If you have any questions, please contact us via twitter at @bobbyli22

Please post any feedback to @ResPlat on twitter!

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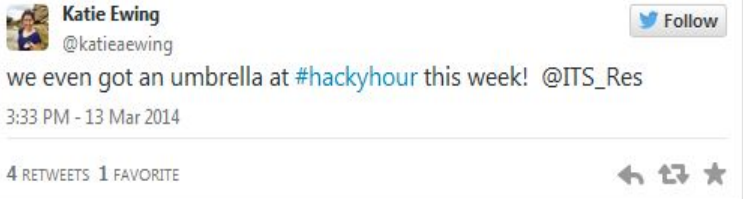
BE PART OF OUR COMMUNITY

- You can share your creating/designs with us through our Twitter handle, or if you have any questions.
  - *@resplat or @bobbyli22*

- Come to our #hackyhour for consultation, or if you just want to have a talk to us over some beers.
  - Every Thursday at 3:00pm – 4:00pm
  - Located at Tsubu Bar



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INTRODUCTION TO ASSEMBLIES WITH AUTODESK INVENTOR

DESIGNED FOR RESEARCHERS

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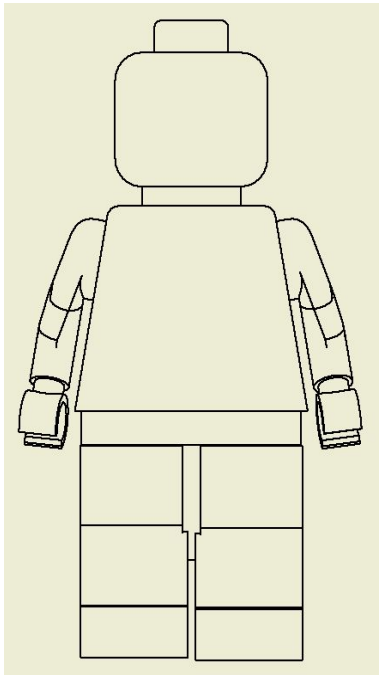
WHAT ARE YOU LEARNING?

- Advanced: How to connect PARTS in an ASSEMBLY, and create technical DRAWINGS

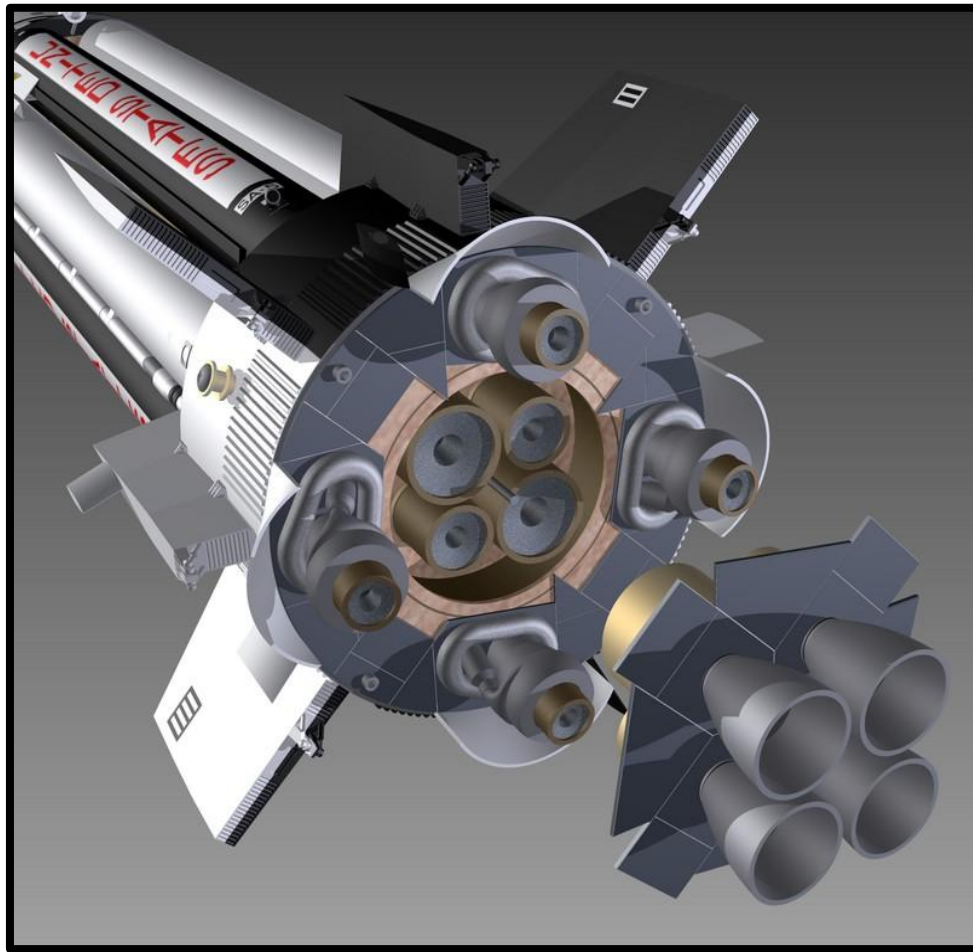


LESSON PLAN

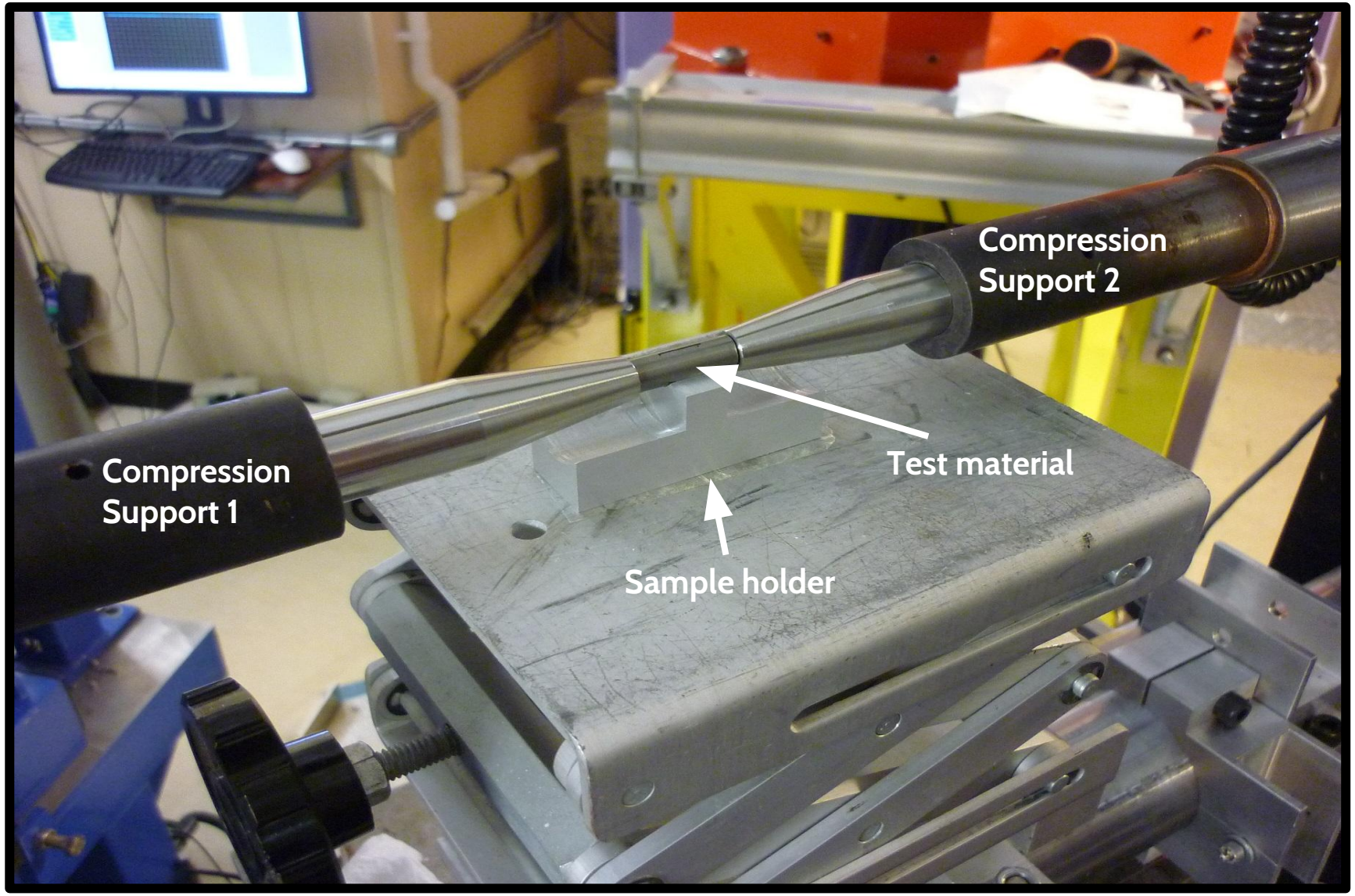
- 9:30am Introduction
- 9:35am Lesson 6: Introduction to Basic Assemblies
- 10:00am Lesson 7: Joints & Constraints
- 12:30pm LUNCH TIME!!
- 1:30pm Lesson 8: Advanced Assemblies
- 2:30pm Lesson 9: Reading Engineering Drawings
- 3:00pm Lesson 10: Creating Engineering Drawings

