[MFG500069]

Creating a Robotic Arm Gripper using Generative Design

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Designwagoon / Mechanical Design Engineer

Learning Objectives

- Learn about creating a robotic arm gripper using different materials and manufacturing techniques at the same time
- Learn about a Generative Design workflow, starting without a shape
- Learn tips and tricks about the algorithm of Generative Design in Fusion 360 to create many durable shapes
  Learn about selecting an optimum and desirable ten of shape

Description

How important it is to adapt your workflow to robotic arms! Well, there is no doubt you can extremely immerse your capabilities of manufacturing using robotic arms which is proper for your projects. You'll be able to create a unique gripper design after attending this session! Fusion 360 software is an amazing product, with lots of environments to master. Generative Design in Fusion 360 is also available. Using the power of Generative Design, you can discover how it changes the future vision of CAD and hybrid manufacturing capabilities. No matter if you're a beginner or a seasoned veteran, this will be a detailed course that everyone can understand. Come along for an action-packed 90 minutes of learning, and find out how to create a Robotic Arm Gripper using Generative Design!

Speaker(s)

Cengiz provides lectures and workshops to university students and academic staff in 3D designing as an Autodesk Registered Instructor for 6 years. He is a Mechanical Design Engineer in France. He has 4 years of experience supporting Start-Ups to develop new smart products in the field of medical technologies. He's currently working on a research project in the Soft Robotics field. Also he's the founder of Designwagoon.com

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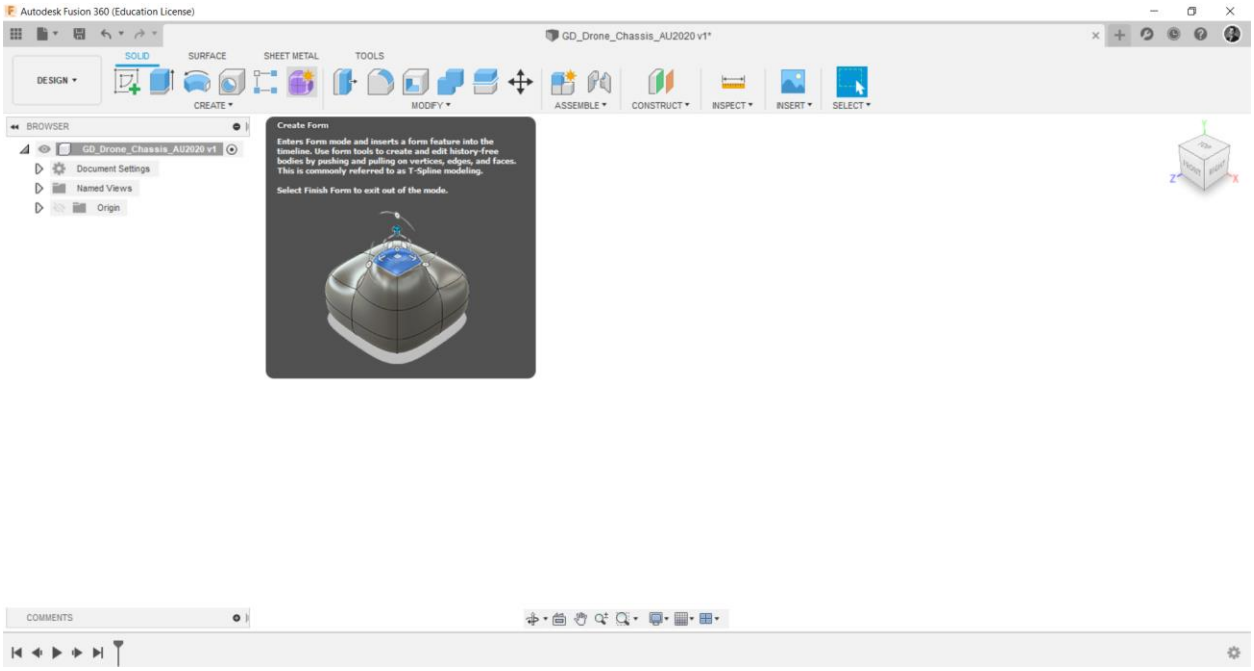
INTRODUCTION

MODELING and PREPARATION for GENERATIVE DESIGN

Designing a Starting Shape for Generative Design Module

To create the necessary parts for Generative Design module, we can use **CREATE FORM** workspace.



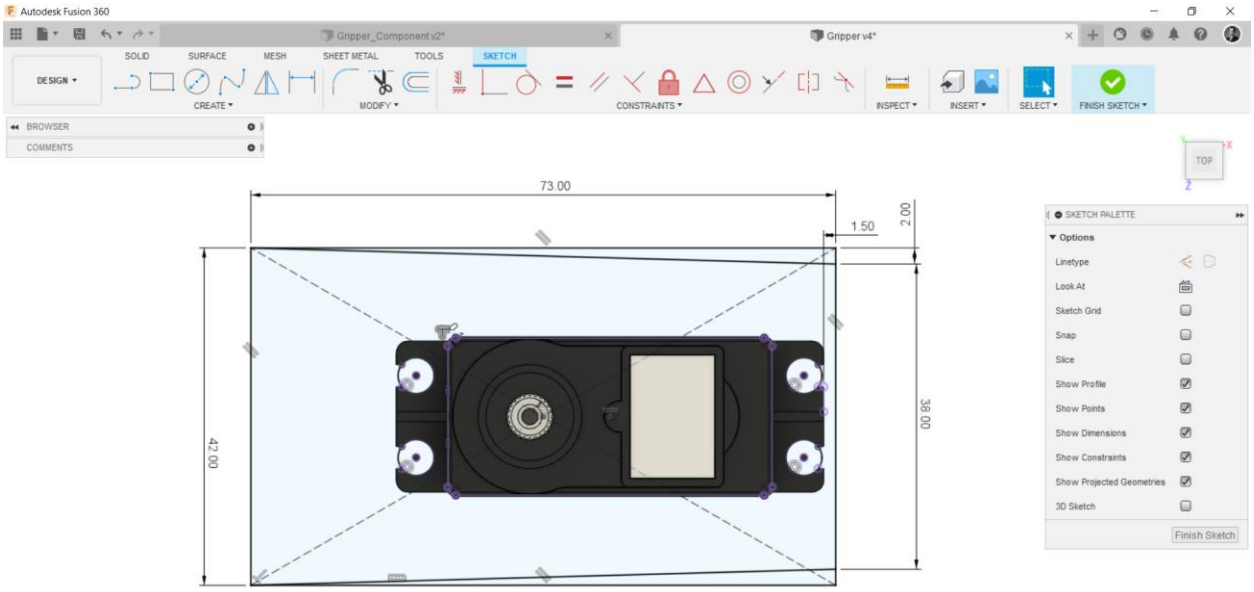
In the **SOLID** tab, there are 3 possibilities to design a part like **CAD**(*Computer Aided Design*) Modeling, **Surface** and **Form Modeling**(*T-Splines*).

In this session, robotic arm gripper needs to Preserve Bodies in Generative Design Study. Well, you can easily create using the next steps to obtain approximate parts for your study.

Follow the next steps;

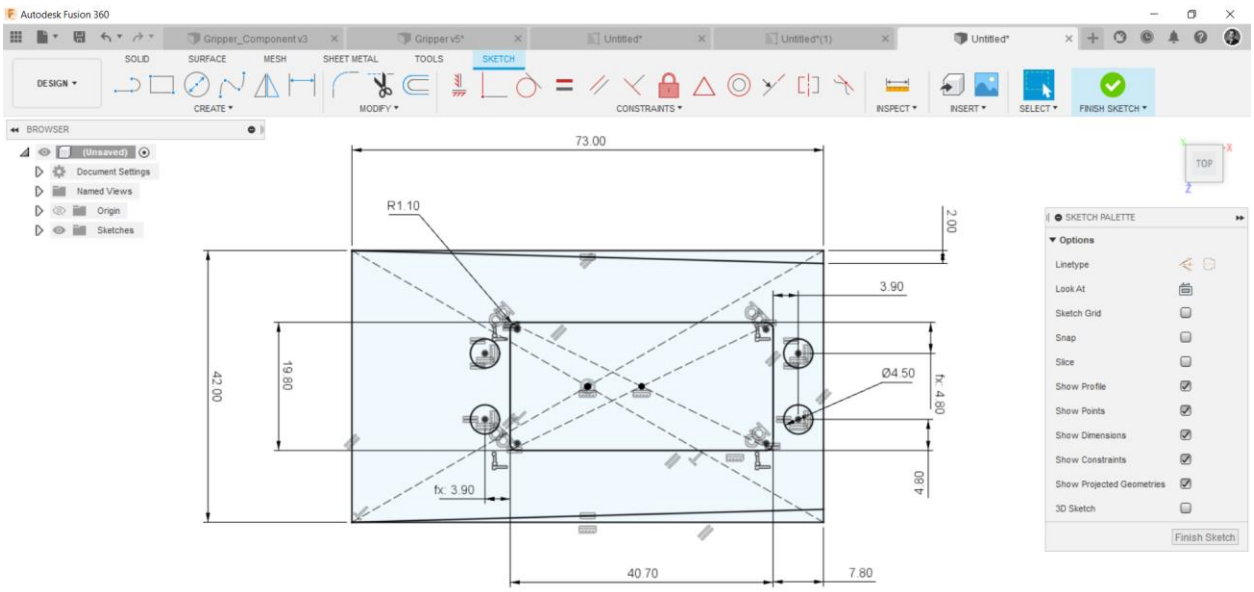
1. After you open the **Fusion 360**
2. Use the **CAD-Modeling** Tool

If you'd like to use your own servo motor model, you can easily download on 3D model websites in free. After you **UPLOAD** your 3D Model, you can use the **Project** tool to draw the necessary lines.

