How to Make Bolts and Nuts Accessible for Fabrication (Design for Assembly – VERY IMPORTANT)

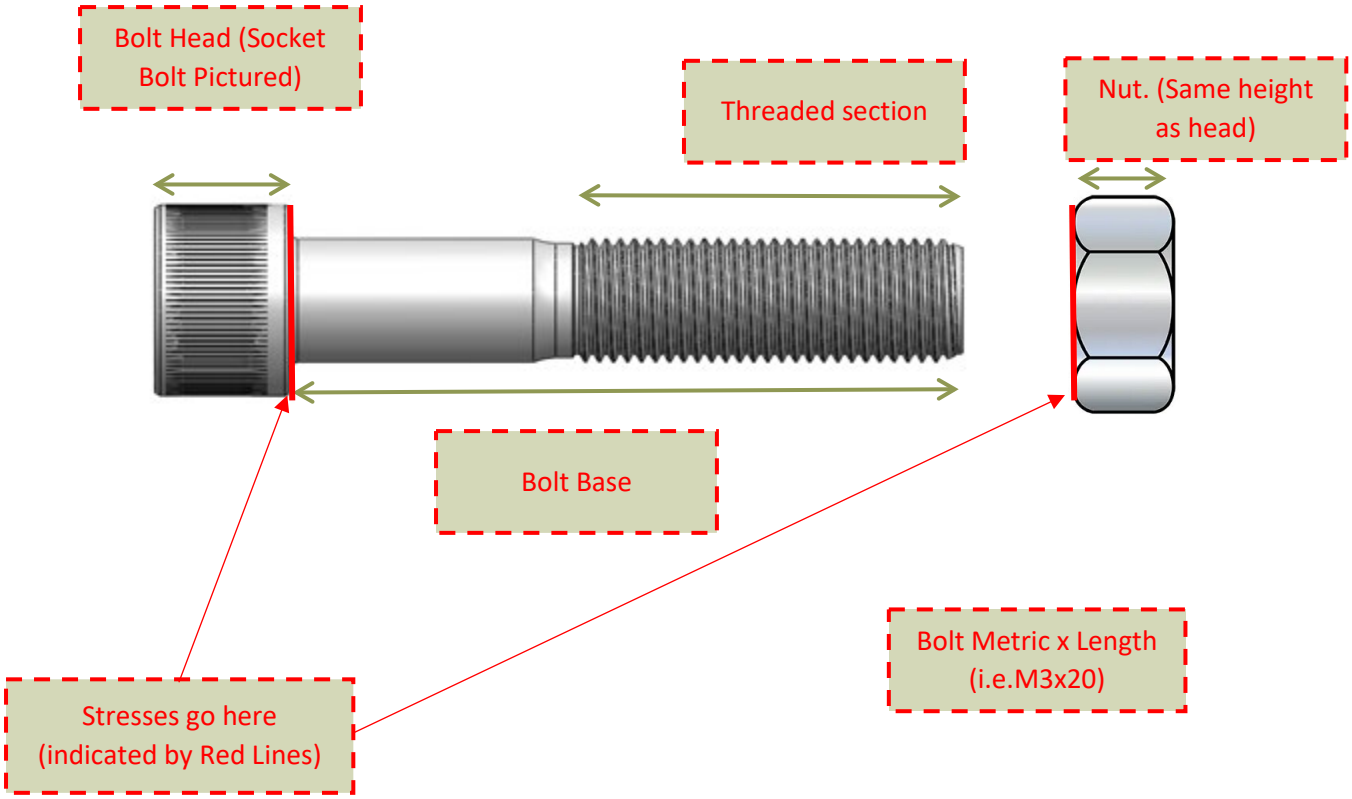
You will learn to:

- Ensure that **ALL bolts and nuts** can be **accessed properly** by engineers.
- Use **advanced extrusion** options.
- Condense processes into **single sketches**.
- Use **User Parameters** to **enforce modularity** in your designs.

The mainly used functions are extrude, user parameters, and the Sketch tool.