ASSEMBLY MODELLING

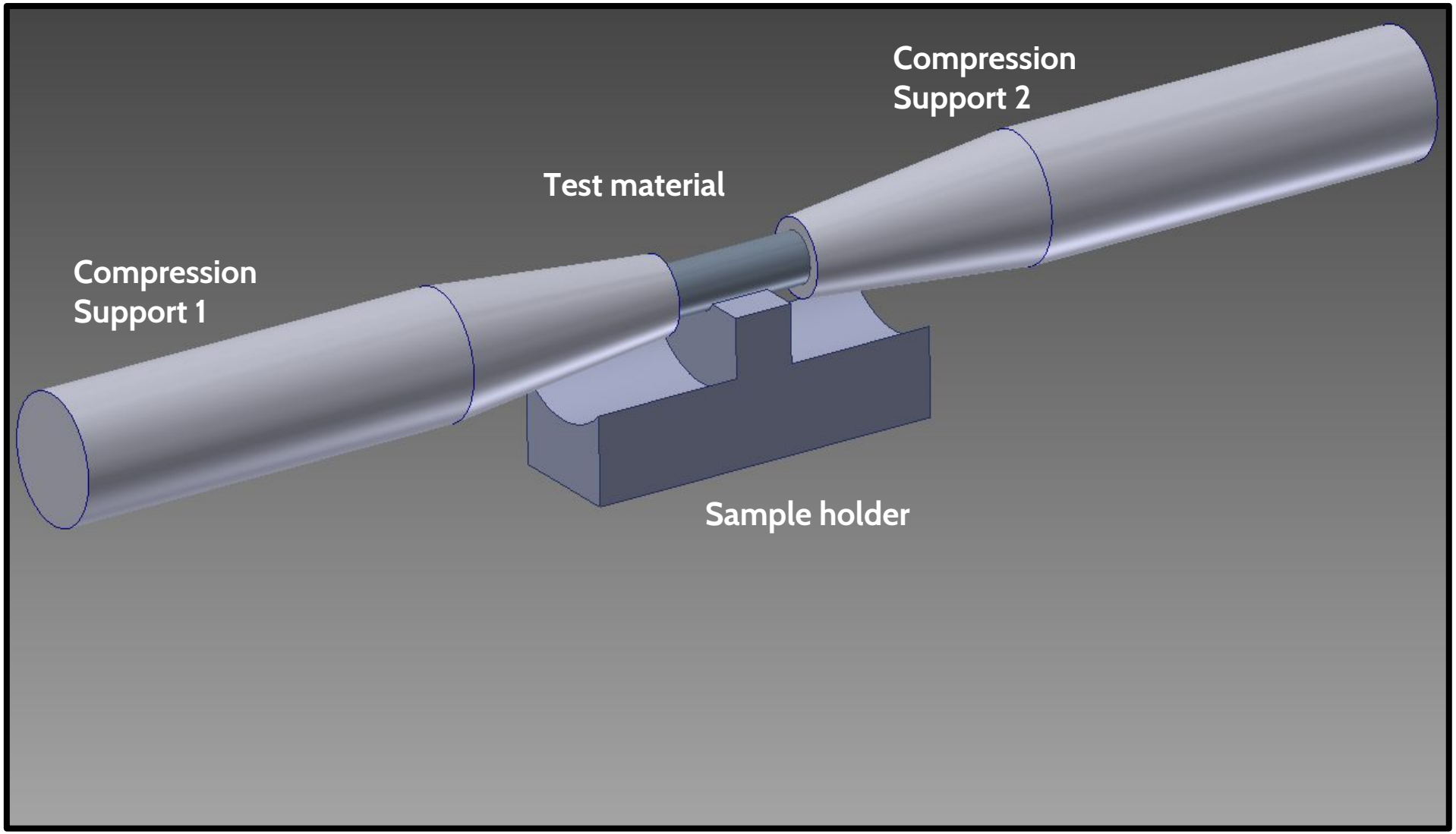
- A method using in CAD software to handle multiple files that represent components within a product design.
- Individual part files are **imported** into the work space and **assembled** together to create the overall product.
- The assemblies module enables users to preview and test the completed product before fabrication.
- Can be used to design apparatus or set ups, i.e. in the example shown.