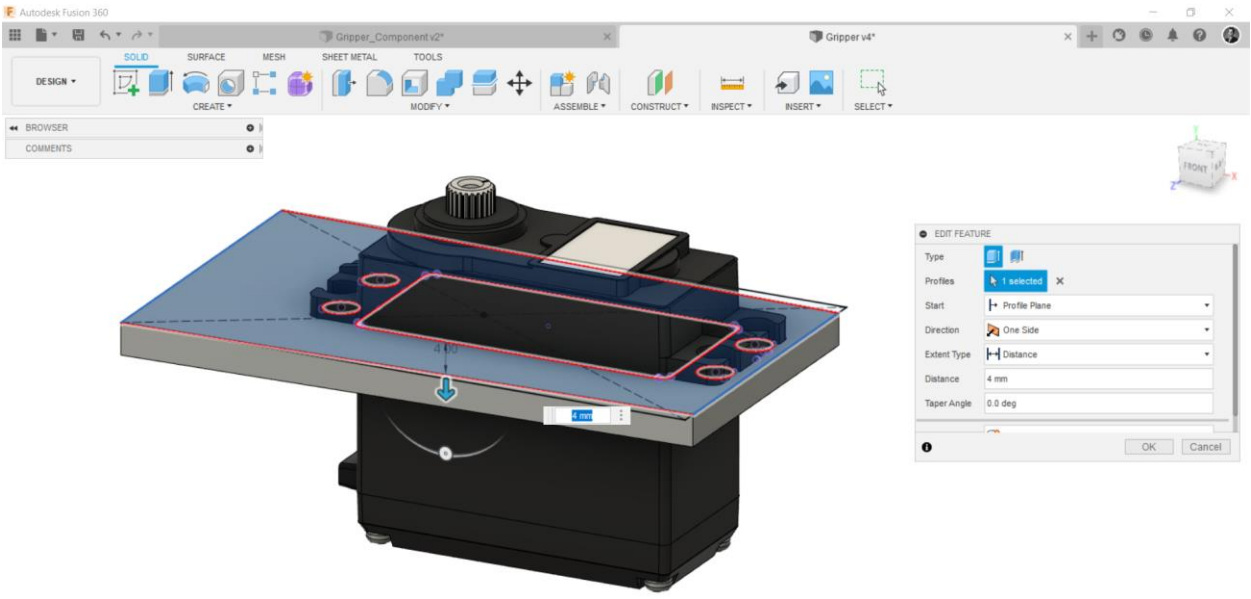


You can follow the next steps to create your own design;

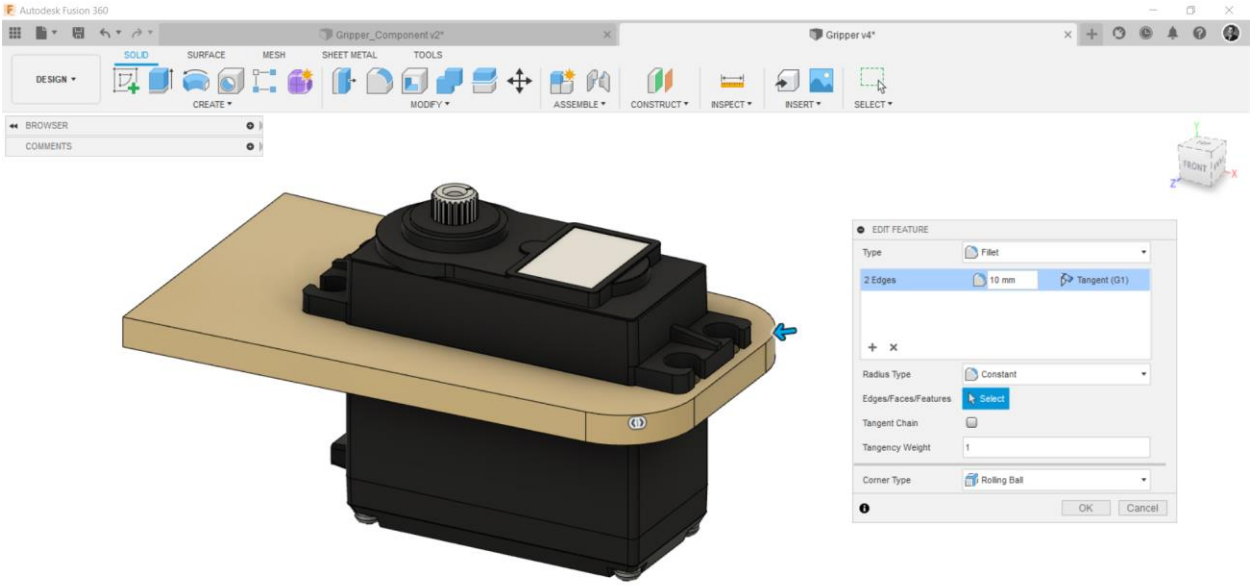
3. Draw rectangles and cirlcles like in sketch below
4. Use the **Smart Dimension** Tool to define the dimensions of geometries, Shortcut is "**D**"



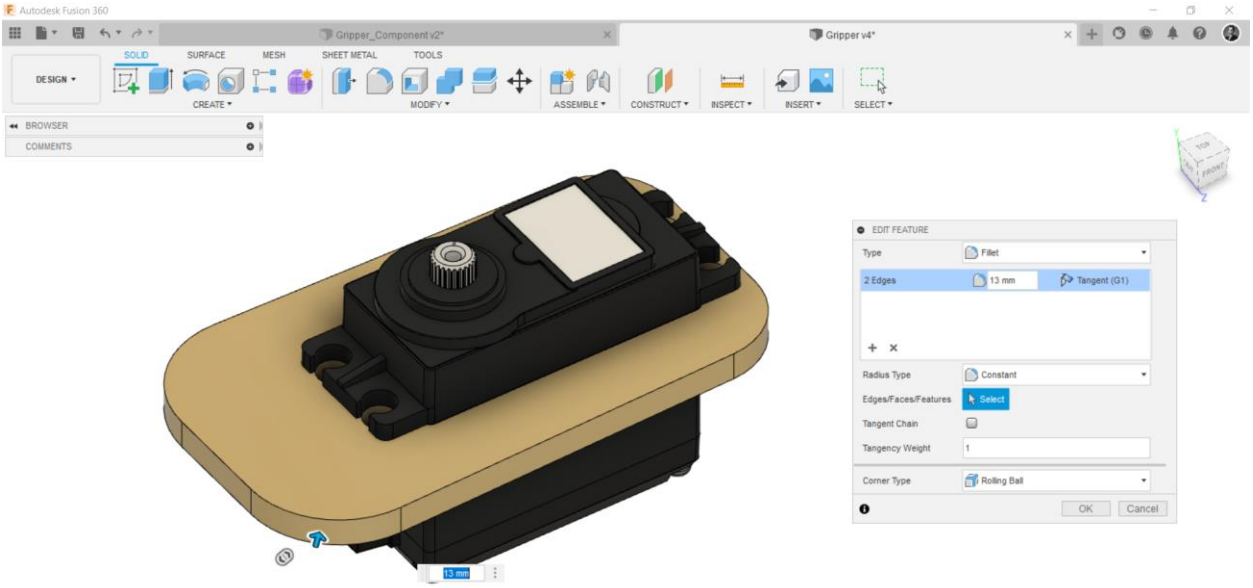
5. After you finish the sketch, use the Exturde Tool, Shortcut is “**E**”
6. Direction as **One side**,
7. Distance as **4 mm**
8. Click the **OK** to confirm



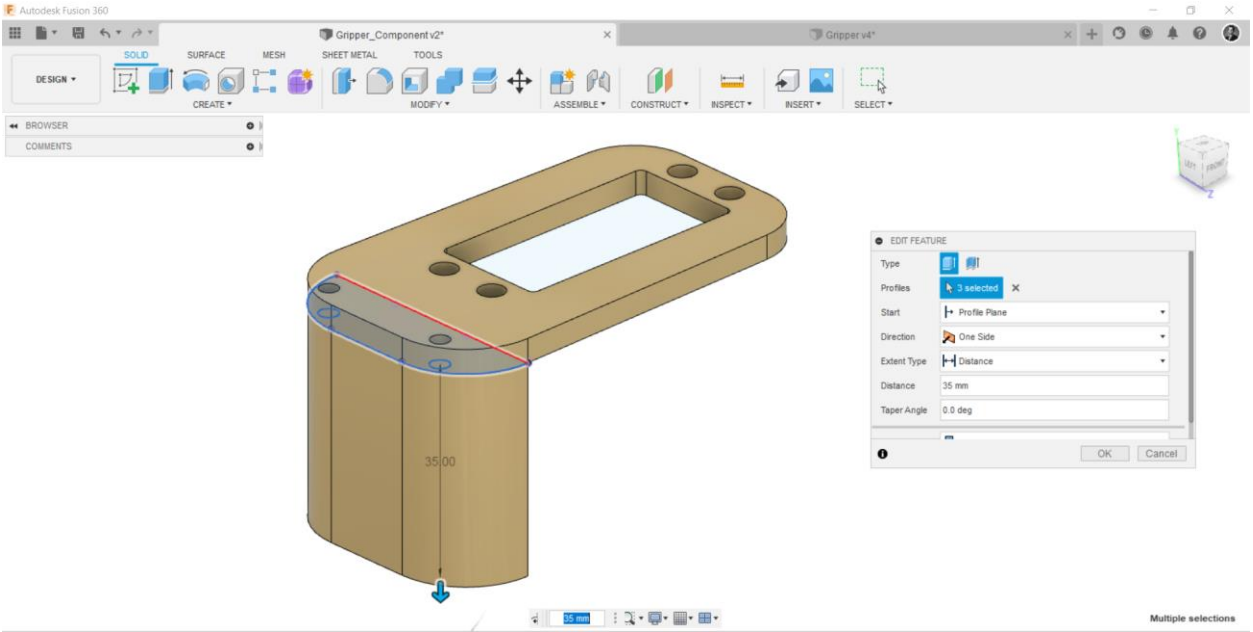
9. Use the **Fillet** tool, shortcut is “**F**”
10. Select **two edges**, shown below
11. Enter the **10 mm**
12. Click the **OK** to confirm the Feauture