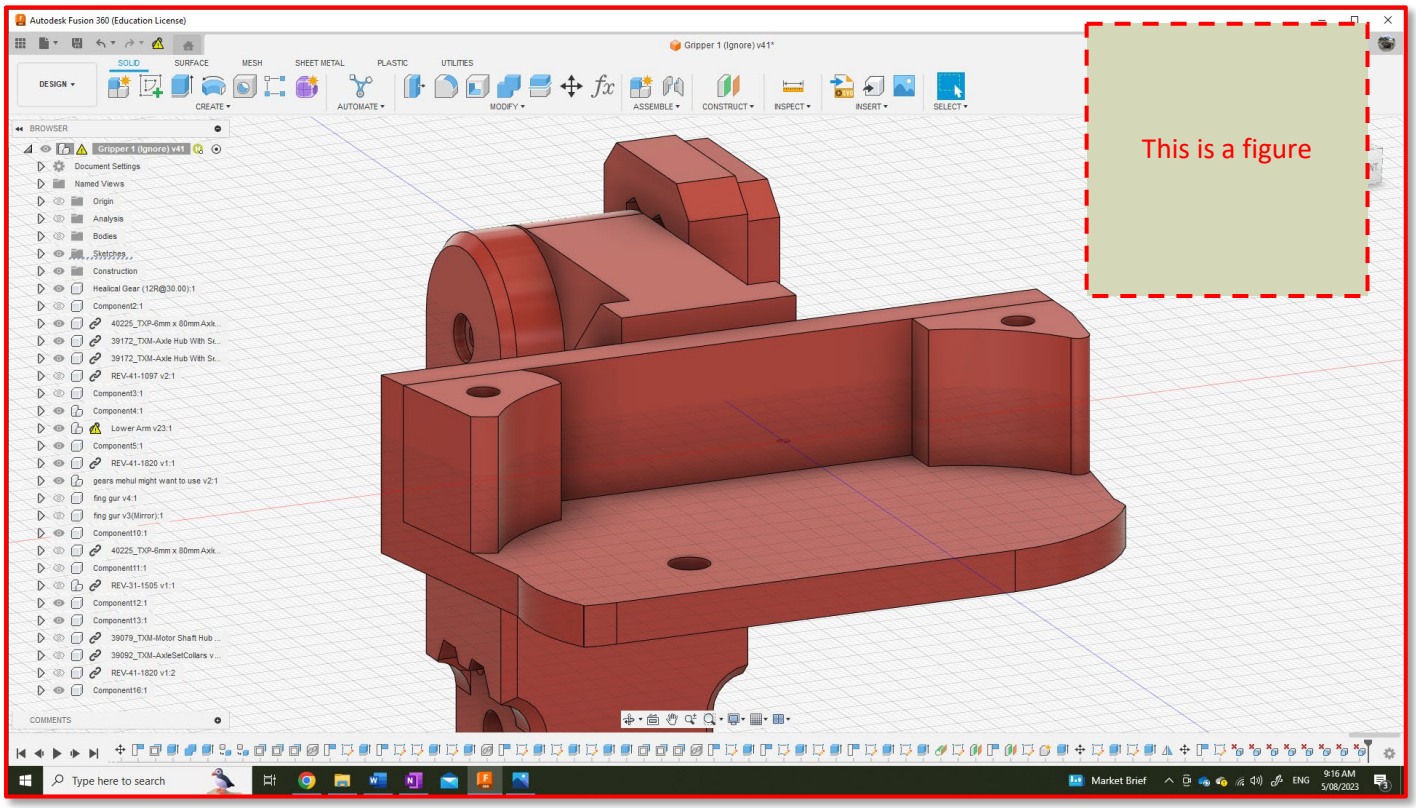
Engineers always have the issue of wondering **what to connect what**, and **how** to connect them together. One super-duper way of doing this is with **bolts and nuts**. And they work most of the time!
But a catch. A pretty big catch.
They're a **headache to CAD in *properly***. Not to worry though!

First, some context. A bolt's anatomy is shown below and comes in different shapes and sizes. For standardization reasons, we **use Metric bolts** which have the "M" and a number after it to indicate diameter. We mainly use **M3** (Bradley confirmed?), which stands for "Metric 3". Below is a side view of a bolt with nut.