EXAMPLE: SAMPLE HOLDER



MODEL: SAMPLE HOLDER

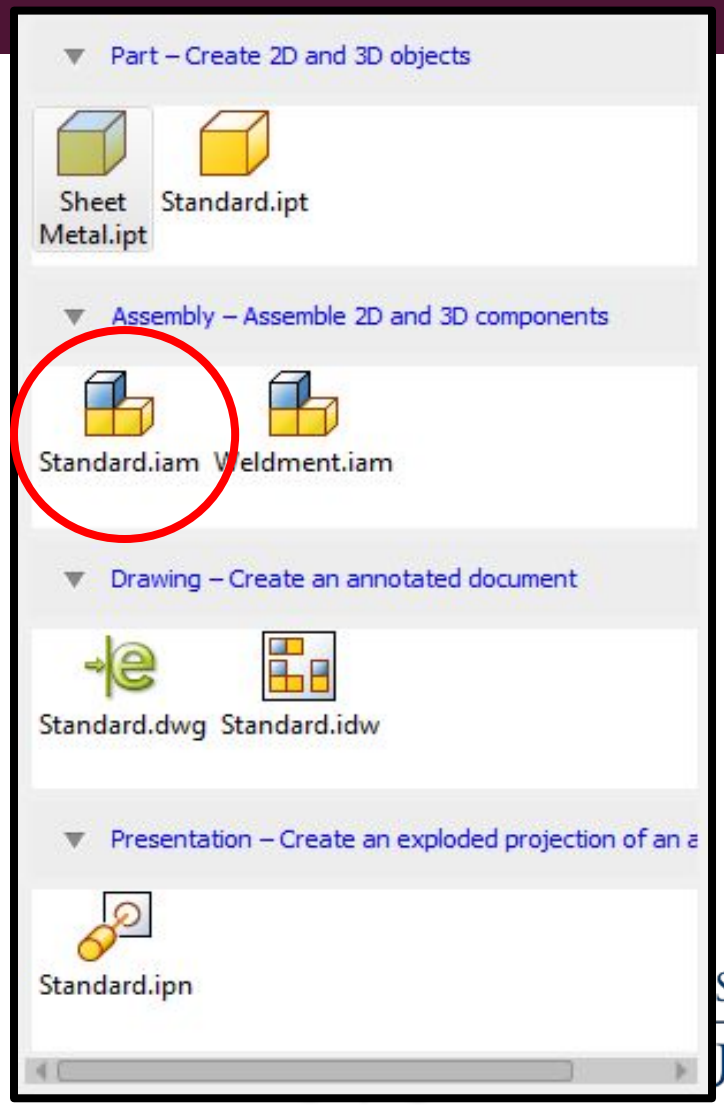


INTRODUCTION TO BASIC ASSEMBLIES

LESSON 6

CREATING AN ASSEMBLY FILE

- A **.iam** extension indicates an assembly file.
- The **standard** .iam assembly files consist of importing part files that can be linked together with **parametric relationships**.
- **Weldment** .iam assembly files assumes that imported part files are **permanently** joined together (using a welded joint).
- Similar to part files we can select between imperial and metric unit systems. We will be using **mm** units.



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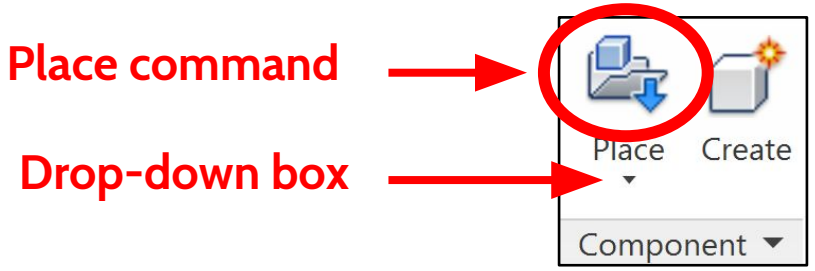
IMPORTING A PART FILE

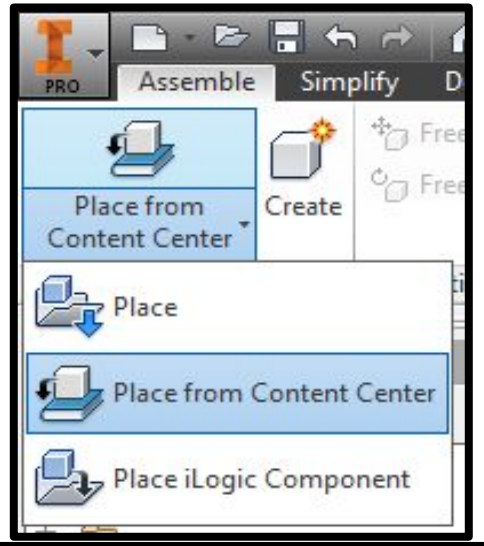
- The assembly interface has similar design to the parts module.
- We can **import** part files with the **place** command. *Click on the box above the drop-down tab, if you do accidentally get the wrong command make sure that the place command is set to **place** (no other text).*

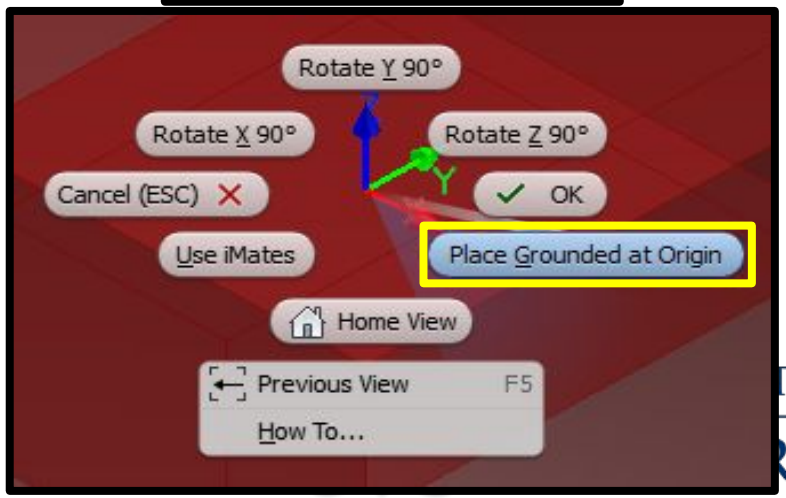


- We can also import part files from the **content centre**. These are standard part files for engineering components (abide by ANSI and other engineering standards).

PLACING PART FILES

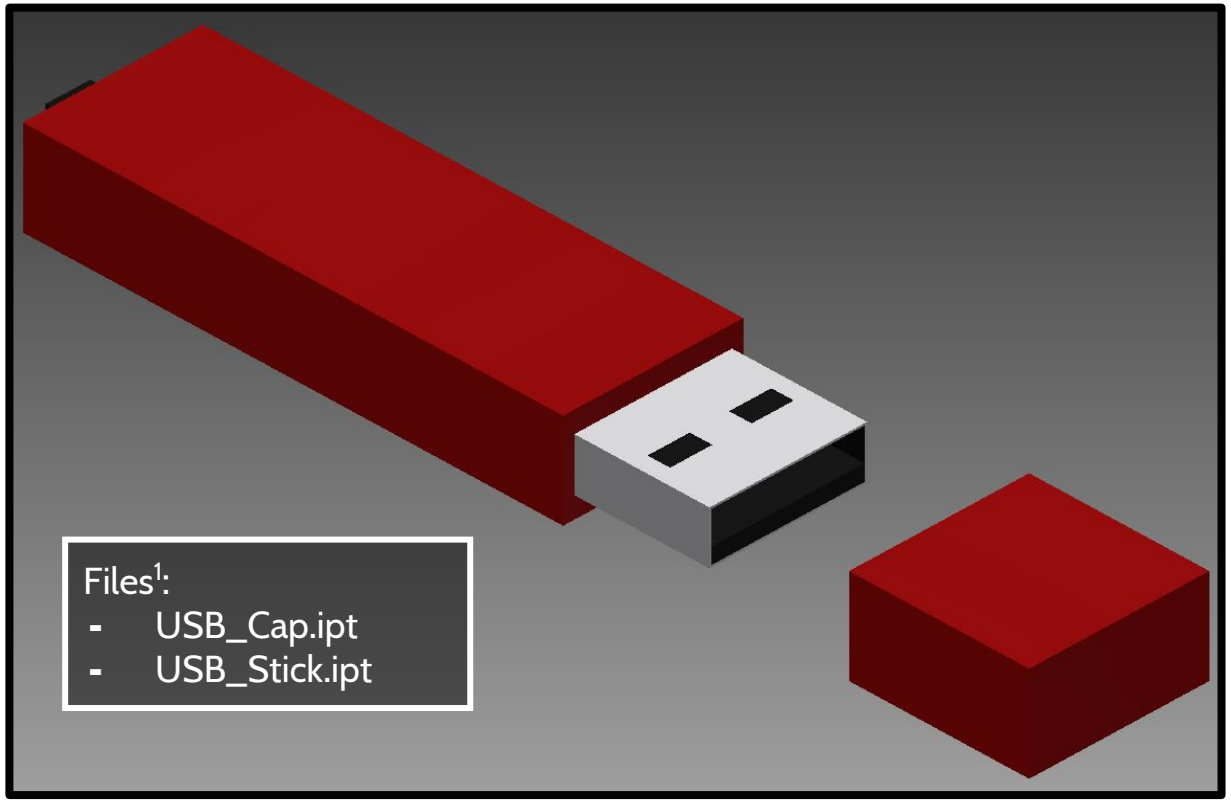
- A valid assembly requires the placement of parts (or components). A part that had been placed in the assembly environment is called an **instance**.
- You can have **multiple** instances of the same part in an assembly file.
- The **sources** of part files include your own local files, the inventor content centre and iLogic components (not covered).
- It is good practice to **ground** the first part you have placed at the origin. *A grounded component will remain fixed to the origin.*





