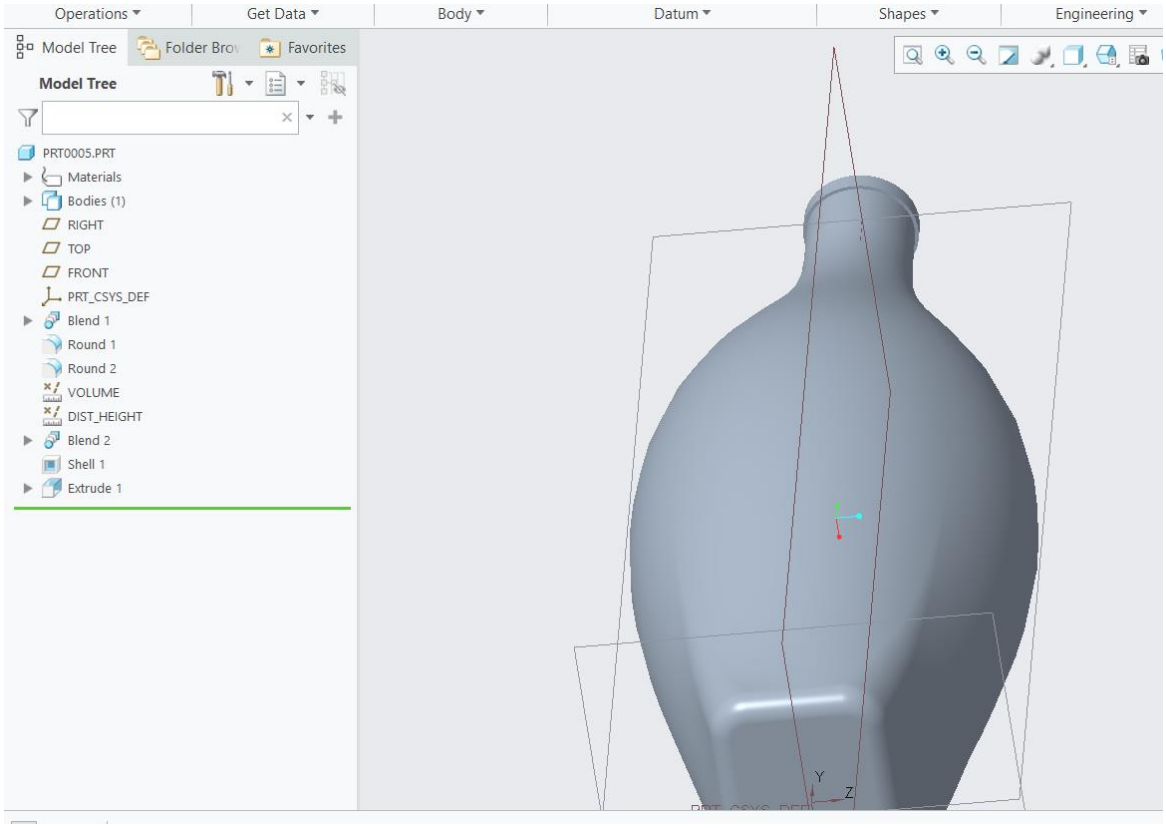
(Fig. 5 measuring the height of the bottle after performing the feasibility analysis)

3. Once the solid model is ready with the required volume and height we have to create space inside the solid model to make it hollow. To achieve this function we use the shell command.