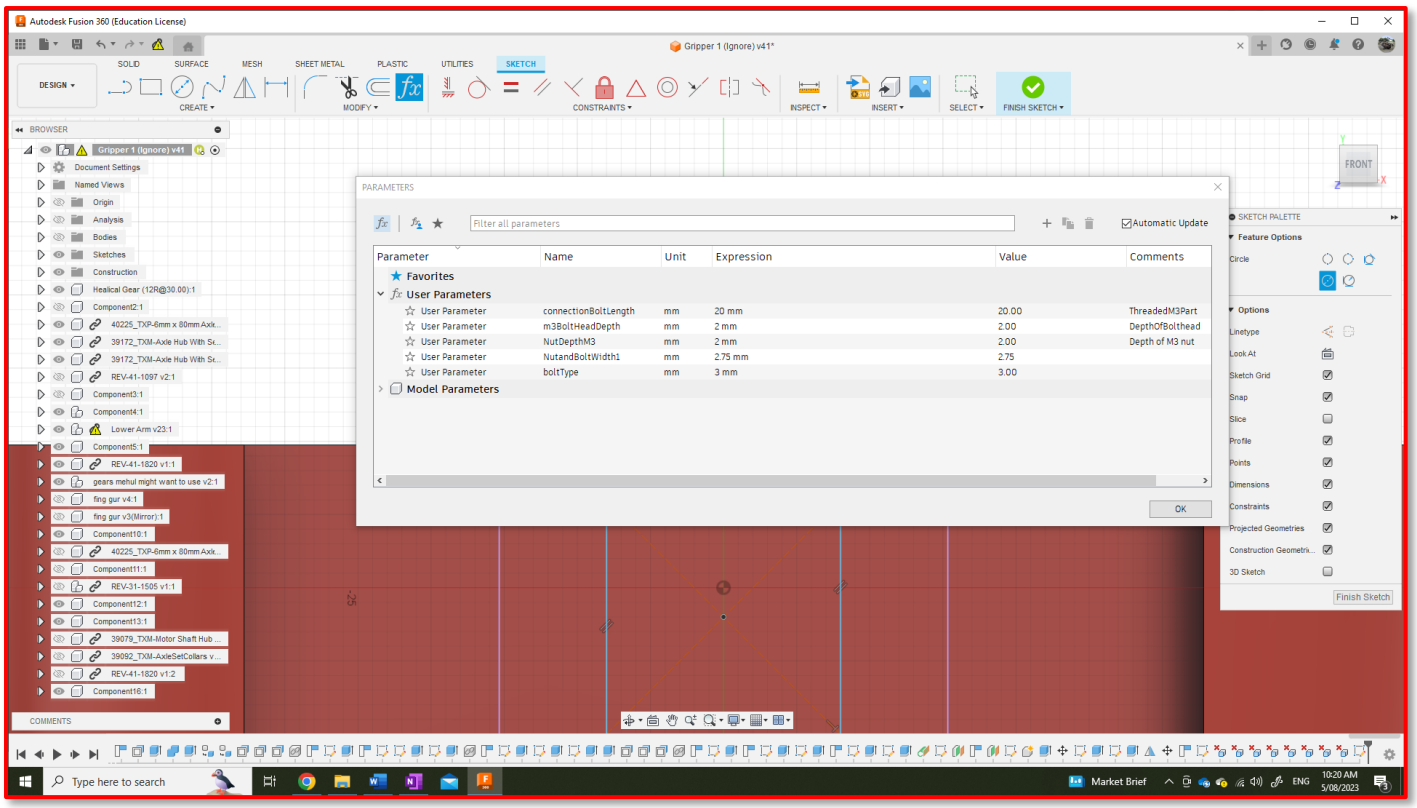
Contributed By: Hugo Lawler

Here I have **2 parts** in a table tennis robot that I must **connect**. I have already pre-bored some holes. I want to do this in the **least number** of sketches possible, as they're hard to keep track of.



First, I need to **set the dimensions** for all the parts. I can do this by using the **user parameters** function. Please see our other cheat sheet for guidance on how to use that!

Contributed By: Hugo Lawler

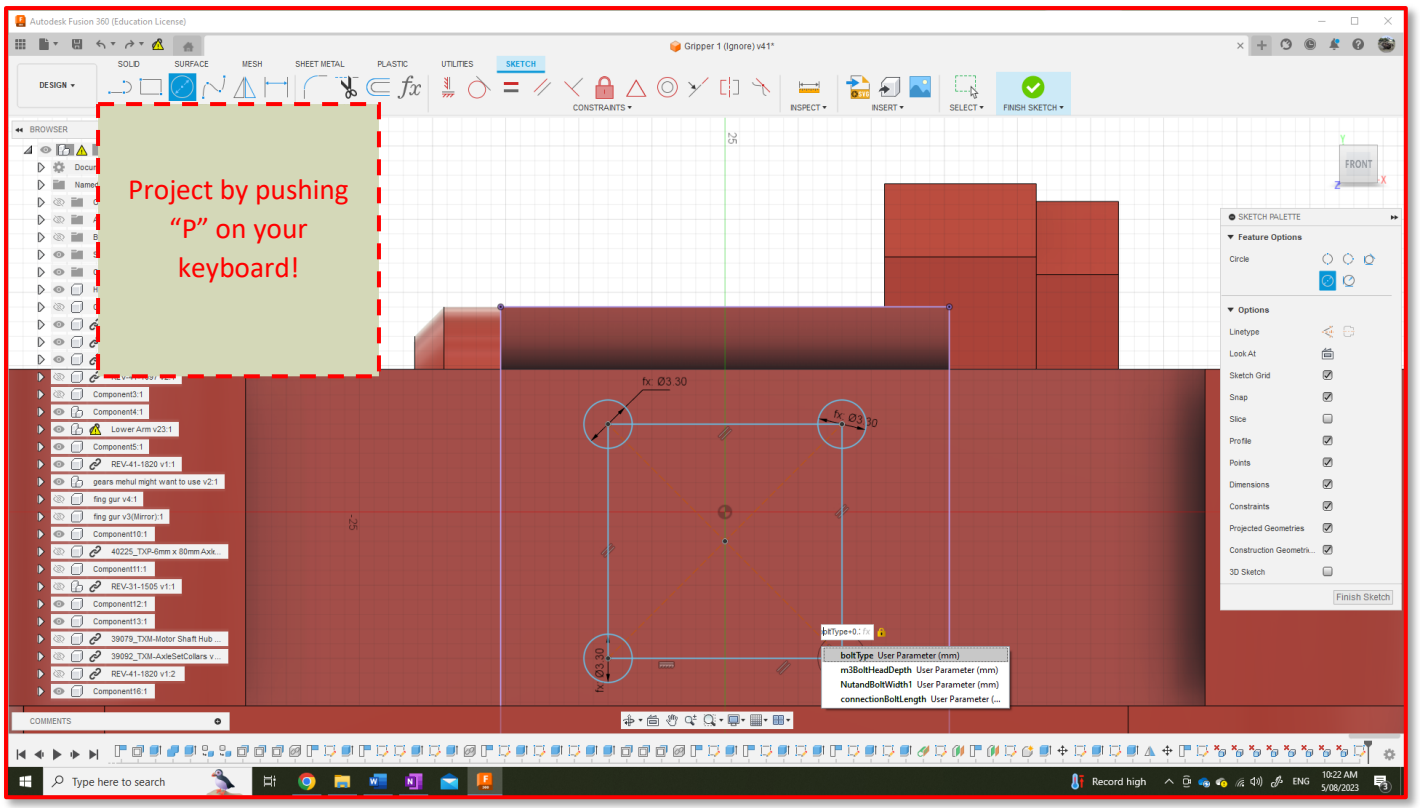


	Function Name(s)		
Bolt Size	NutandBoltWidth1	DepthNutandHead	Bolt Length *(SMT Exclusive 2023)*
M3 *Bradley*	2.75	3	x8, x10, x12, x16 or x20mm
M4 *Sherman*	3.5	3.2	x10, x16 or x25mm
M5 *Stuart*	4	4	x10, x16, x20, x25, x30, x40 or x45mm