EXAMPLE: USB

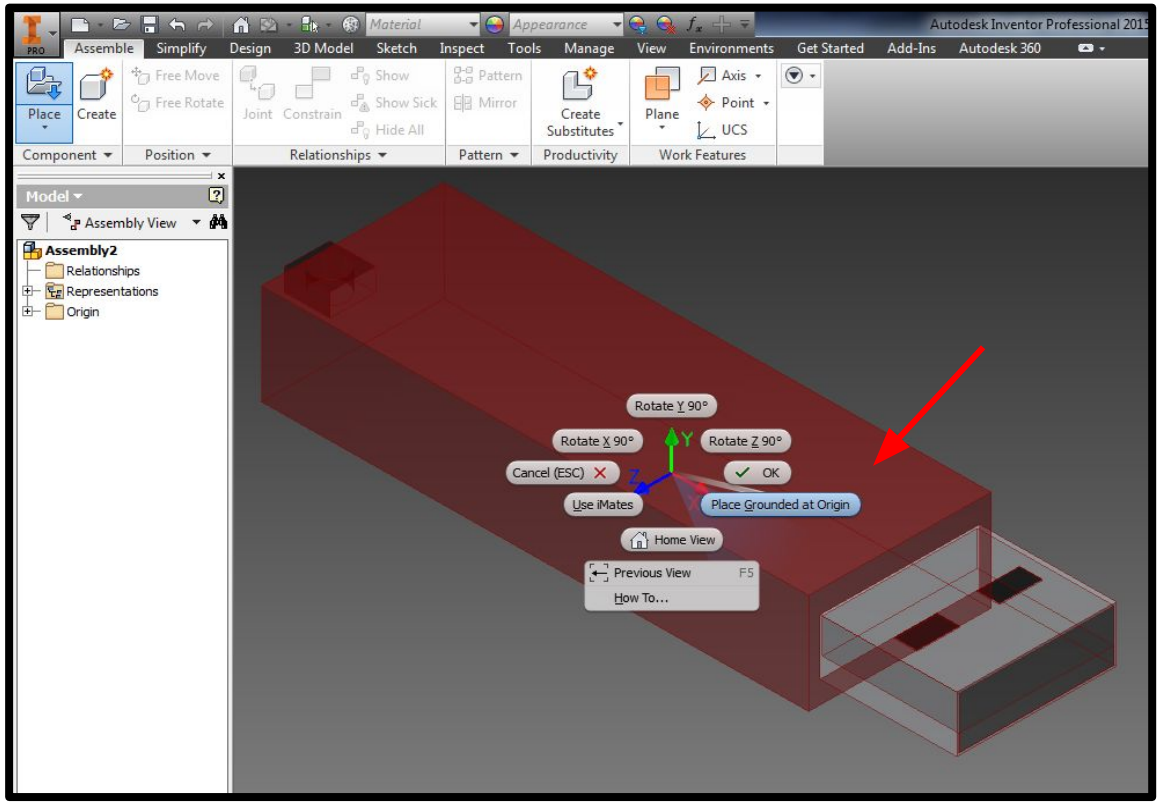
- Throughout this assembly course we will be using an example of a USB, which will comprise of two part files: the USB cap and the USB stick.
- *The files can be found in the "05_Assembly" folder in the downloaded materials.*



[1] MODIFIED FROM ORIGINAL SOURCE FILES

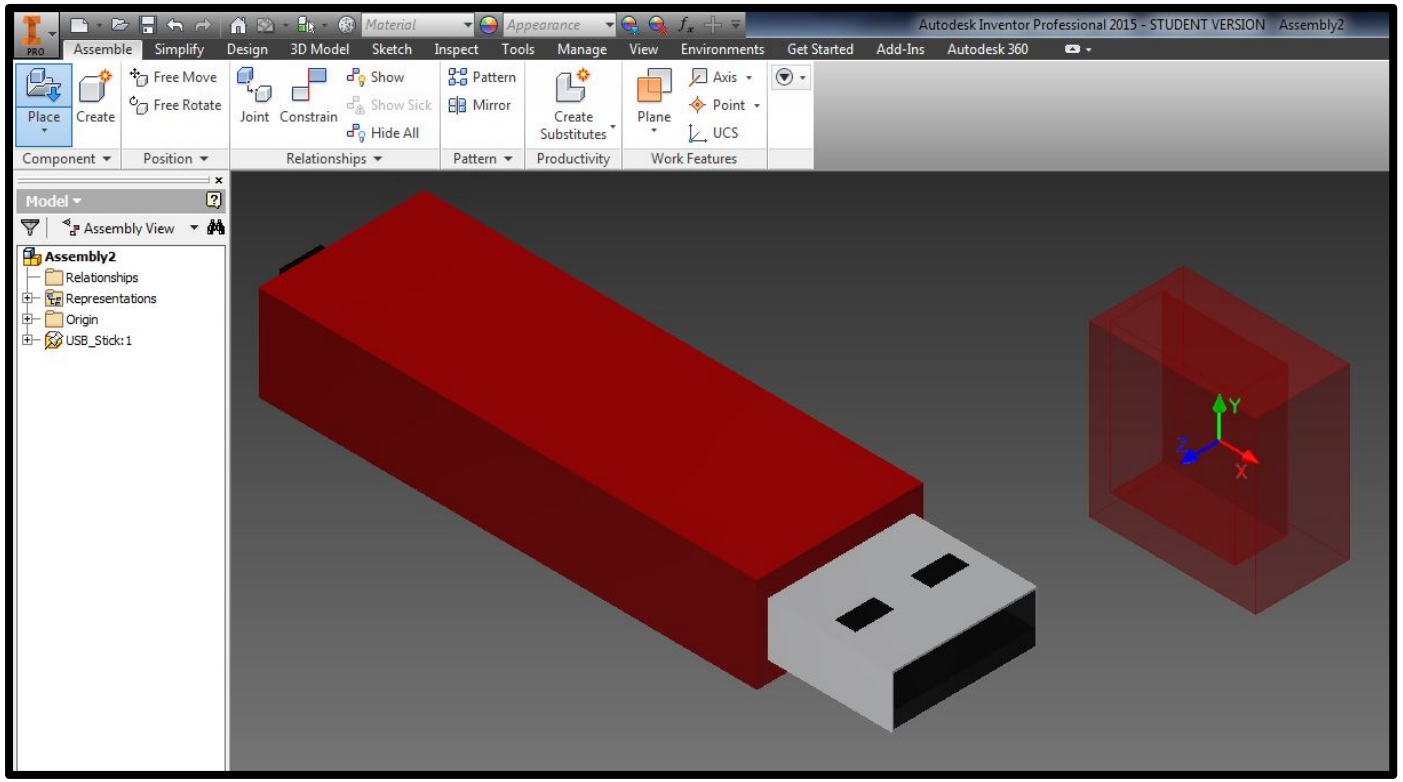
GROUND USB STICK AT ORIGIN

- Once you have imported your part file (it will appear as a **phantom component**) you will need to place it in the environment.
- For the USB stick component, right-click to use the '**Place Grounded at Origin**' option.