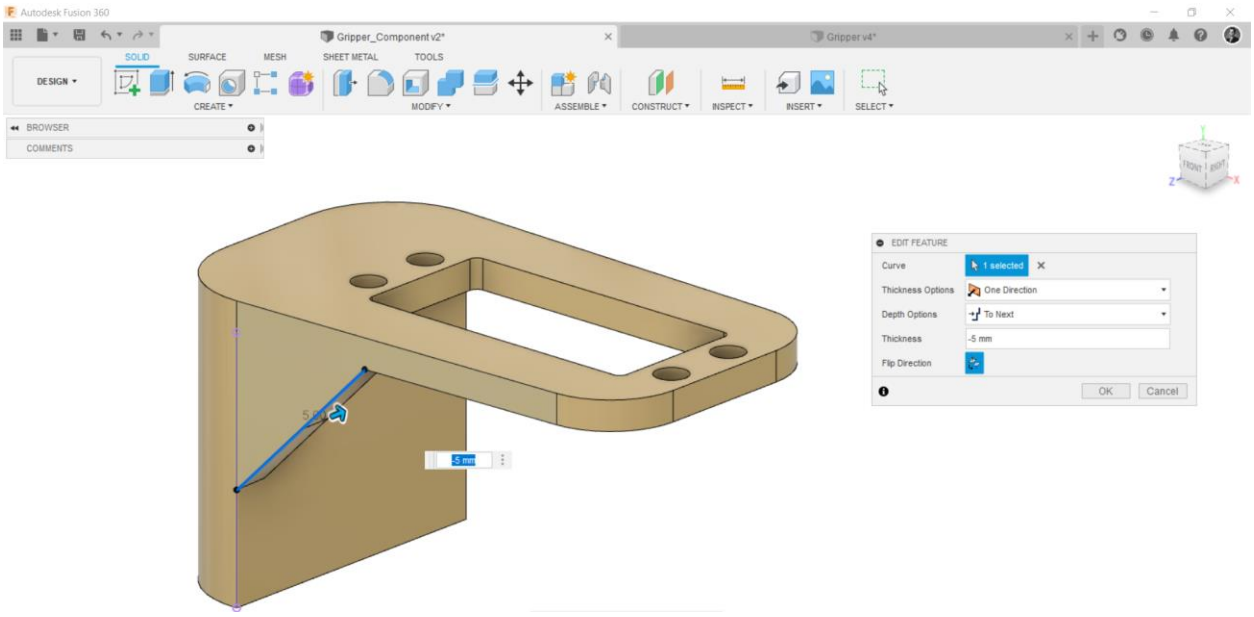
13. Use the **Fillet** tool again, shortcut is "**F**",
14. Select **two edges**, shown below,
15. Enter the **13 mm**,
16. Click the **OK** to confirm the Feauture



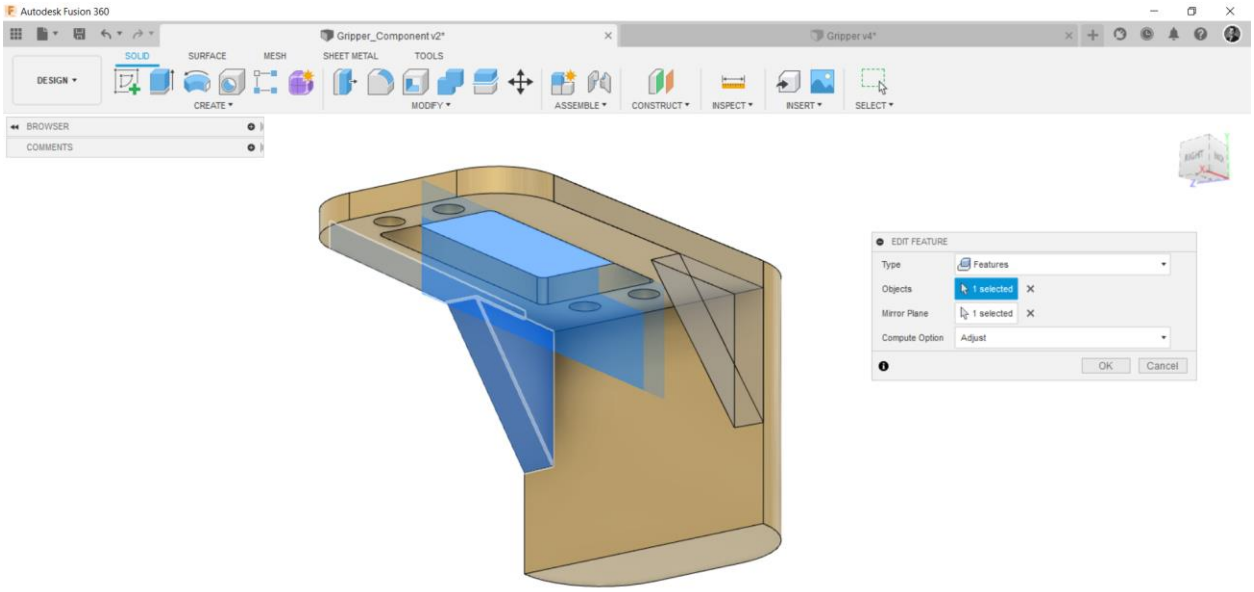
17. Create a **sketch** below side of the part
18. Draw a **line**
19. Use the **Extrude** Tool
20. Distance **35 mm**



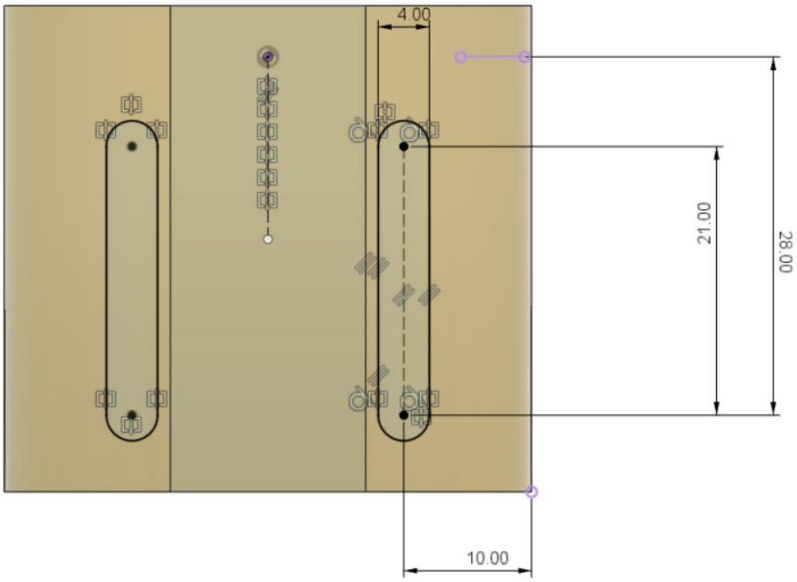
21. Use the **Rib** tool after you create a line
22. Enter a Thickness as **5 mm**
23. Select **Flip Direction** if necessary



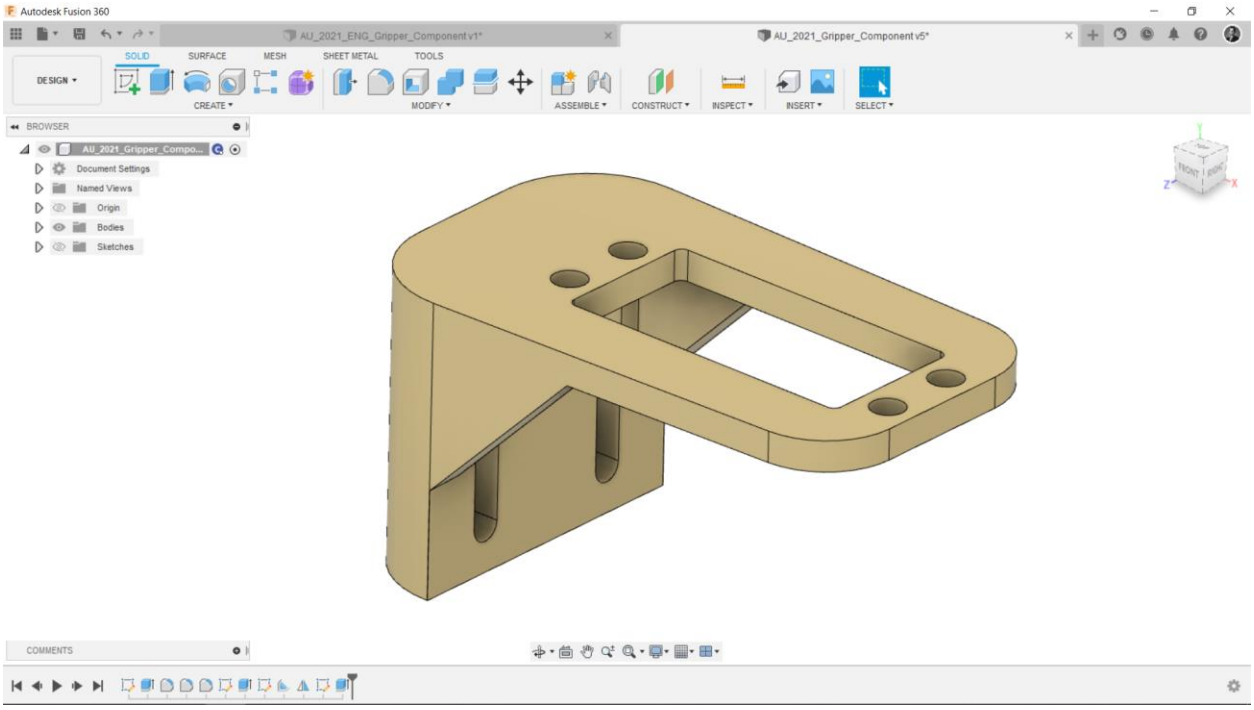
24. Use **Mirror** tool
25. Select **Feature** as Type
26. Choose **Mirror** Plane
27. Then hit the **OK** to confirm



28. Create a **sketch** to backside of the part
29. Draw a **Slot**, and enter the dimensions below
30. Use the **Sketch Mirror** tool to create another