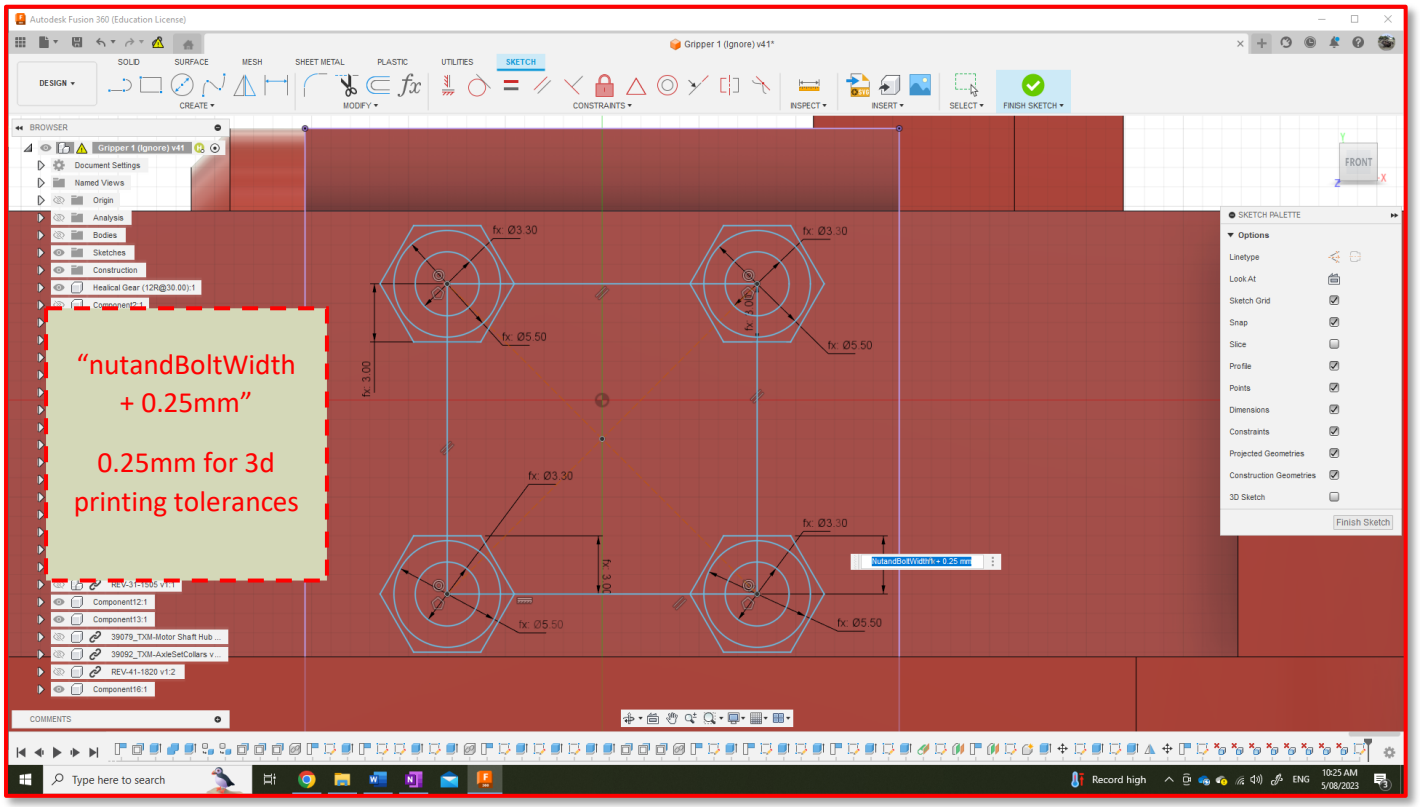
Above are the main bolt dimensions that **QASMT students** can use for FTC as of 2023.

After making the params, I'll create a **sketch on the face** with the bolt head and **create an array of holes** for the bolt to go through. I did this using the **center square tool** to indicate where the holes will go.