INSTANCE THE USB CAP

- The USB cap can be placed anywhere in the assembly environment.
- Left-click to place an **instance** of the component, then right-click ‘ok’ or press ‘esc’ to end the operation.

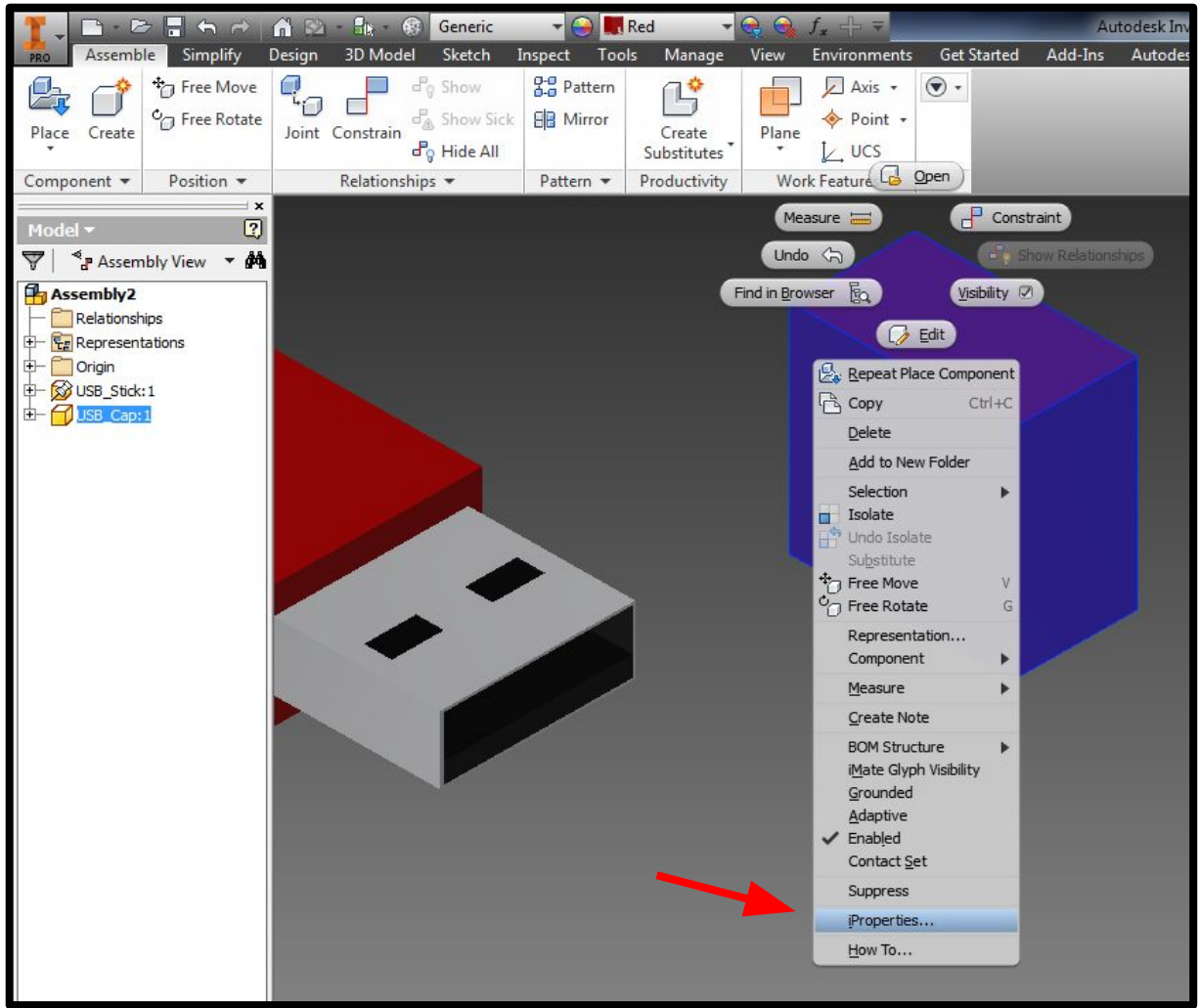


MORE ON PART PLACEMENT

- The assembly environment has a **universal** xyz coordinate system. While each part file will have its own **dedicated** xyz coordinate system that determines its orientation.
- Recall when you were in the parts module drew your profiles on origin planes.
  - How did you determine which ones you were going to use?
  - If you are going to import your part files should you consider their orientation?
- When you instance your part files, there are options available to **orientate** your components before instancing them (right-click to use the '**rotate 90 degrees**' options).
- However this might not be entirely useful when we start applying constraints onto our parts.

CHANGING PART PROPERTIES

- While in the assembly module you can still work on the individual components.
- Assess the iProperties of the USB cap to change its material.
- Right-click on the USB cap component.