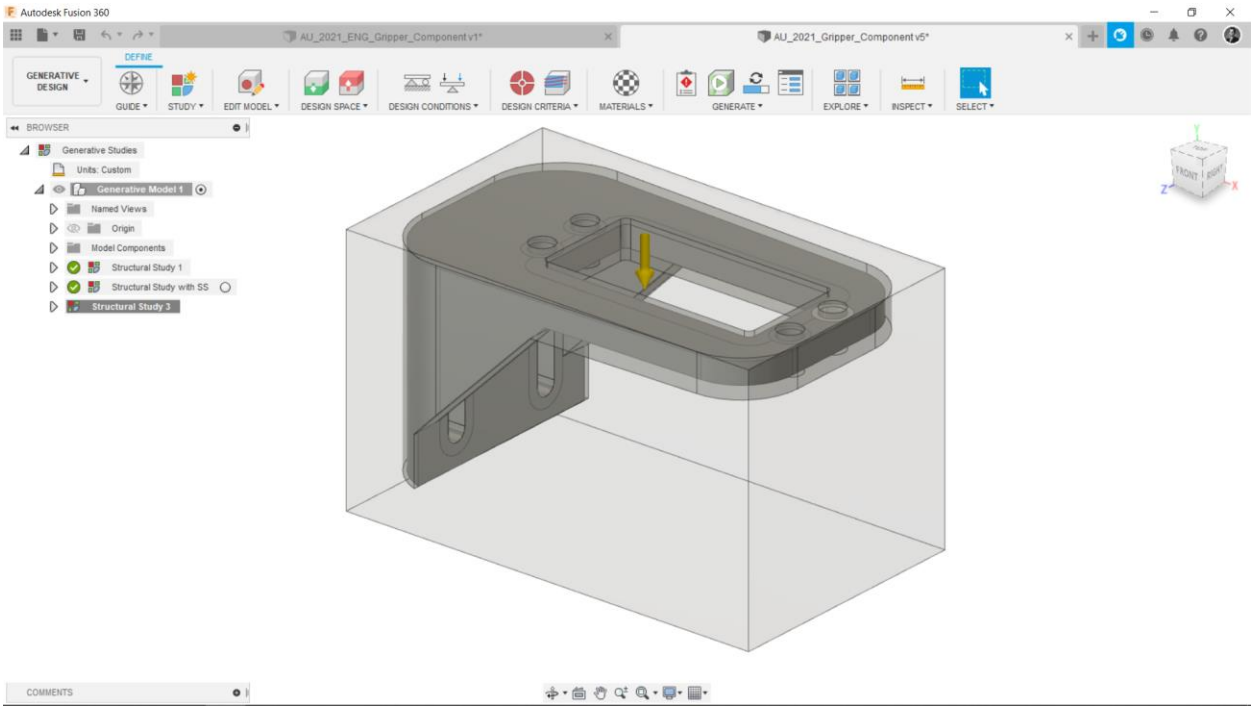
Before the enter Generative Design Module, the concept robotic arm gripper part;



GENERATIVE DESIGN

New Generative Design Study

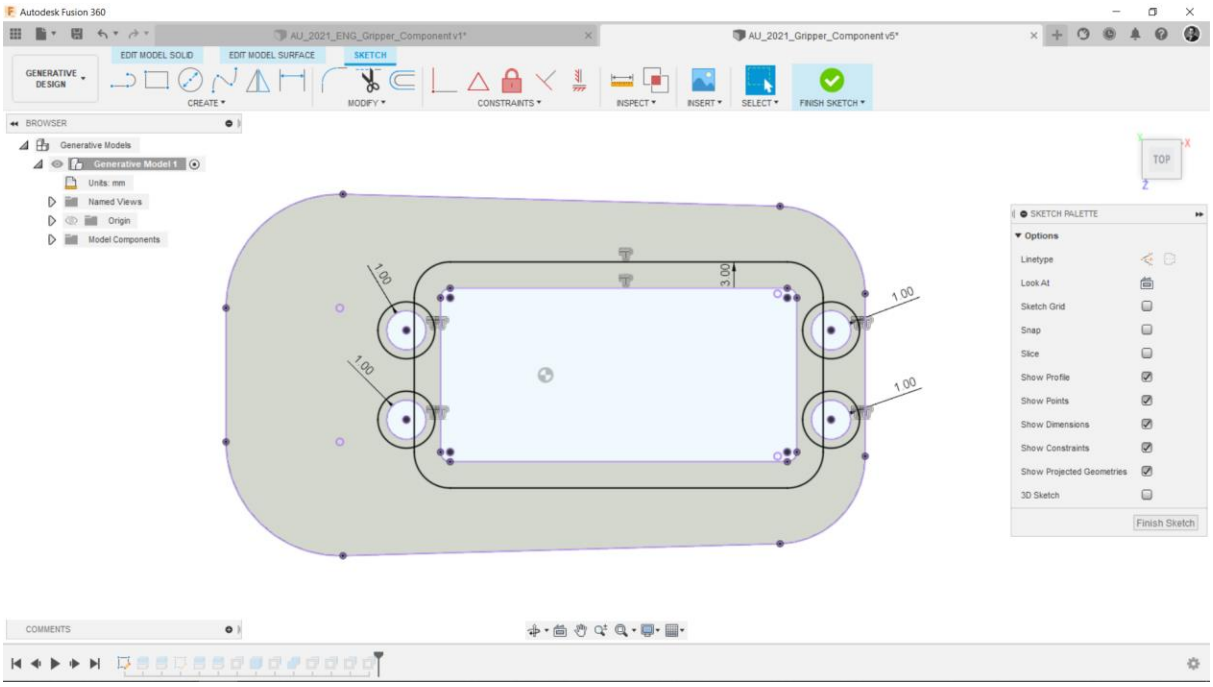
When you enter the Generative Design Workspace in Fusion 360, it will automatically open a new generative design study named as **Study 1**. You can get information from **GUIDE**, there are detailed definitions of all steps for Generative Design. When you complete the assignation of all necessities of Generative Design, you can see the green check icon in every title.



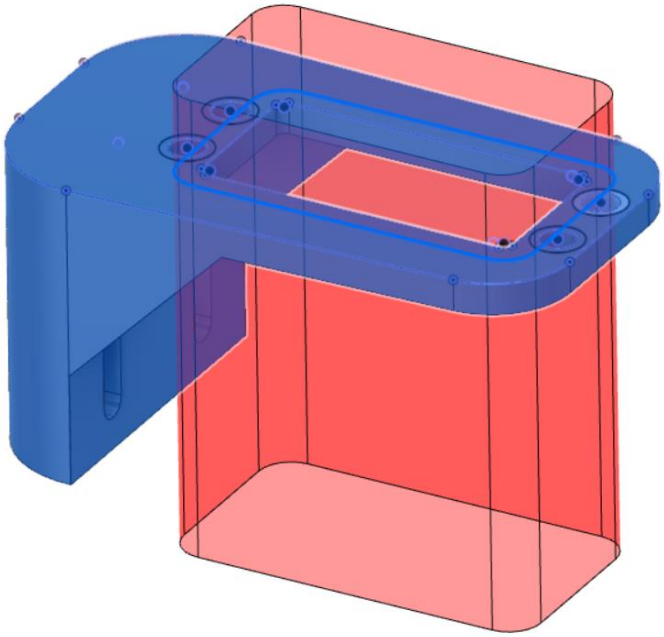
Preparation of the model for Generative Design

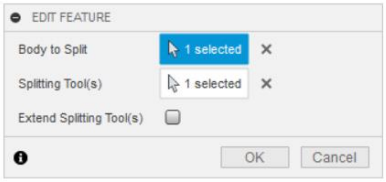
Normally, you can create the necessary part in Design Module for Generative Design, but **EDIT MODEL** tool is very hand to create necessary geometries(*Like preserve, obstacle, starting shape*). The changes will only appear in Generative Design module, you cannot see any change in **DESIGN** module.

1. Create a sketch in **EDIT MODEL** workspace
2. Use **offset** tool to create new lines, shortcut is **"O"**

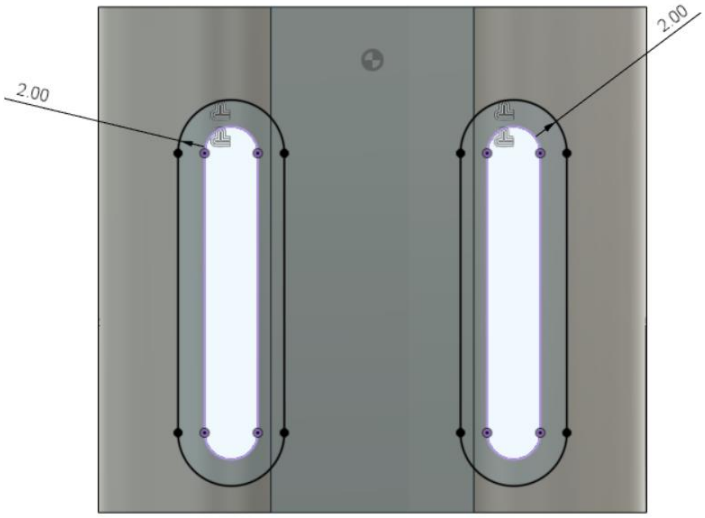


3. After you finish drawing lines using **offset** tool
4. Select the **Body Split** Tool
5. Select the Body as **Body to Split**
6. Select the Line as **Splitting Tool**

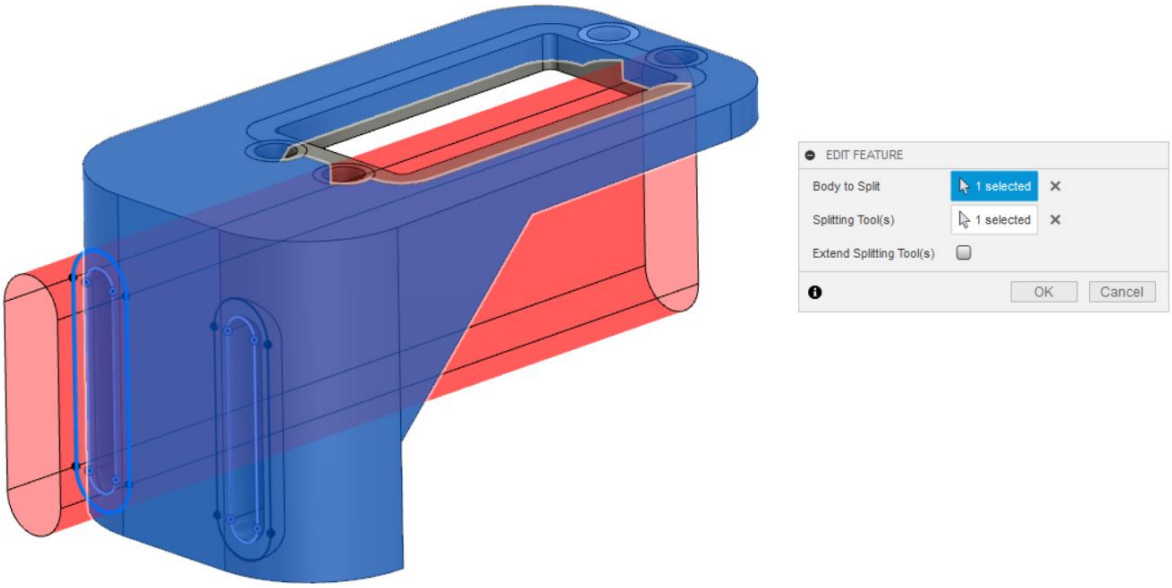




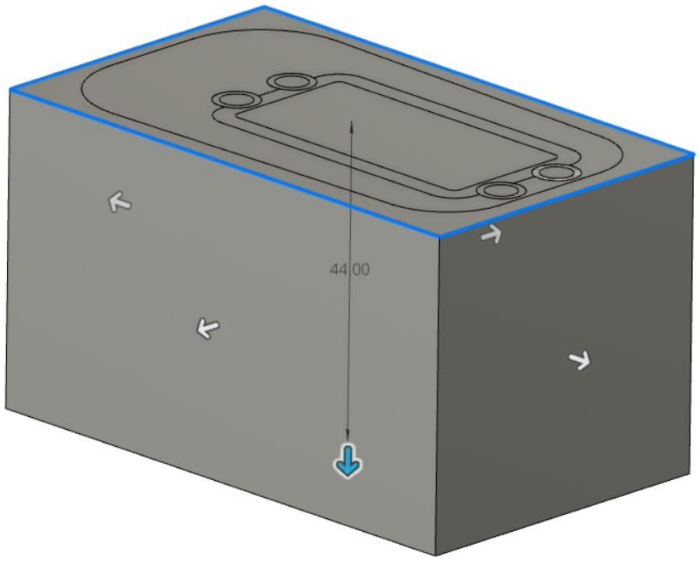
7. Create a new skectch in the backside of the part
8. Use the **Offset** Tool for Slots