Contributed By: Hugo Lawler

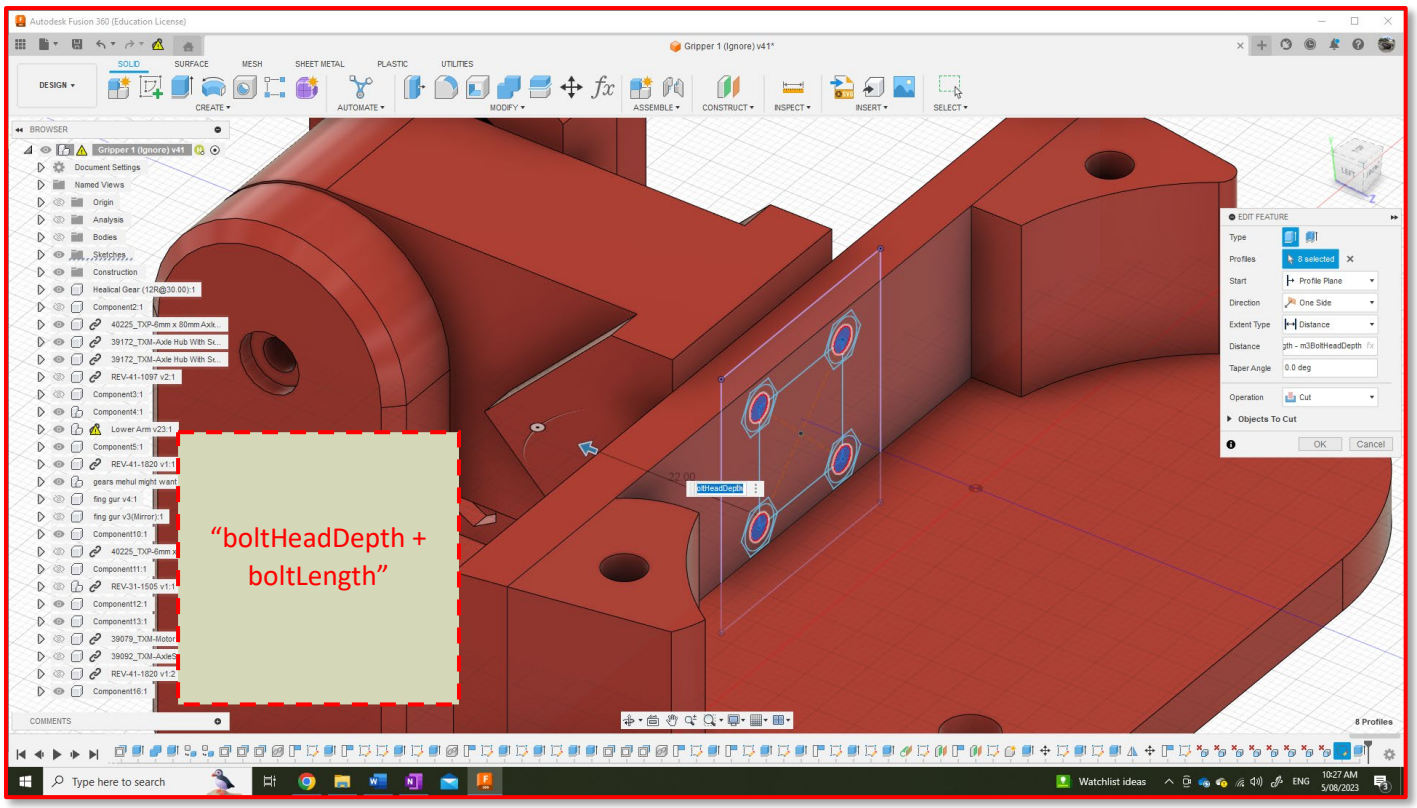


Next I'll make a **circle and nut** using the **user params** from above. This should create a funky looking pattern of nut, circle, circle.

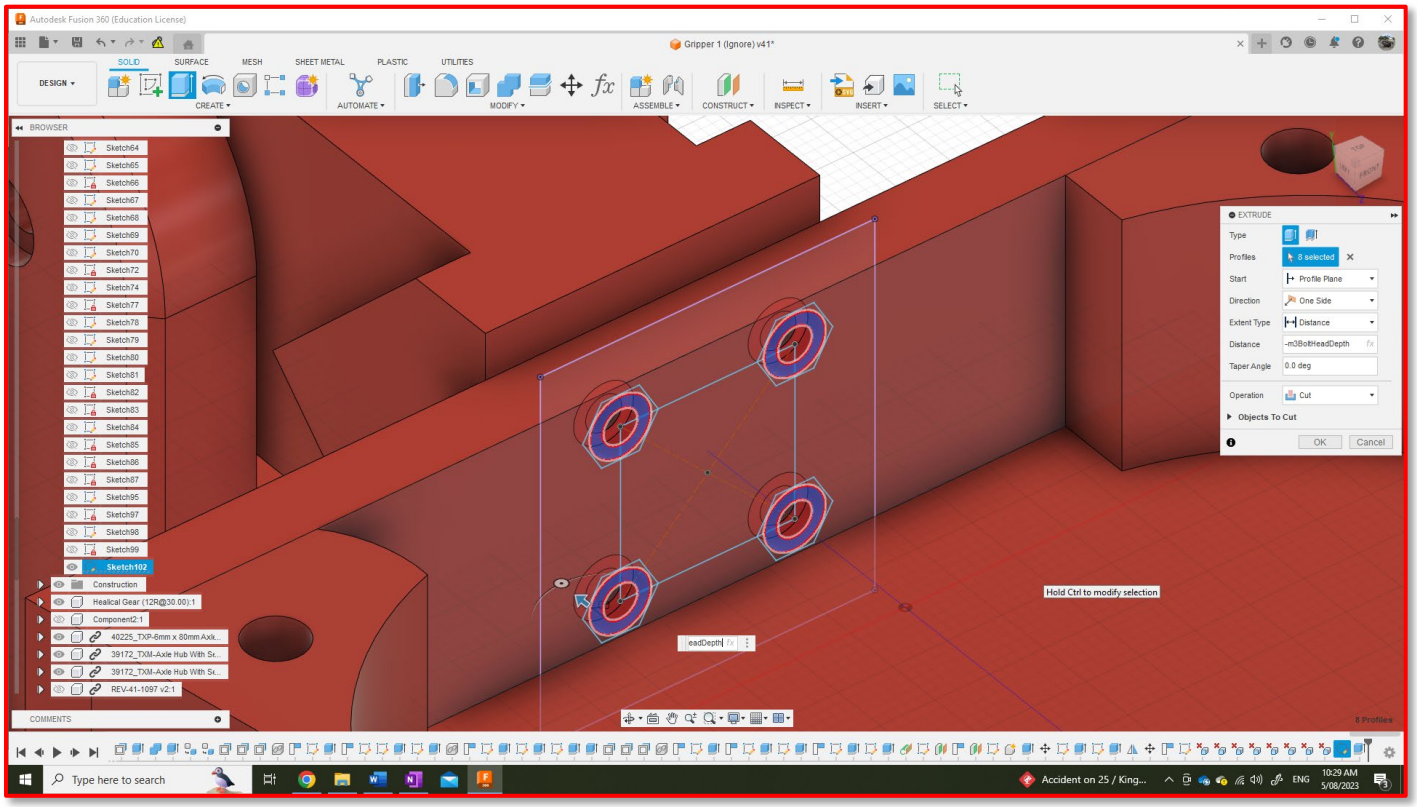


After that, I'll **extrude the middle hole downwards** by the **length parameter WITH the bolt head included**. (i.e. boltLength + DepthNutandHead)