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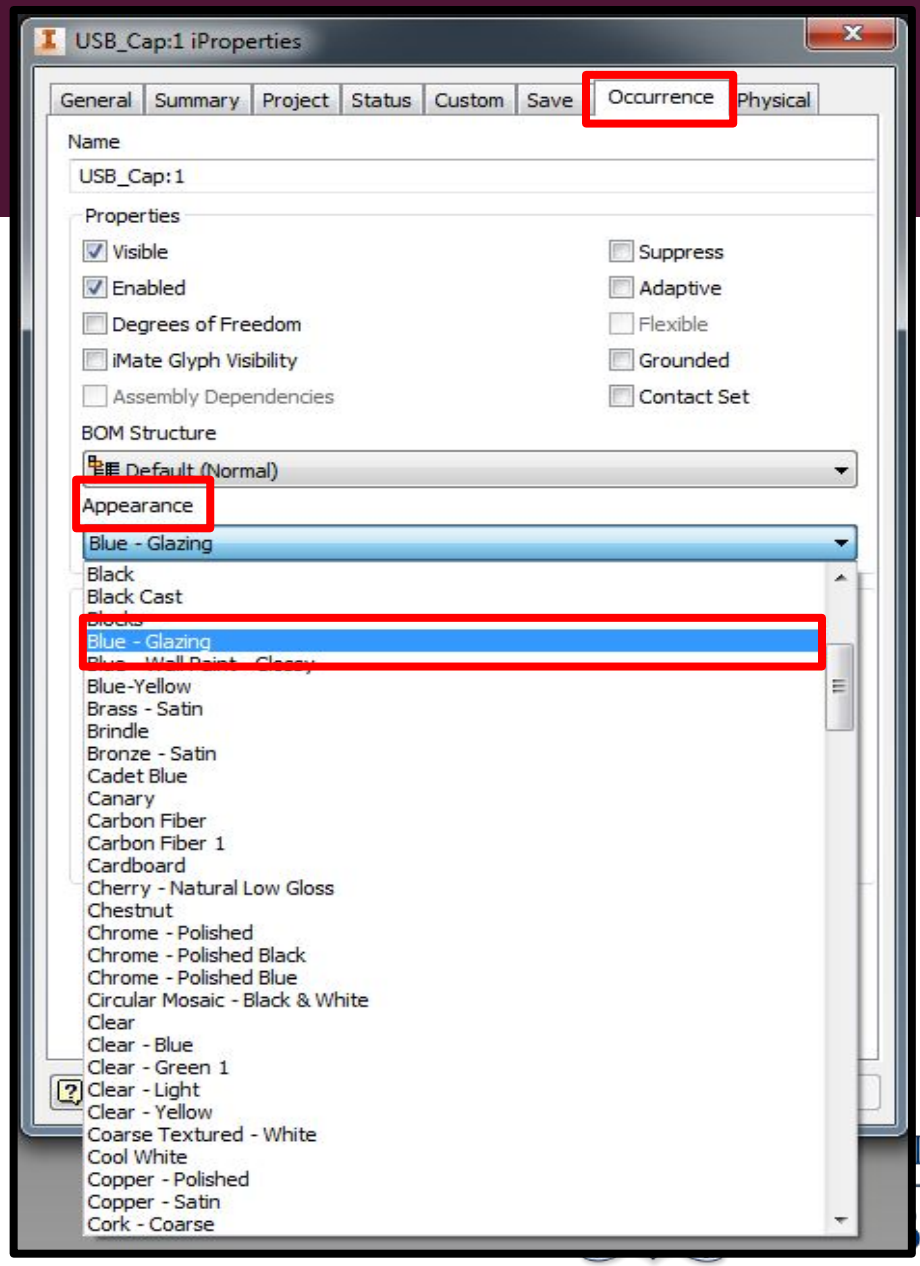
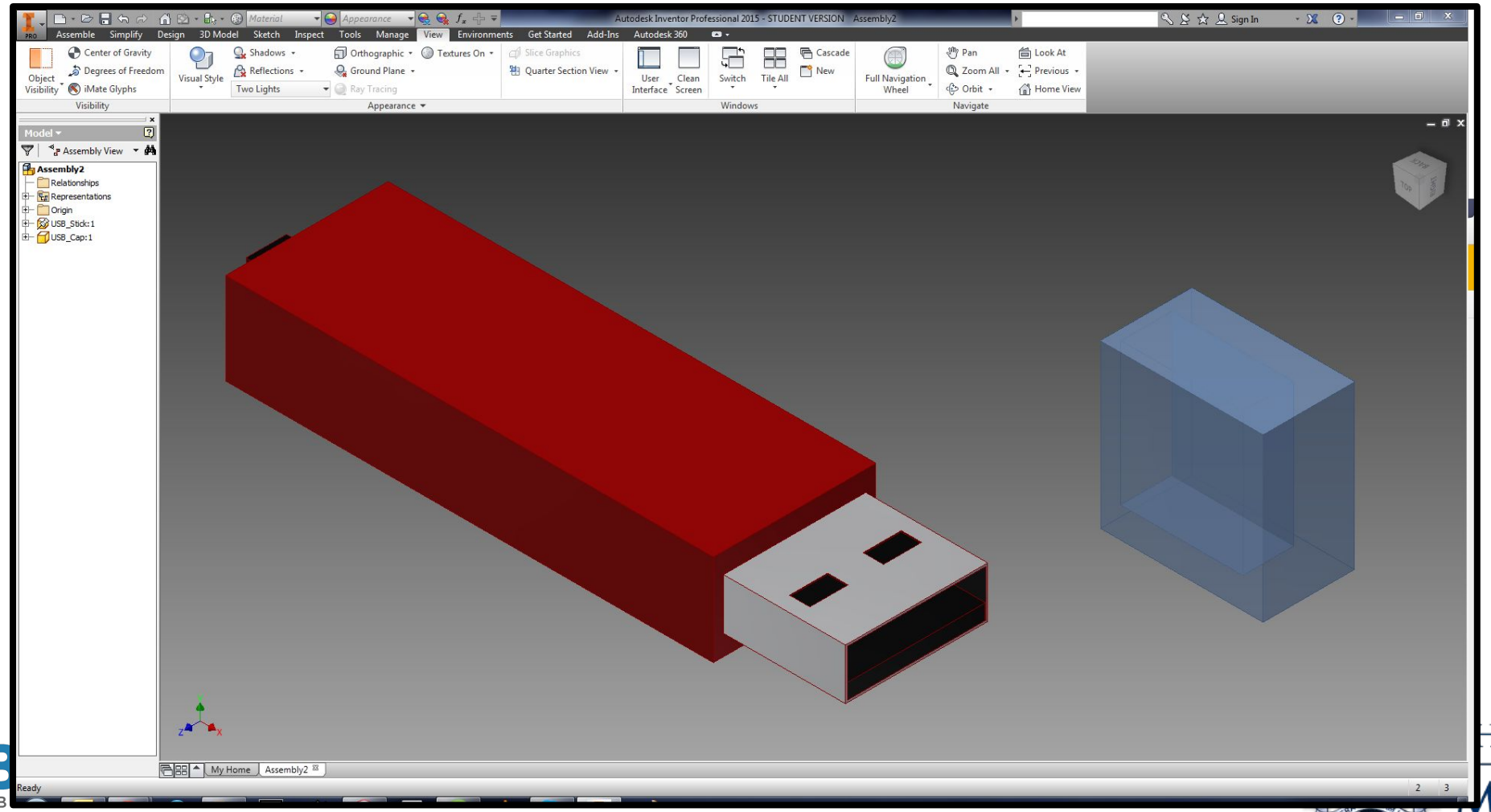
SELECT ‘BLUE - GLAZING’

- In the iProperties menu, under the **occurrence** tab.
- Go to **appearance**, and select the material ‘**Blue - Glazing**’ from the drop-down menu.



SAVE YOUR PROGRESS!



CONCLUSION

- You have been introduced to the assemblies module, where would will be handling **multiple** part files.
- You have learnt how to import files from a couple of different places: local files, content centre.
  - There are a range of standard parts provided in the content centre so you will not have to create these yourself.
- When you assemble your designs, you should have a think about the **order** in which you will import your part files. It is always good practice to **ground** a central component and be able to assemble about that.