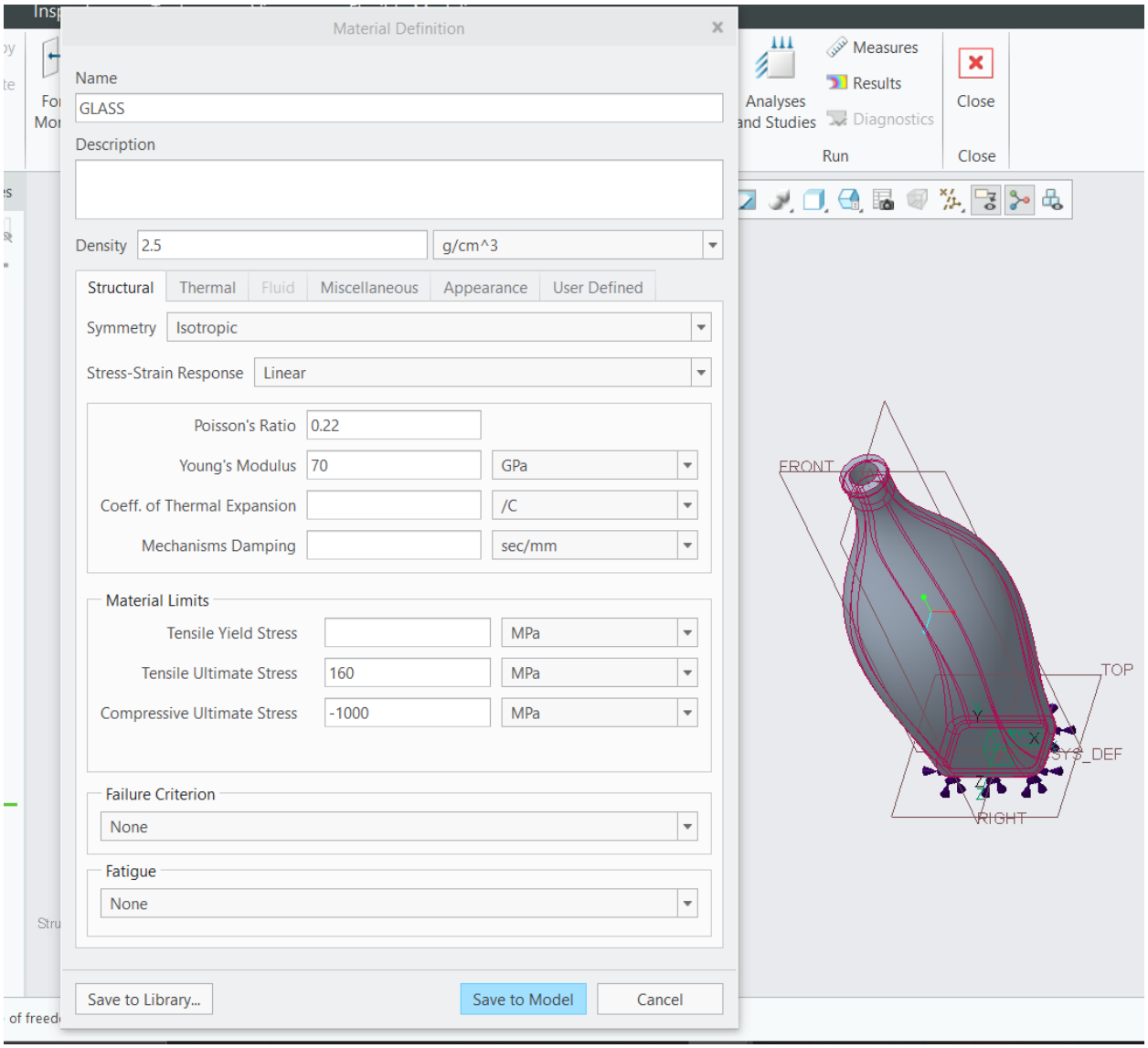
(Fig. 6 Bottle design after using the shell command)

4. Last step to complete the bottle design is to make the neck of the bottle. To make the neck of the bottle we use the extrude command.