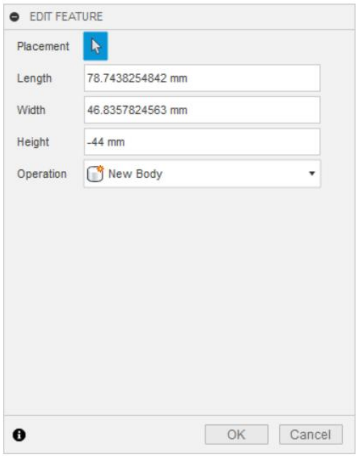


9. Use the **Split Body** tool again

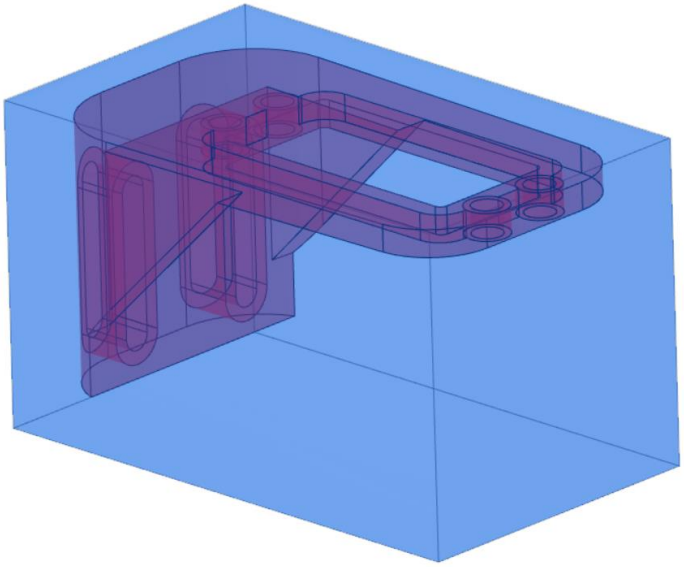


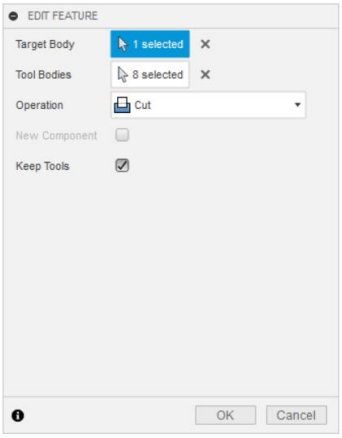
10. Draw a **Box** to create a Obstacle Main Body





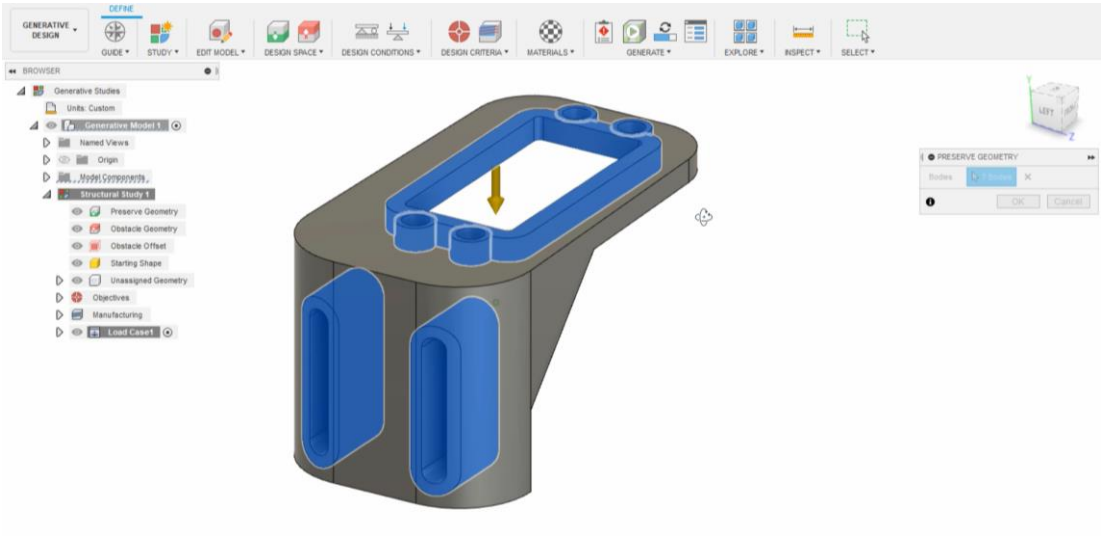
11. Use the **COMBINE** tool
12. Select **CUT** as operation
13. Checkmark on **Keep Tools**





Assignation of Preserve Geometries

In Generative Design Study, it should be assigned **Preserve Geometry** that it allows adding Loads and Constraints. Preserve Geometries also will appear in the final shape of the design.

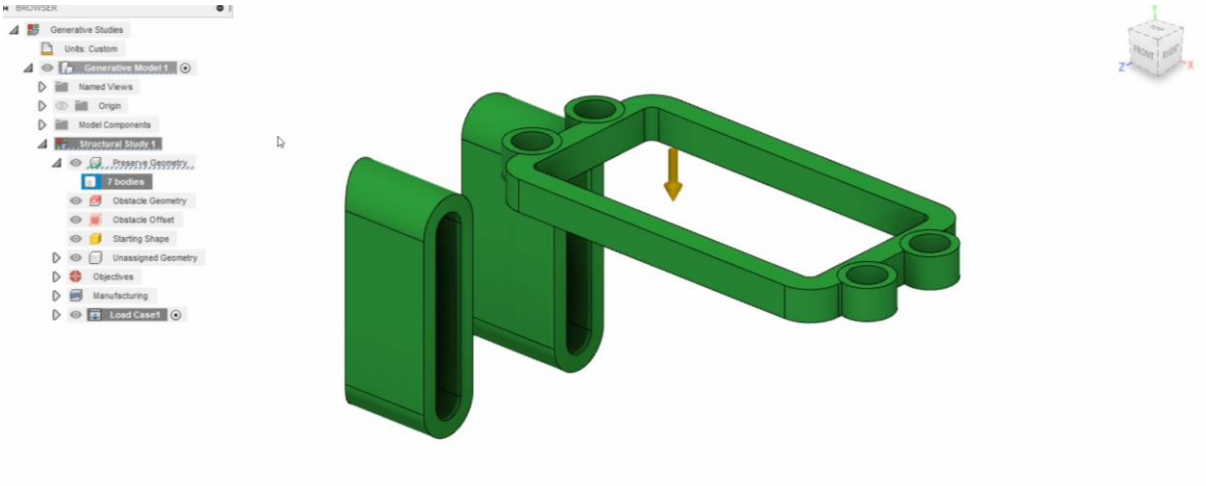


Follow the next steps to assign *Preserve Geometry*;

1. Select the **7 Bodies** shown in the screenshot
2. *Click the **OK** to assign Preserve Bodies*

After you correctly assign the preserve geometries, the bodies will appear in the Preserve Geometry Group.

To show only Preserve Geometries; **Right-Click** to 6 bodies and click the **Isolate**

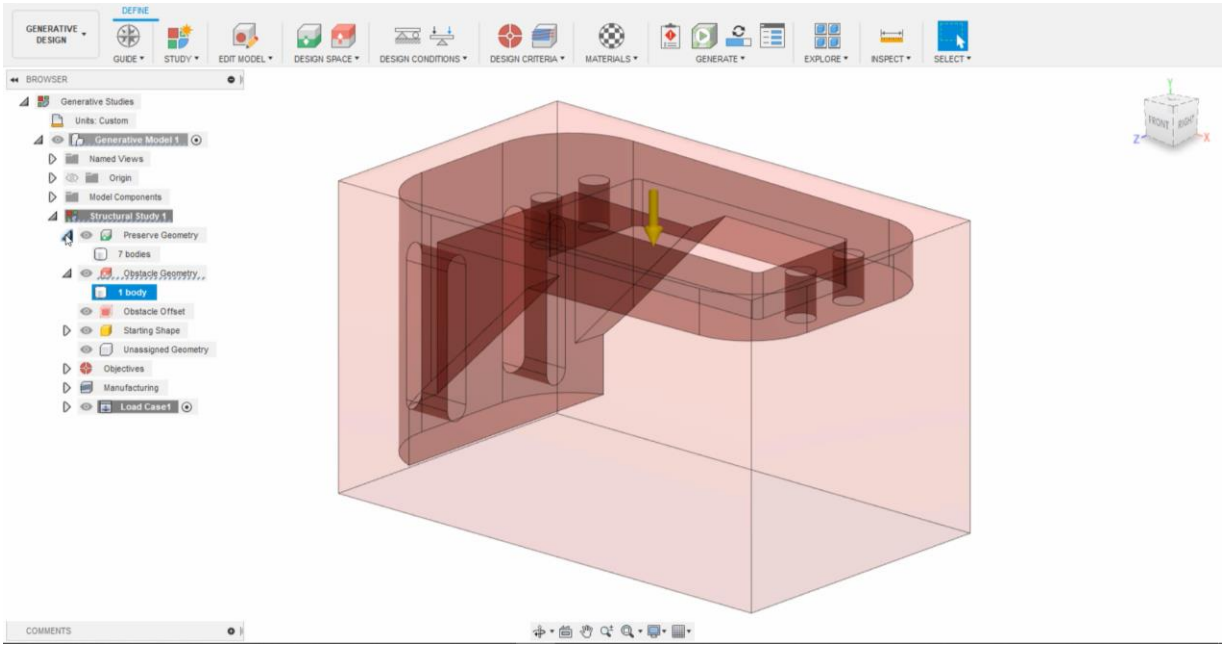


Assignation of Obstacles Geometries

It's not obligatory to add **Obstacle Geometry** in Generative Design Study. But in many cases, it will help you when you need to assign empty spaces where material placed during the generation of outcomes.