JOINTS & CONSTRAINTS

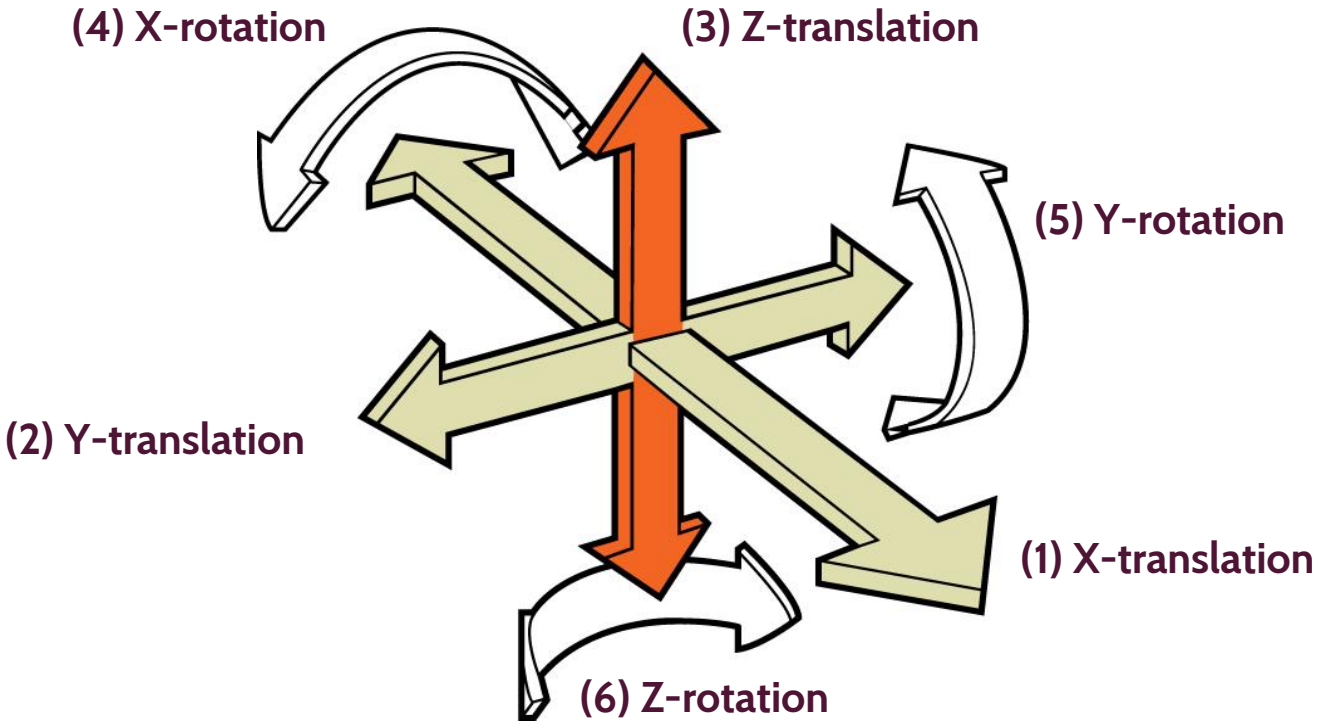
LESSON 7

MOTIVATION

- Aside from your grounded component all the parts you have imported are free to move around.
- When we start to start to assemble our designs, we want to connect them together such that they will only be able to move in the ways that we want them to.
- We will introduce joints and constraints to attach parts together and restrict how they move in space.
- We will focus more on using constraint in this course rather than joint commands. Applying constraints will give you a better understanding and more control over how these models are assembled.

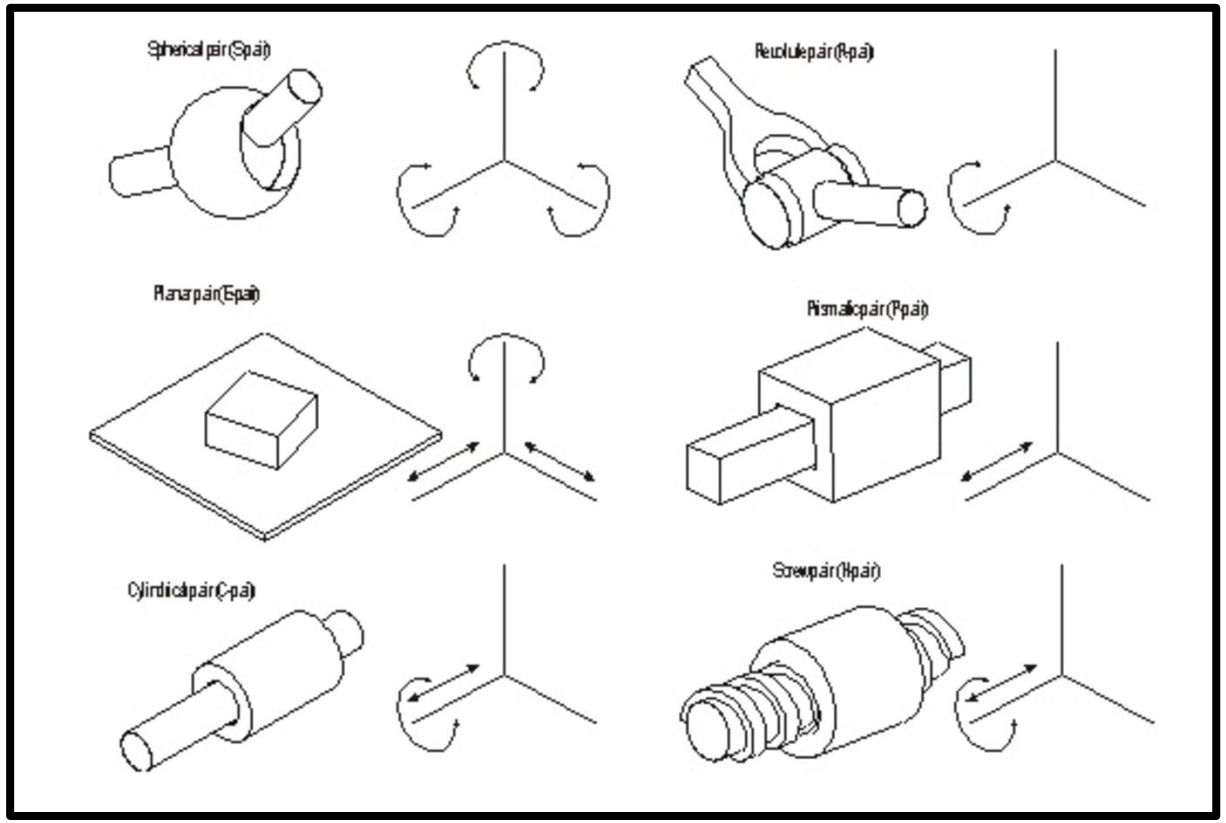
SOME BACKGROUND INFORMATION

- In a 3D environment, a component that is **completely free** can exhibit six types of motion, also known as, its **six degrees of freedom.**



SOME BACKGROUND INFORMATION

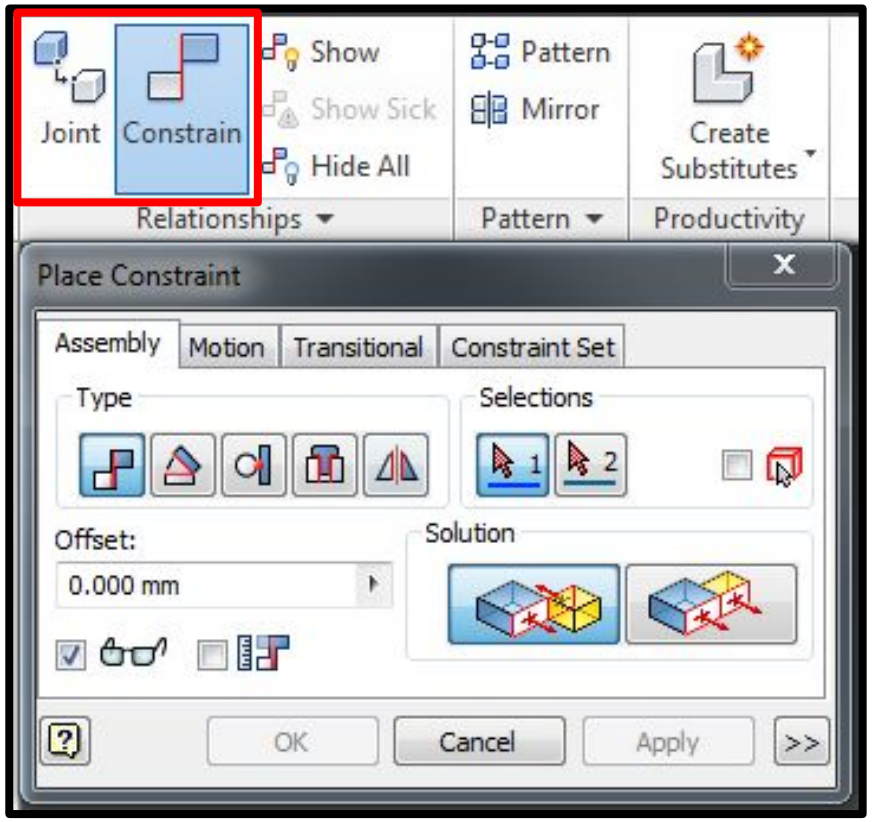
- There are six common types of joints in mechanical dynamics, which can apply to your designs.