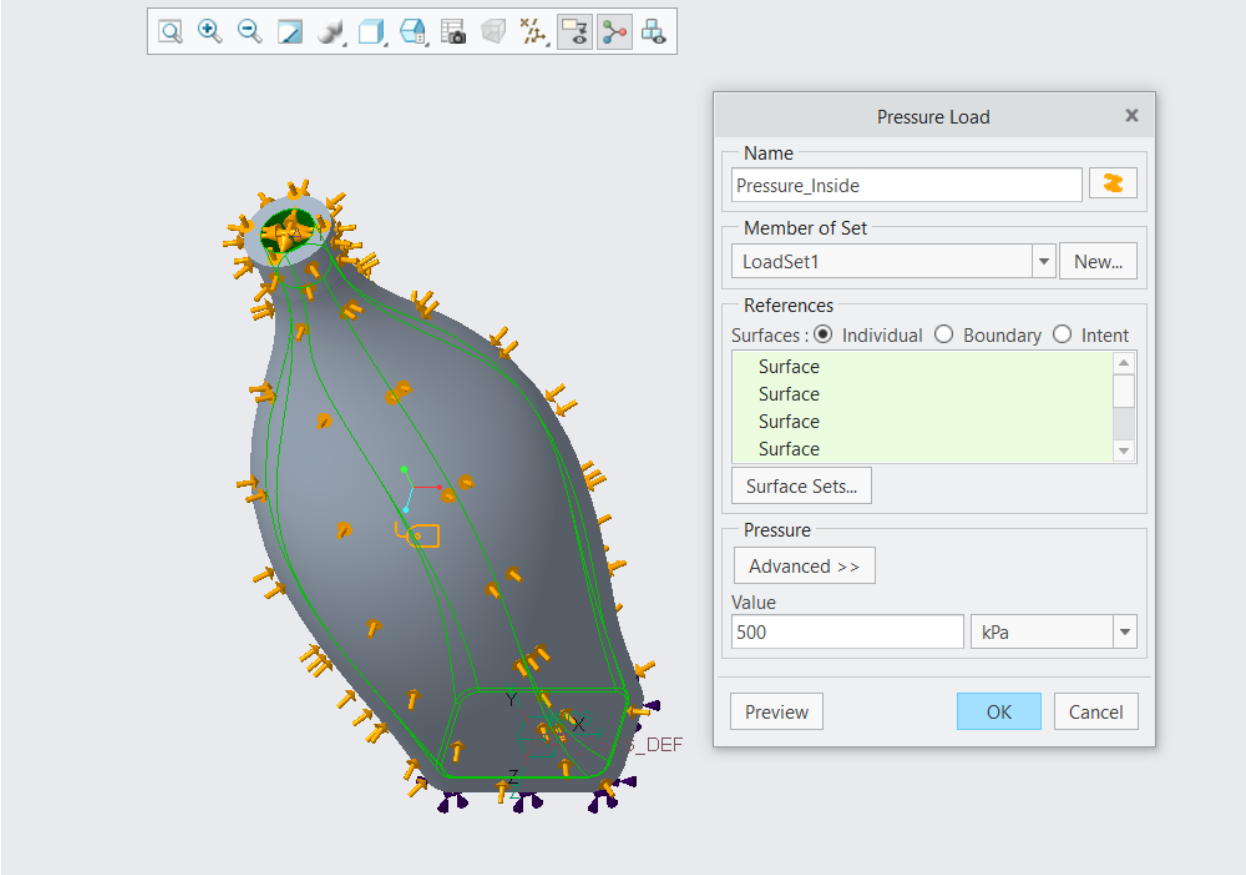
(Fig. 7 Neck of the bottle using extrude command)

5. Now we have to assign the material to the bottle, we make our own material as required, here we use GLASS as the material with the following properties.