Follow the next steps to assign *Obstacle Geometry*;

1. Select the **Obstacle Body**
2. *Click the **OK** to assign Obstacle Bodies*



After you correctly assign the obstacle geometries, the bodies will appear in the Obstacle Geometry Group.

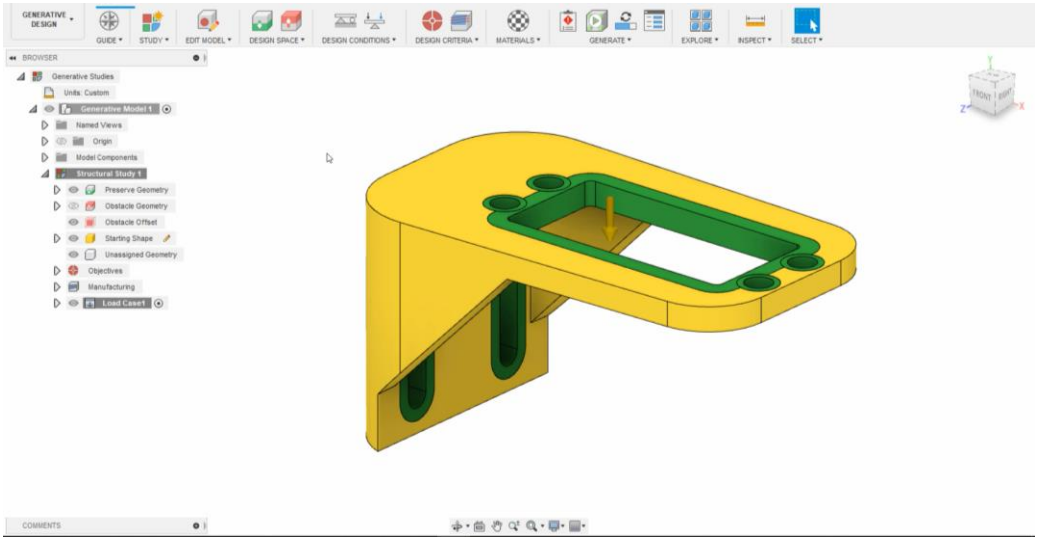
To show only Obstacle Geometries; **Right-Click** to the body and click the **Isolate**

Starting Shape

In Generative Design Study, Starting Shape is an optional tool. You can assign it as initial shape. In this Session, you will explore two different Generative Design Studies, one of which contains Starting Shape and the other one without Starting Shape.

Follow the next steps to assign Starting Shape;

1. Select the **Main Body** as Starting Shape Body
2. *Click the **OK** to assign* Starting Shape



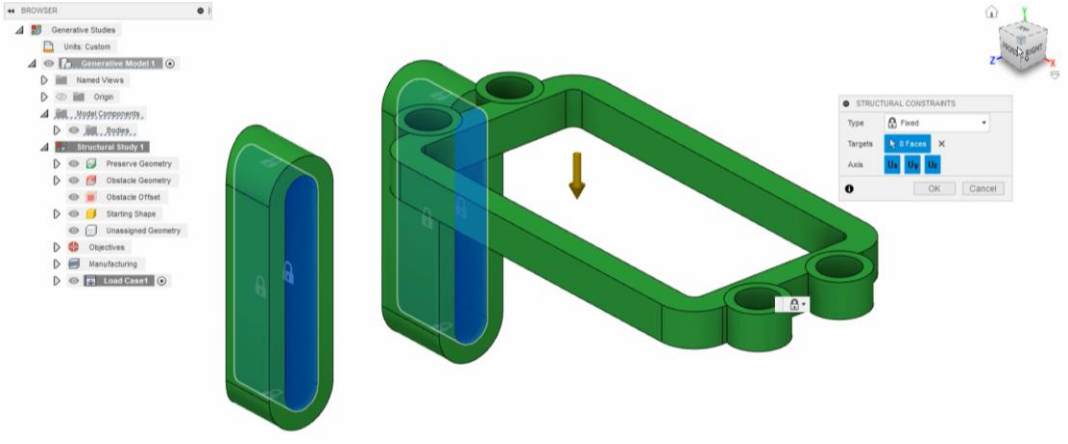
After you correctly assign the Starting Shape, the body will appear in the Starting Shape Group. The **Main Body** will display in *yellow* on canvas.

Structral Constraints

In the Generative Design Study, **Structural Constraints** restrict or limit the displacement of the model. In this session, you can consider that *Generative Design Study* should create a Concept robotic arm gripper in estimated conditions.

Follow the next steps to assign *Structural Constraints*;

1. Select the 8 faces shown in the screenshot
2. *Click the **OK** to assign* Structural Constraints



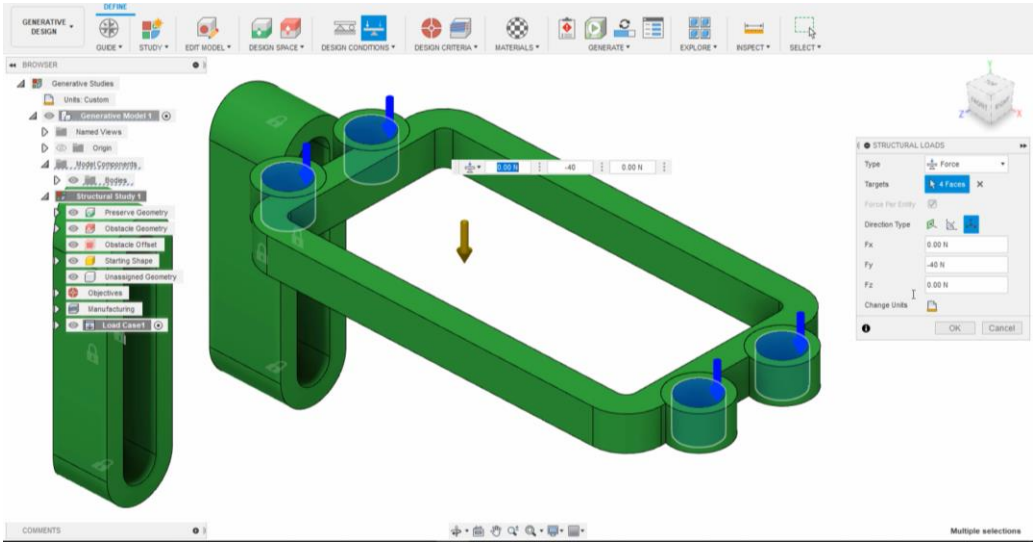
Structural Loads

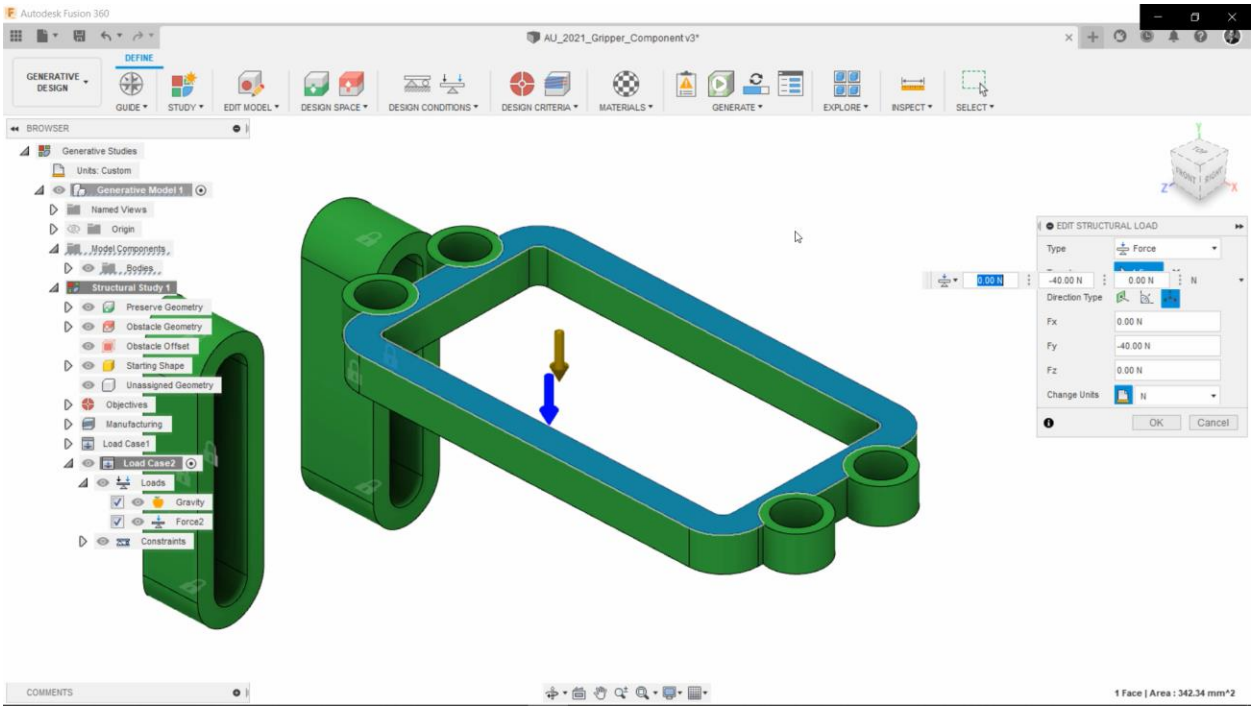
In this Session, it will be used type of **Force** from *Structural Loads* but there are 4 different Load types available as *Force, Pressure, Moment and Bearing Load in Generative Design Workspace*. Depending on your load type, you can select faces, edges or vertices from multiple objects.

In below, there are several forces given as **Newton***(Unit of Force)*, they are just averaged values to create the concept robotic gripper arm, you can make changes as you wish according to your scenario(For different materials, manufacturing methods, scale etc.).