Contributed By: Hugo Lawler

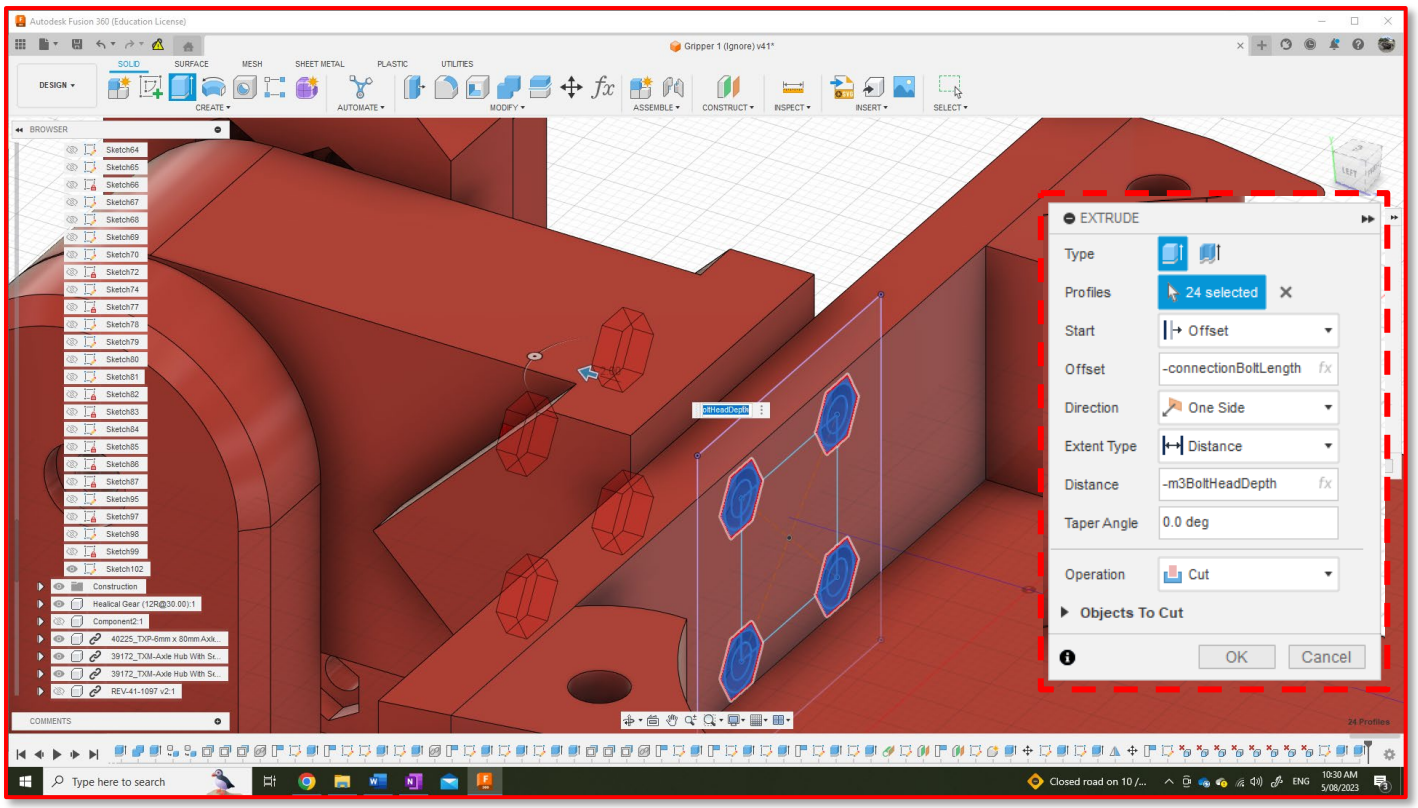


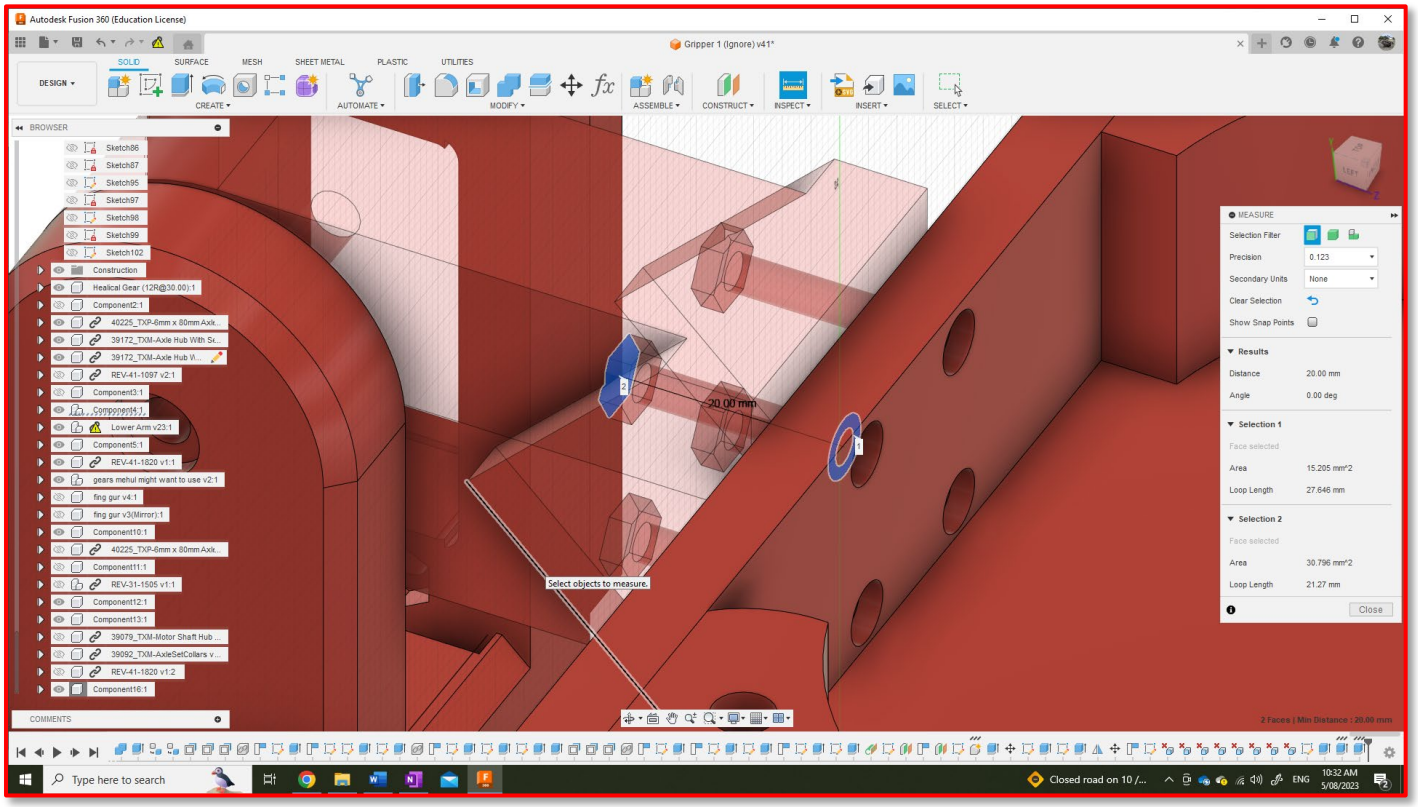
After this, I **extrude the bolt head downwards** by the bolt head depth parameter.



Next, I'll use the **extrude tool again**. Except this time, I **offset** it by the **length of the bolt**. This allows for the nut to still be connected to the end of the bolt very precisely.