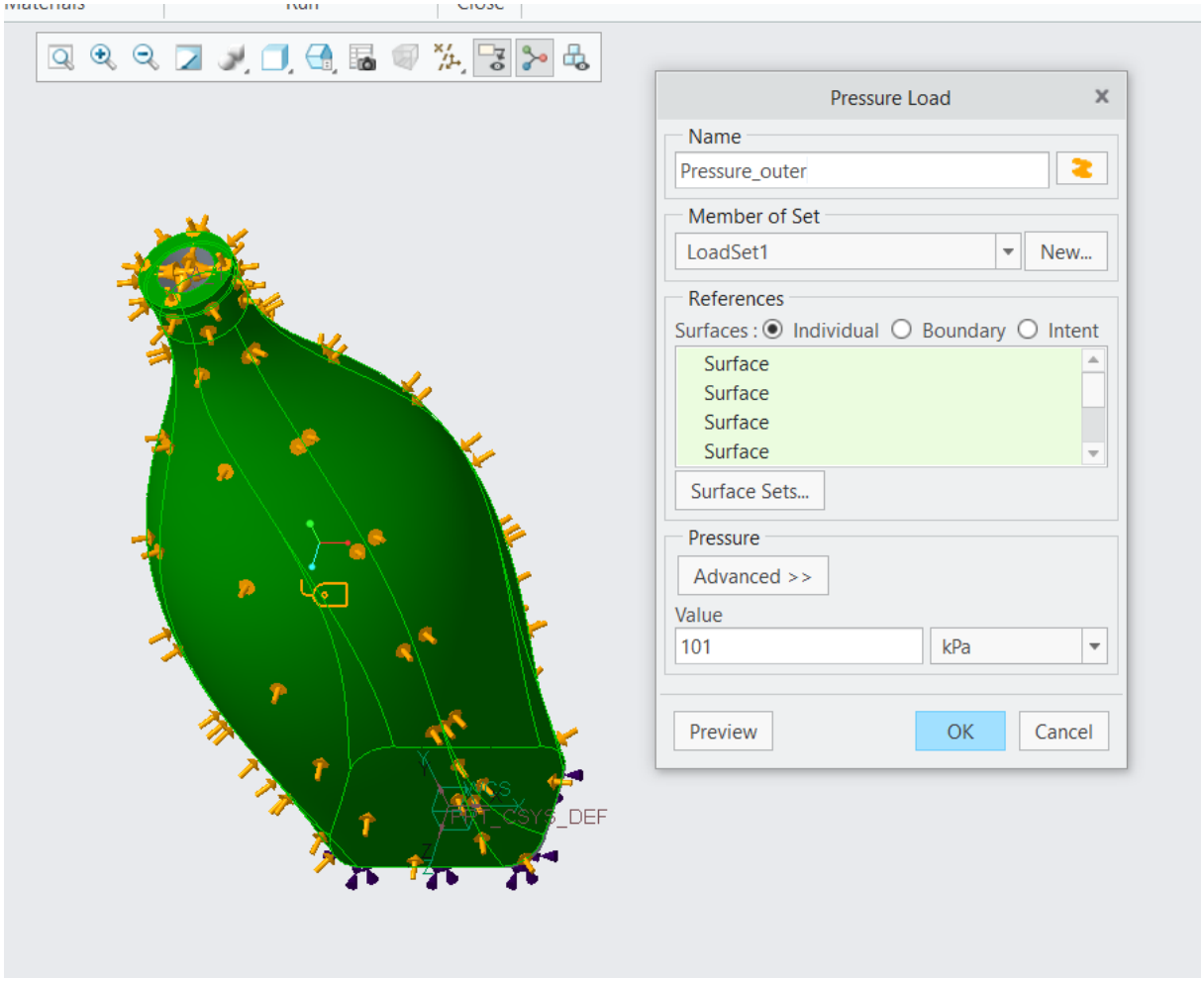


(Fig. 8 Material properties)

6. After modeling the part as per the given dimensions fix the respective surfaces and apply the given loads inside and outside the body in the Creo Simulate.