Follow the next steps to assign Structural *Loads*;

1. Select the Structural Loads from Design Conditions ***(L** key is the shortcut)*
2. *Select 4 faces shown in screenshot,*
3. *Enter 40 newton, if necessary you can use -40 Newton*





4. Select the top face shown in screenshot
5. *Enter -**40** newton to **Fy***

Objective Limits

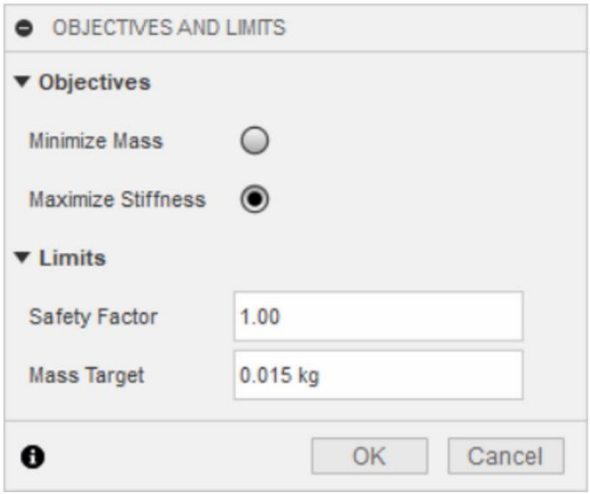
In this session, we would like to reach the lightest solution for Concept Drone Chassis. For this aim, you can easily choose the Minimize Mass as Objectives. In general, it's proper to enter a value of 2 for Safety Factor on Limits.

If you'd like to reach more detailed design outcome, you can enter a Mass Target after you determine from **Right Click to Body in Browser > Properties.**

For the Generative Design Study with Material of *Titanium 6Al-4V*;

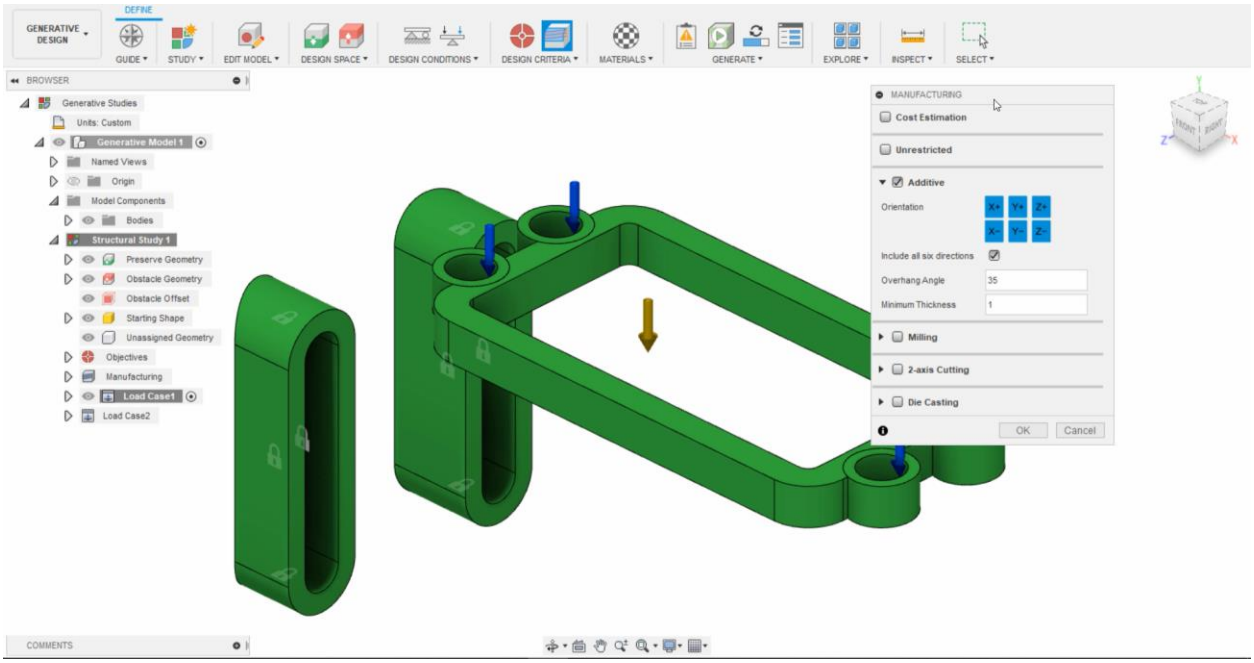
1- Enter the **Safety Factor** Value as 1.00

2- Enter the 0.015 kg as **Mass Target**



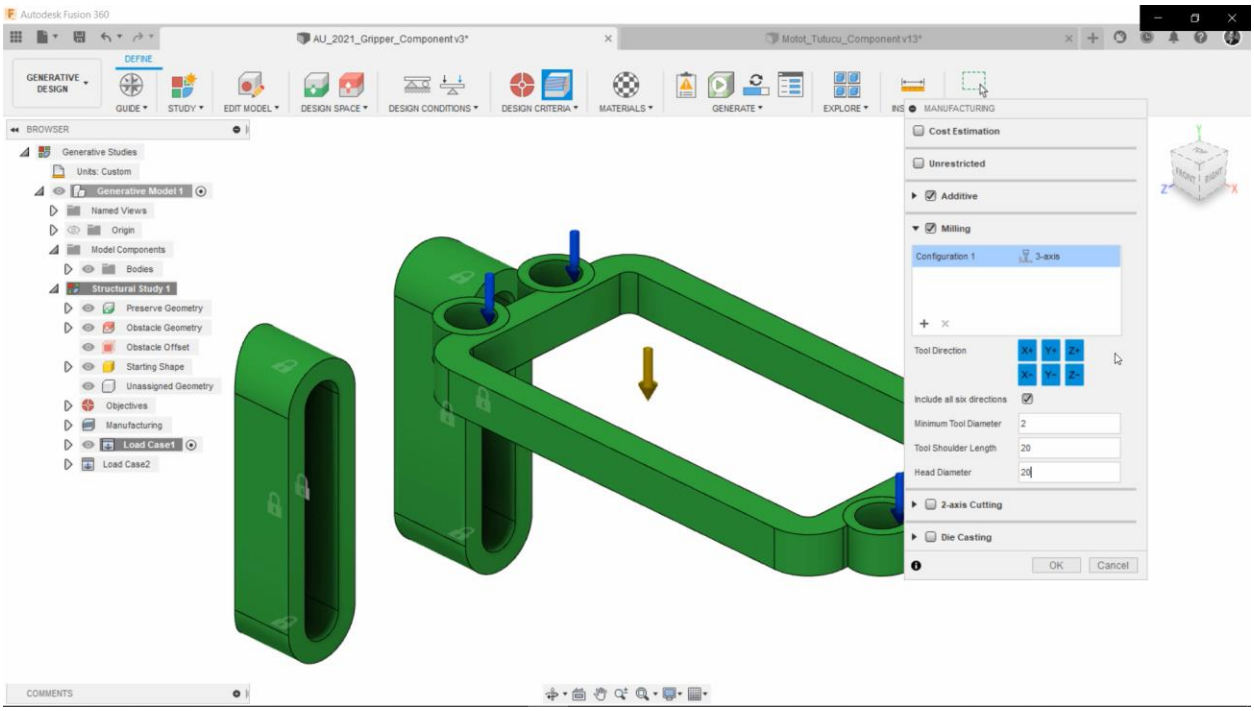
Manufacturing

You can Select the **Manufacturing Tool** from Design Criteria. It specifies the manufacturing constraints for the design process. There are 5 different options available as *Additive, Milling, 2-Axis Cutting, Die Casting and Unrestricted.* In this session, it will be chosen **Additive manufacturing and unrestricted method,** but, of course, you can try other methods for concept drone chassis.



Follow the next steps to assign *Manufacturing Method*;

1. Put a checkmark on **Unrestricted**
2. Put a checkmark on **Additive**
3. Select **X+, Y+, Z+** for Orientation
4. Enter the **35 Degree** to Overhang Angle
5. Enter the value of **1.00 mm** to Minimum Thickness
6. You can also add different manufacturing methods, for example Milling;

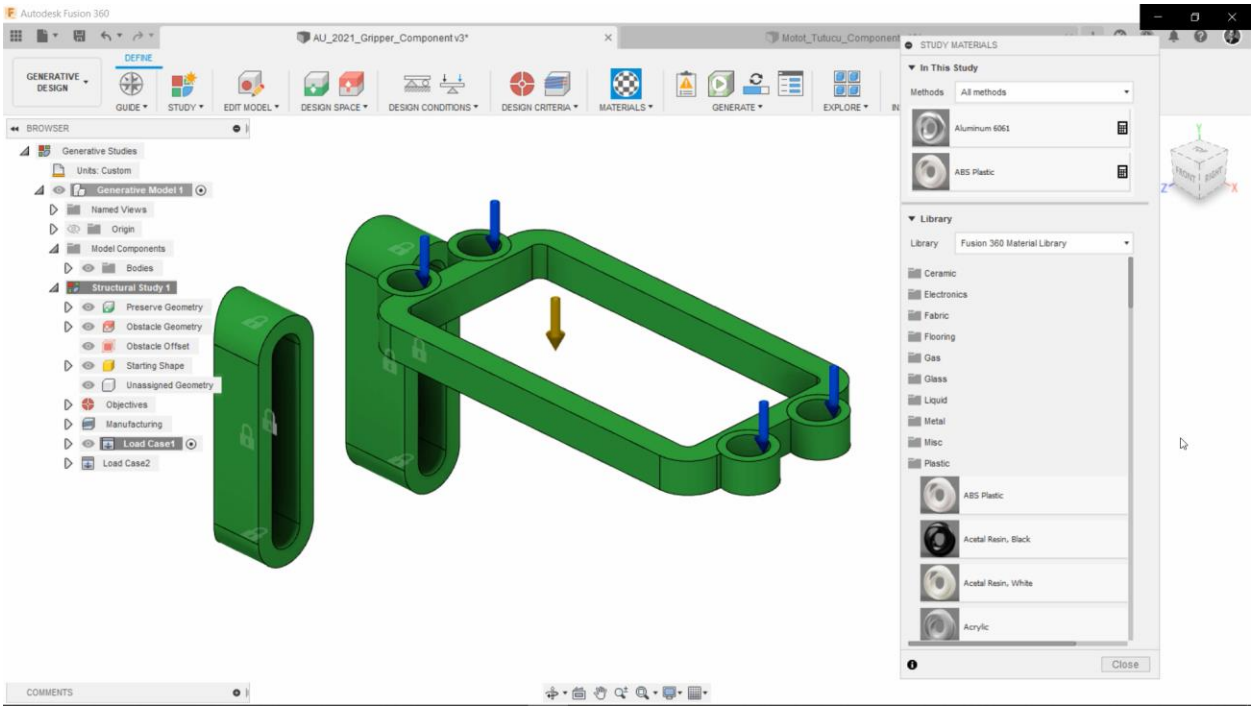


Choosing Materials

You should select at least one material for your **Generative Design Study**. Fusion 360 offers Aluminum AlSi10Mg as default but you can *delete* it from in this study section.