Contributed By: Hugo Lawler



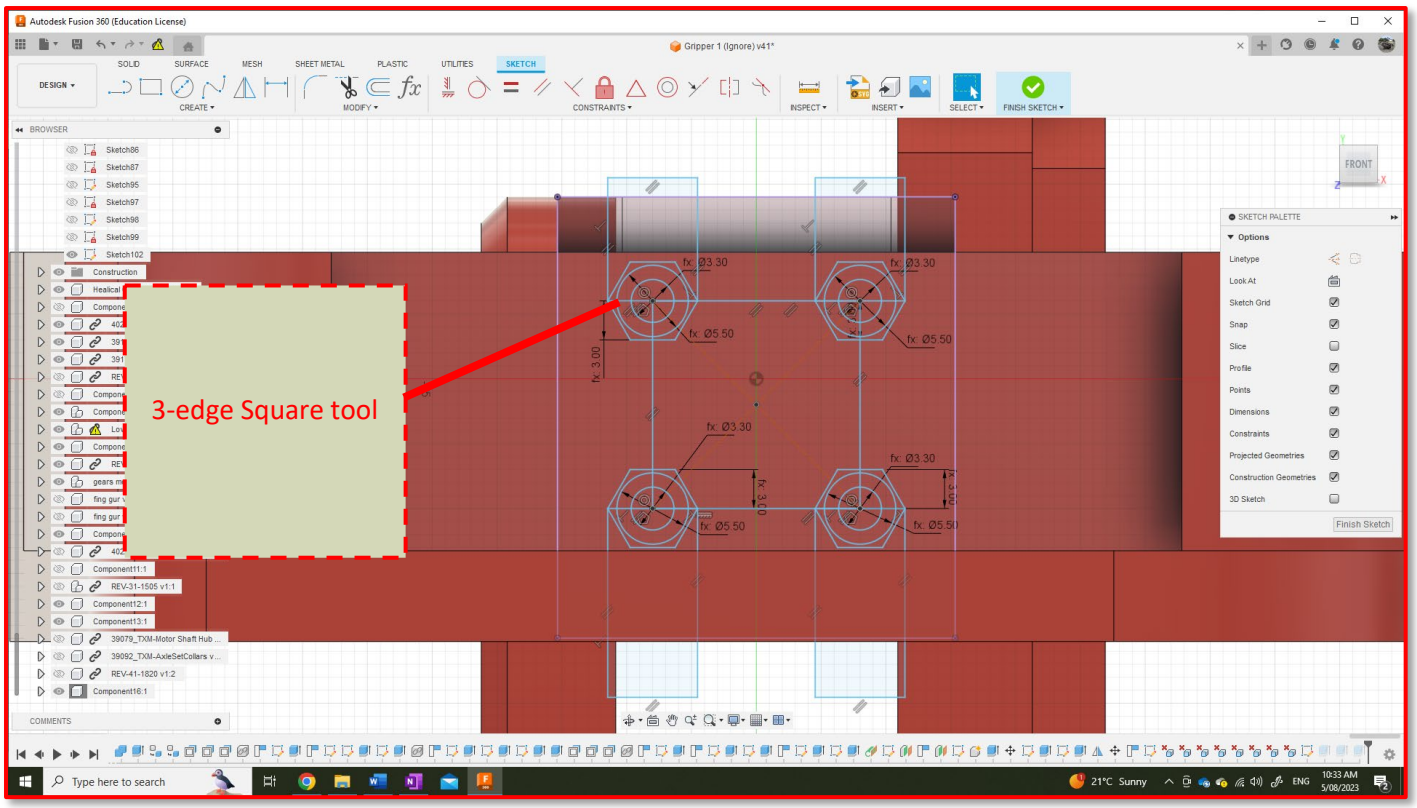


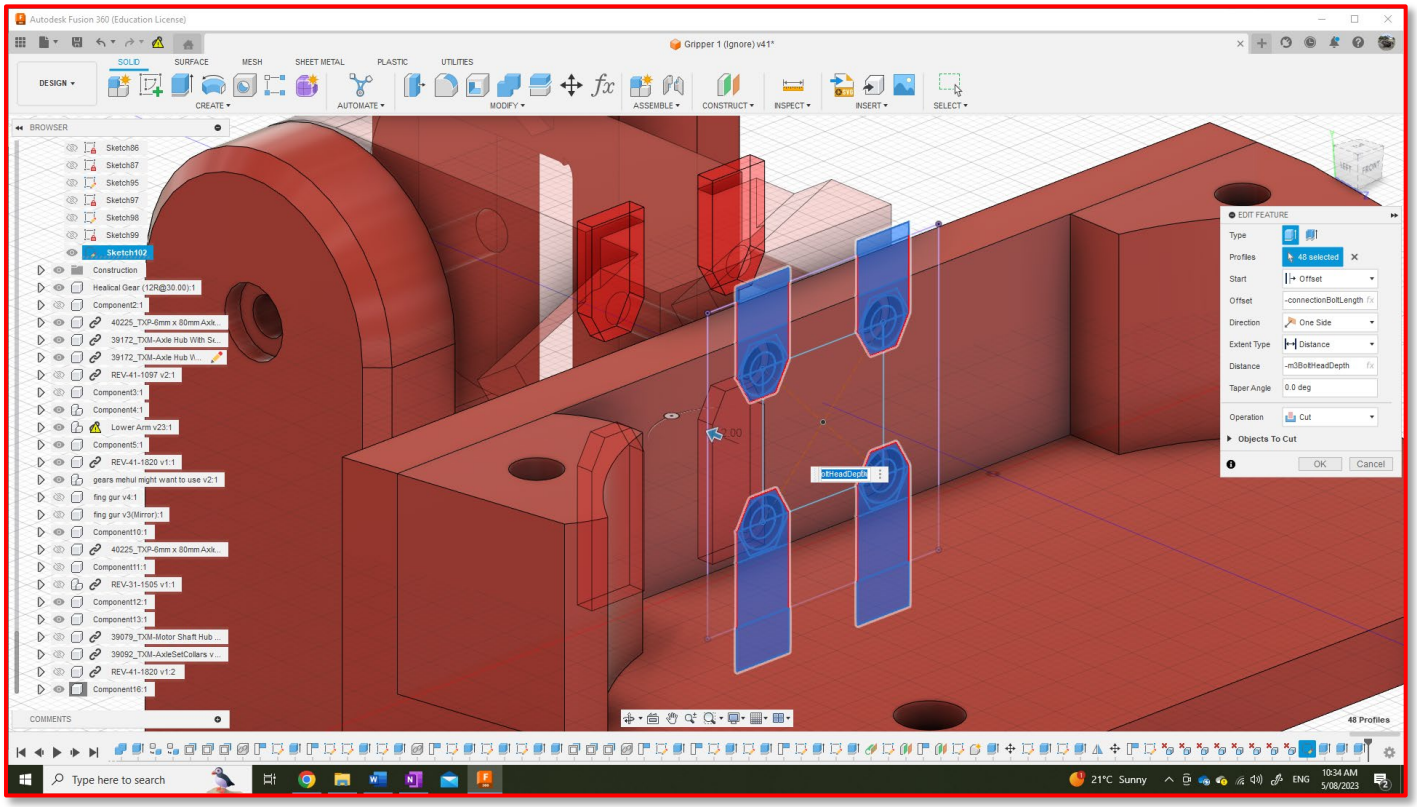
But… There's a problem…

The **nuts can't be dropped in** for this instance! The **Holes have been made**, but there's **no way to get the nuts in**.

For this we can edit the original sketch to **include tabs** that go on top and bottom.

Contributed By: Hugo Lawler





Now I have a **completely modular**, ready to go bolt system for attaching 2 parts together. If it fails, I can **easily swap it out** for an m4 or a 30mm long bolt. Happy Fusioning!

Find checklist for easy reference next page

Contributed By: Hugo Lawler

Checklist:

1. (optional) make the user parameters for the hole dimensions.
2. Make new sketch on bolt head face
3. Create bolt profile in sketch (i.e. M3 ->3mm)
4. Create bolt head profile in sketch
5. Create circumscribed polygon same size as bolt head diameter
6. Extrude main bolt hole by bolt length AND added bolt head depth
7. Extrude bolt head profile by bolt head depth
8. Extrude nut profile by bolt head depth and offset by bolt length.