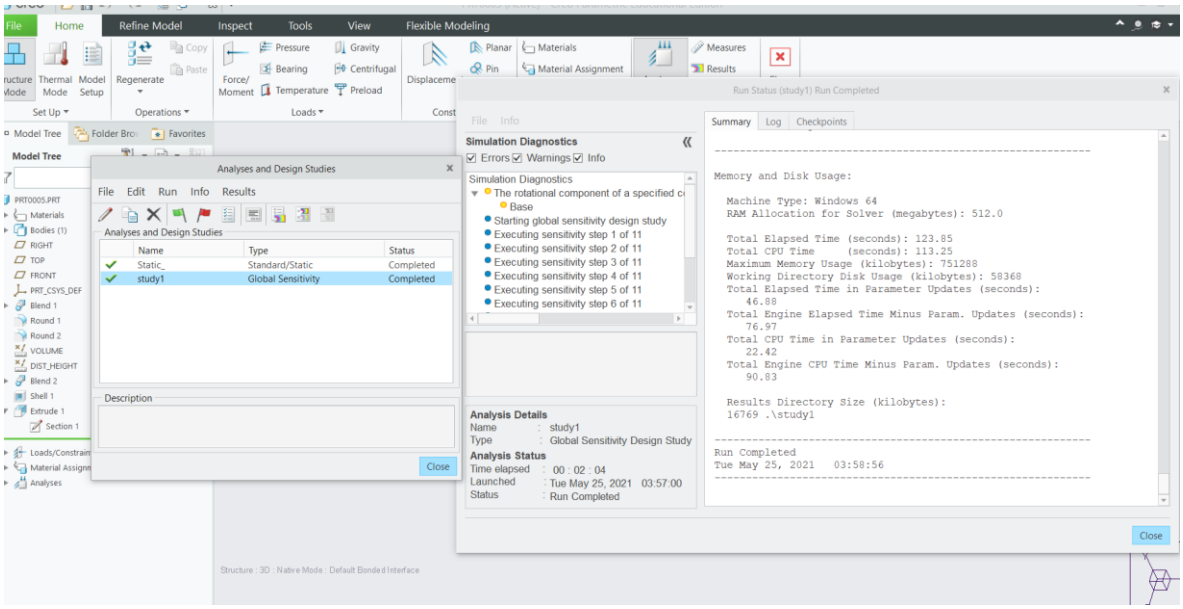


(Fig. 9 Filled with pressurized gas at 500kPa)

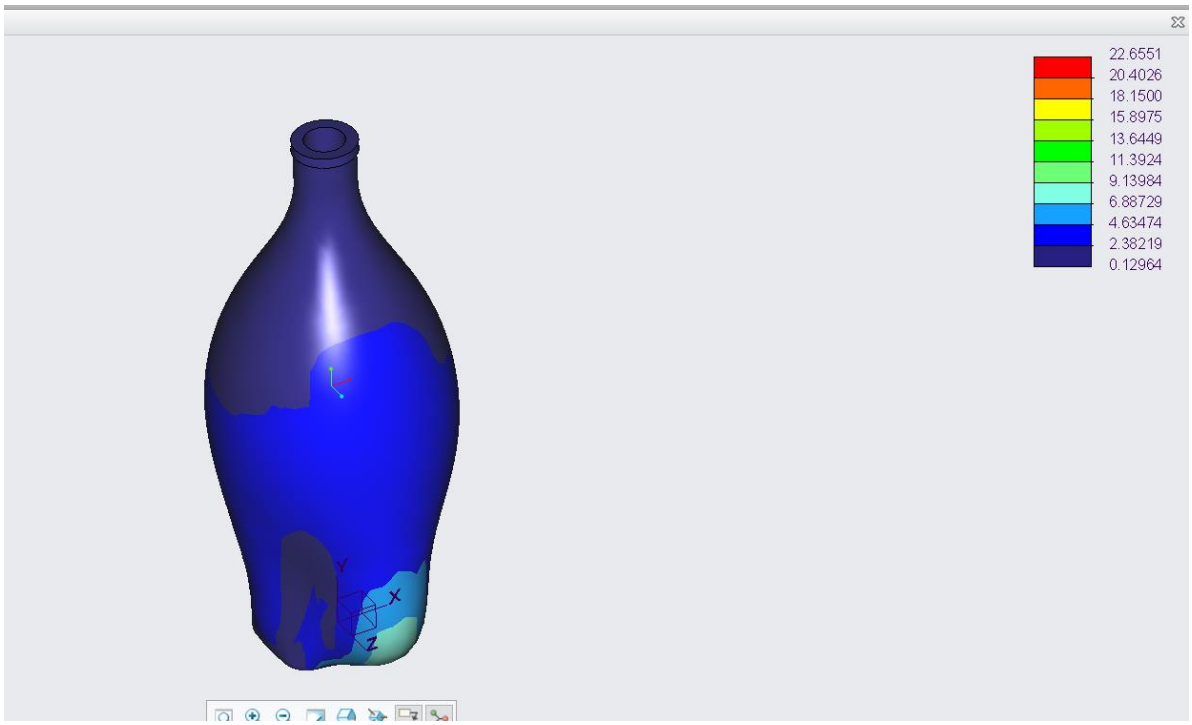


(Fig. 10 Atmospheric pressure of 101kPa)