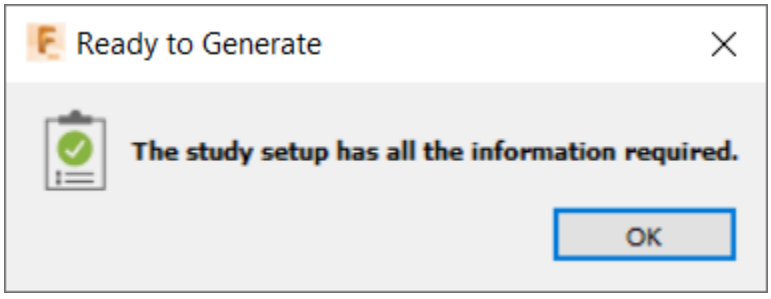
In this session, it will select two different materials as Plastic and Metal. But feel free to choose different materials for your cases.

1- Select the **ABS Plastic** from Fusion 360 Material Library
2- Drag & Drop to in this Study Section
3- Select the **Aluminum 6061** from Fusion 360 Additive Material Library



Pre-Check and Generate

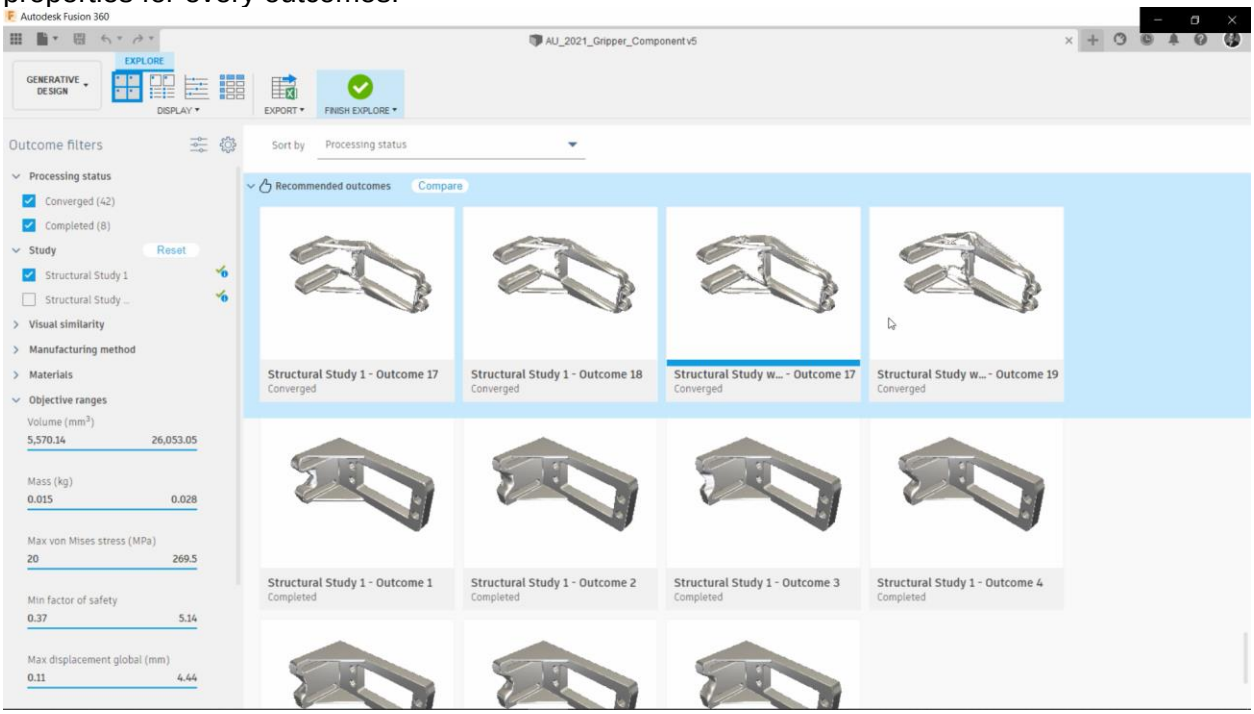
Pre-Check tool ensures to the setup meets requirements to generate outcome. When you see the Green Check icon in the Pre-Check tool, it's all good and you're ready to **GENERATE!**



Exploring Generative Design Outcomes

Fusion 360 offers us a detailed Explore page which contains many outcomes. You can easily change the objective ranges from Outcome Filters and you will see only outcome thumbnails that you need for your necessary.

When you switch the **Properties View** from Display, you can quickly take a look detailed properties for every outcomes.



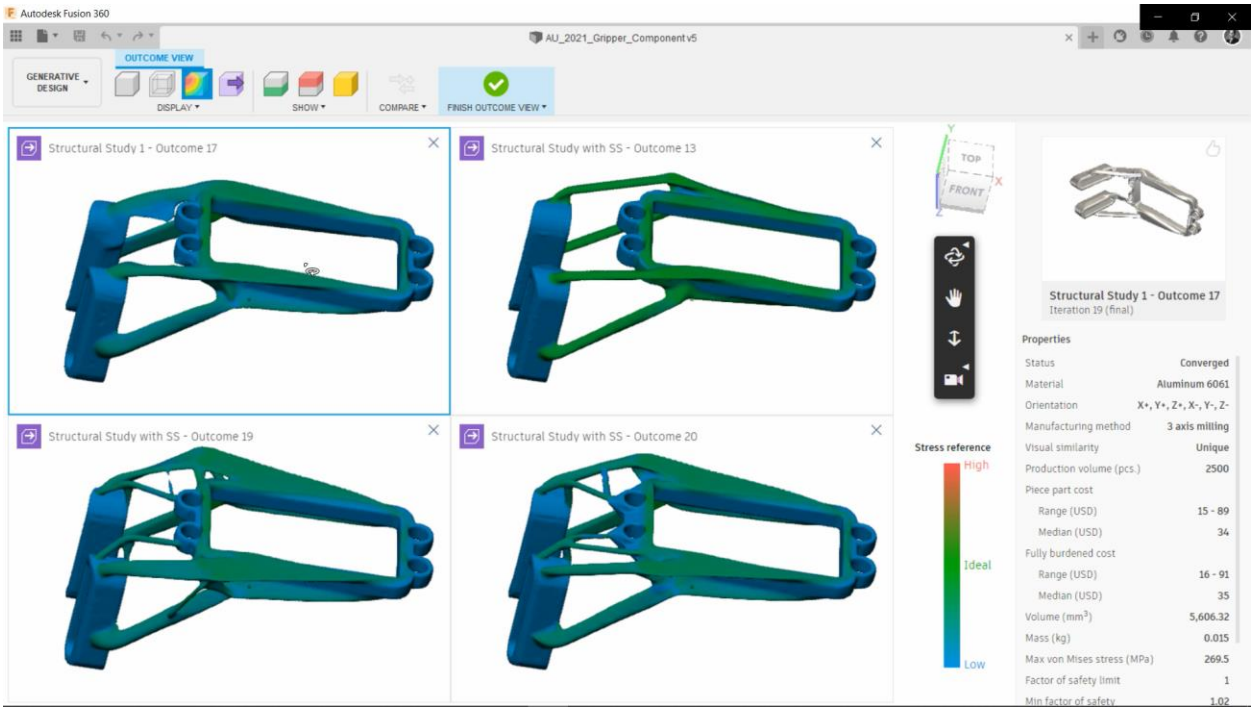
Outcome view offers 3 different Display view as **Model view, Stress View and Design Preview.** Also, there is very useful tool to modify your outcome as **CREATE** tool. Design From Outcome tool create a **3D Design** *which you can edit*, from the current outcome's iteration.

Details of the Scatter Plot View

If you want to take a look all outcomes in the same table, Scatter Plot View will be the best tool for you. You can change the axis like Volume, Mass, Min Factor of Safety etc. And colors represents materials which used by Generative Design Study.

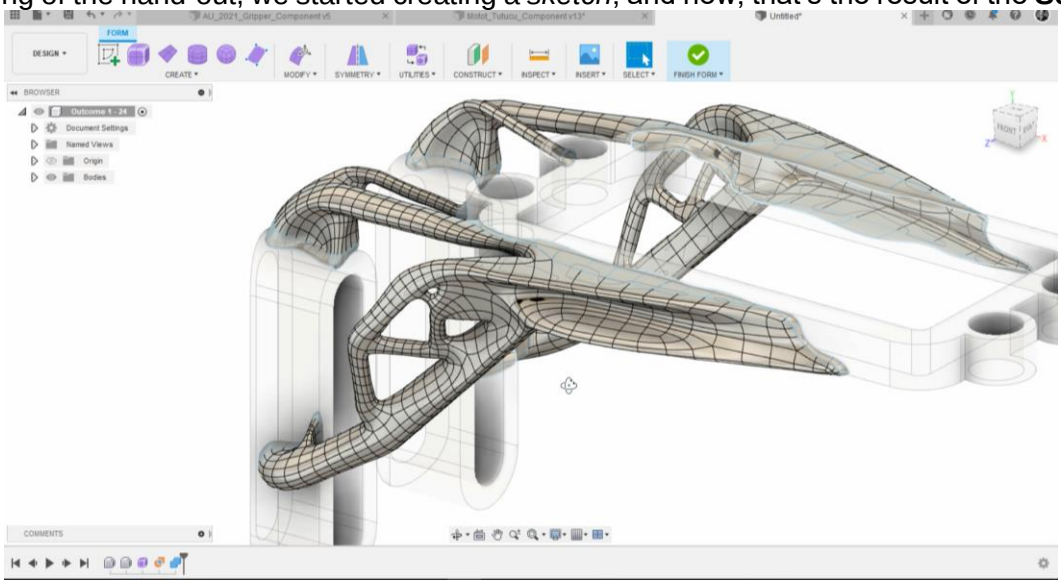
Comparasion View

You can compare up to **four outcomes**. It will be useful for you to compare *outcomes as visual similarity, stress views, and other details at the same time.*



Design from Outcome

You can easily modify your selected outcome design from your **Generative Design Study.** At the beginning of the hand-out, we started creating a *sketch*, and now, that's the result of the **Session**.



I hope this hand-out and session will contribute your work. **All the best!**