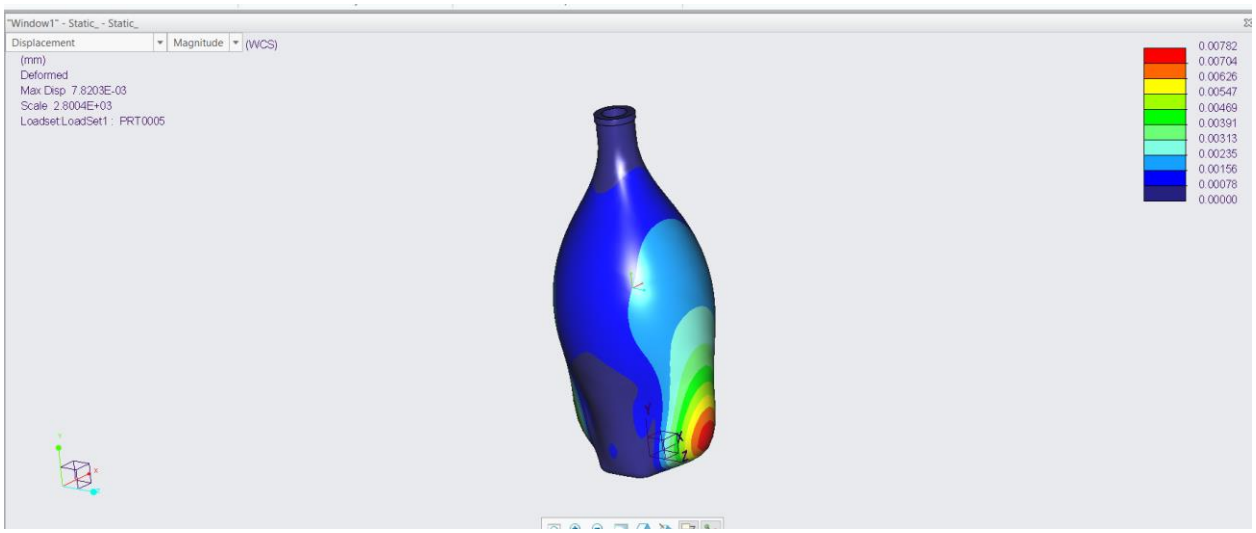
7. Static study



(Fig. 11 Static analysis study procedure completed)



(Fig. 12 Result of static analysis, stress)

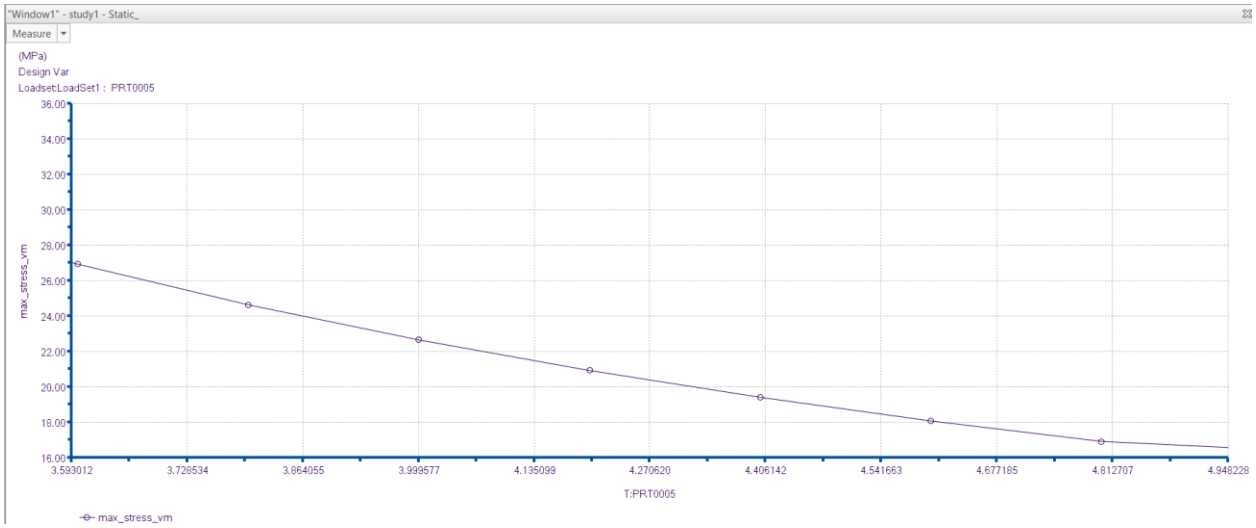


(Fig. 13 Result of static analysis, displacement)

8. Global Sensitivity Analysis

By the given sensitivity plots it is evident that the parameter thickness is tending to increase as the stress value decreases

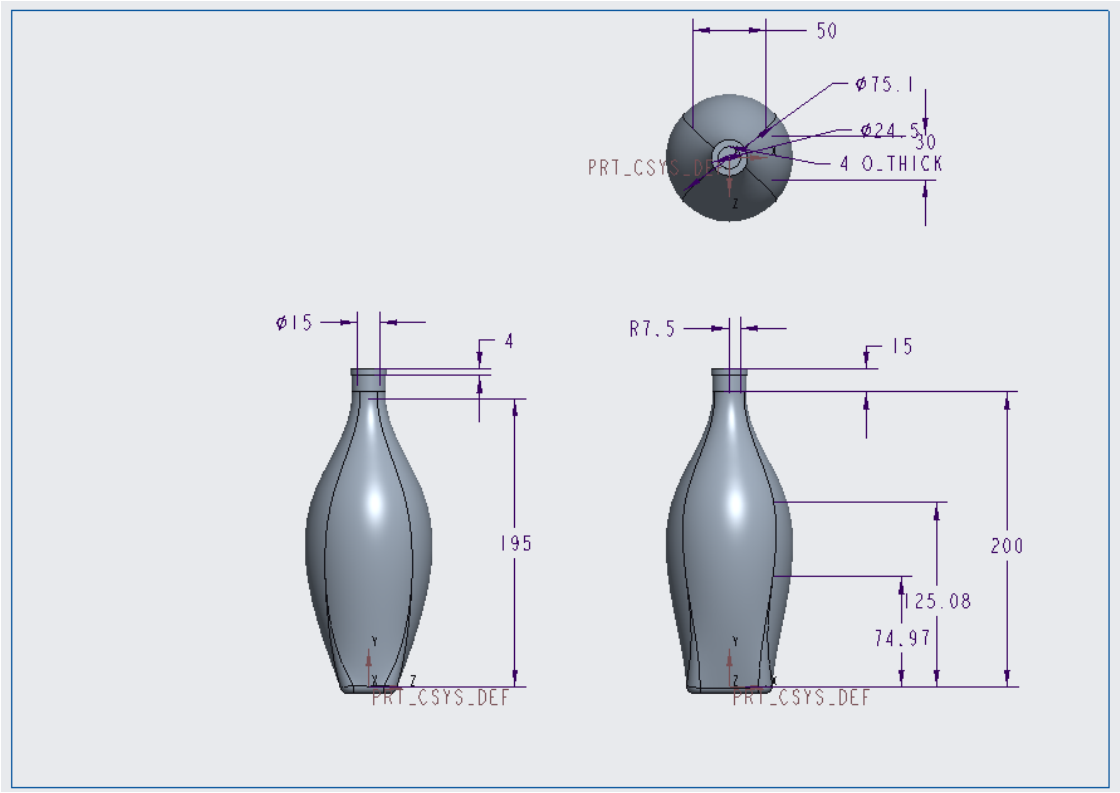
Final thickness of the bottle = 4mm.



(Fig. 14 final sensitivity plot)

Conclusion

Approach towards the design: Keeping the base fixed the design of the bottle with a 200mm height in which 550 ml of fluid can be filled was completed successfully. Analysis was done to get the minimum thickness which can bear all the pressure of the fluid and atmospheric pressure. The sensitivity analysis which was done on the bottle gave us an estimated range of variables that were needed to vary the volume.



(Fig. 15 final drawing of the bottle ready for manufacturing)