https://au.pinterest.com/pin/344877283939870568

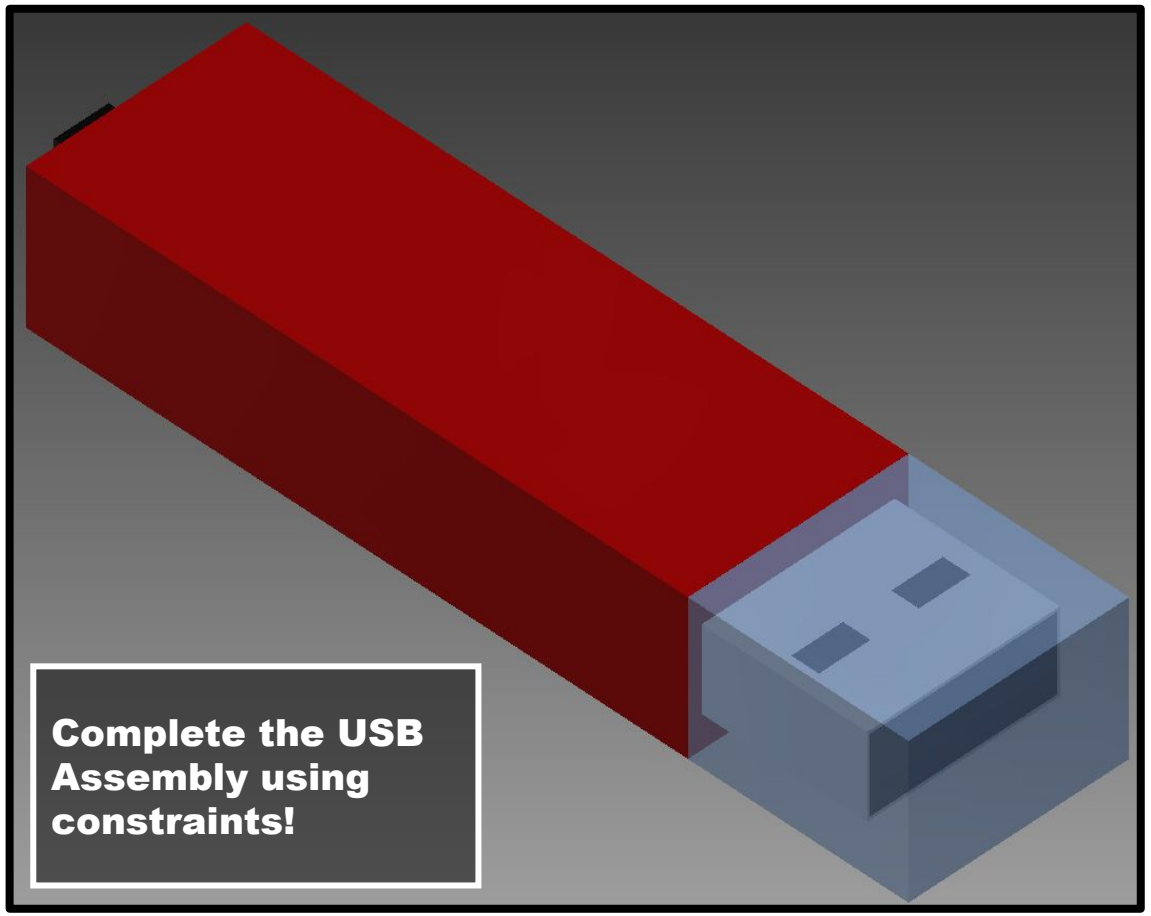
JOINTS AND CONSTRAINTS

- Joints and constraints in the assembly module create relationships that determine the placement of components and their movement with respect to each other.
- When we apply constraints we are gradually removing the available degrees of freedom (i.e. translation and rotation about the xyz axis).
- Joints are pre-defined connections between two components.



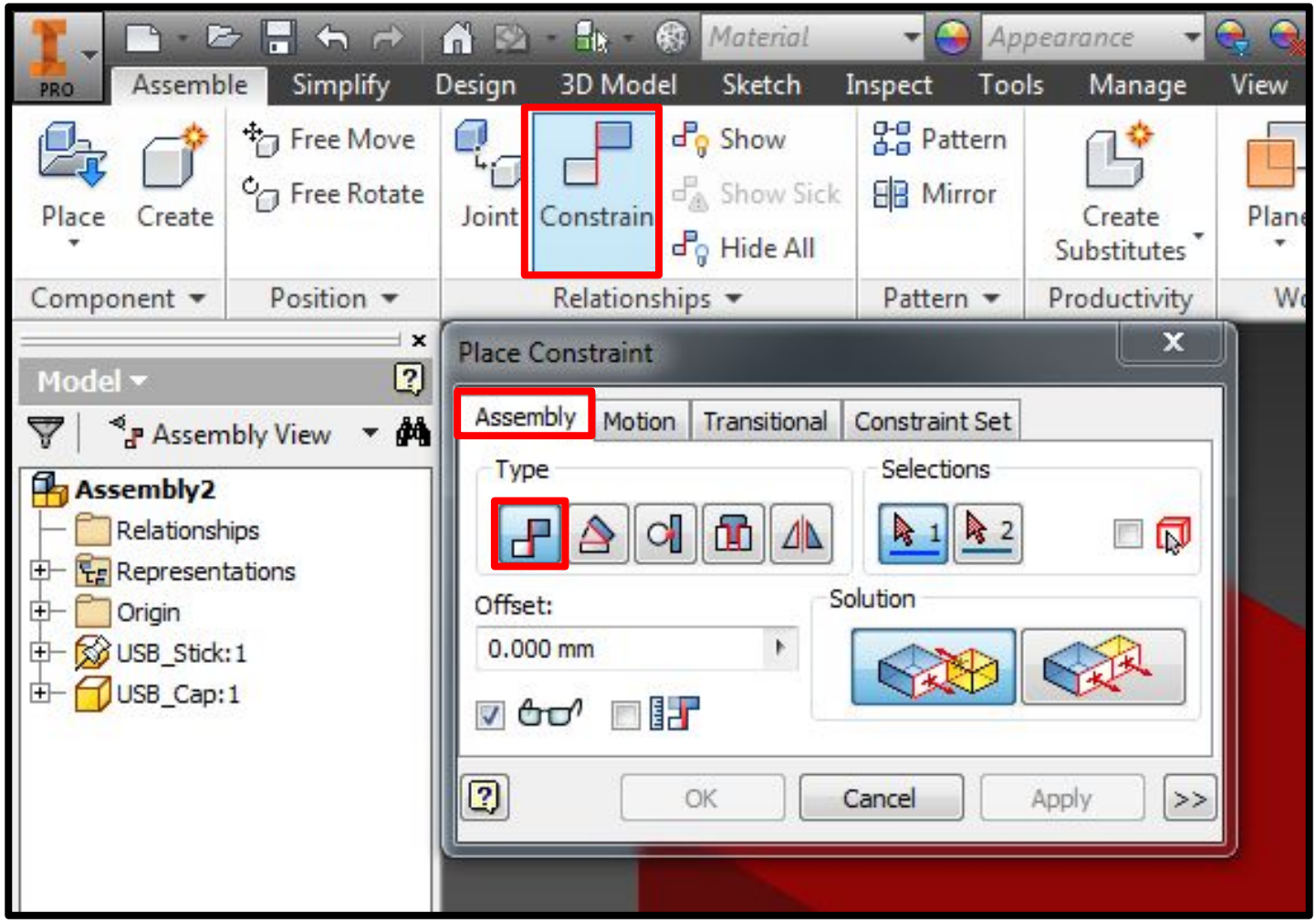
EXAMPLE: USB

- We will be applying a number of **constraints** to assemble the USB, by connecting the cap to the stick.



APPLYING CONSTRAINTS

- Select the constraint, which will place two **surfaces** on the same **plane of action** according to their surface **normal**. *Their surface normal will point in the same or opposite directions.*
- To place them exactly on the same place, we will relate them with no **offset** distance.



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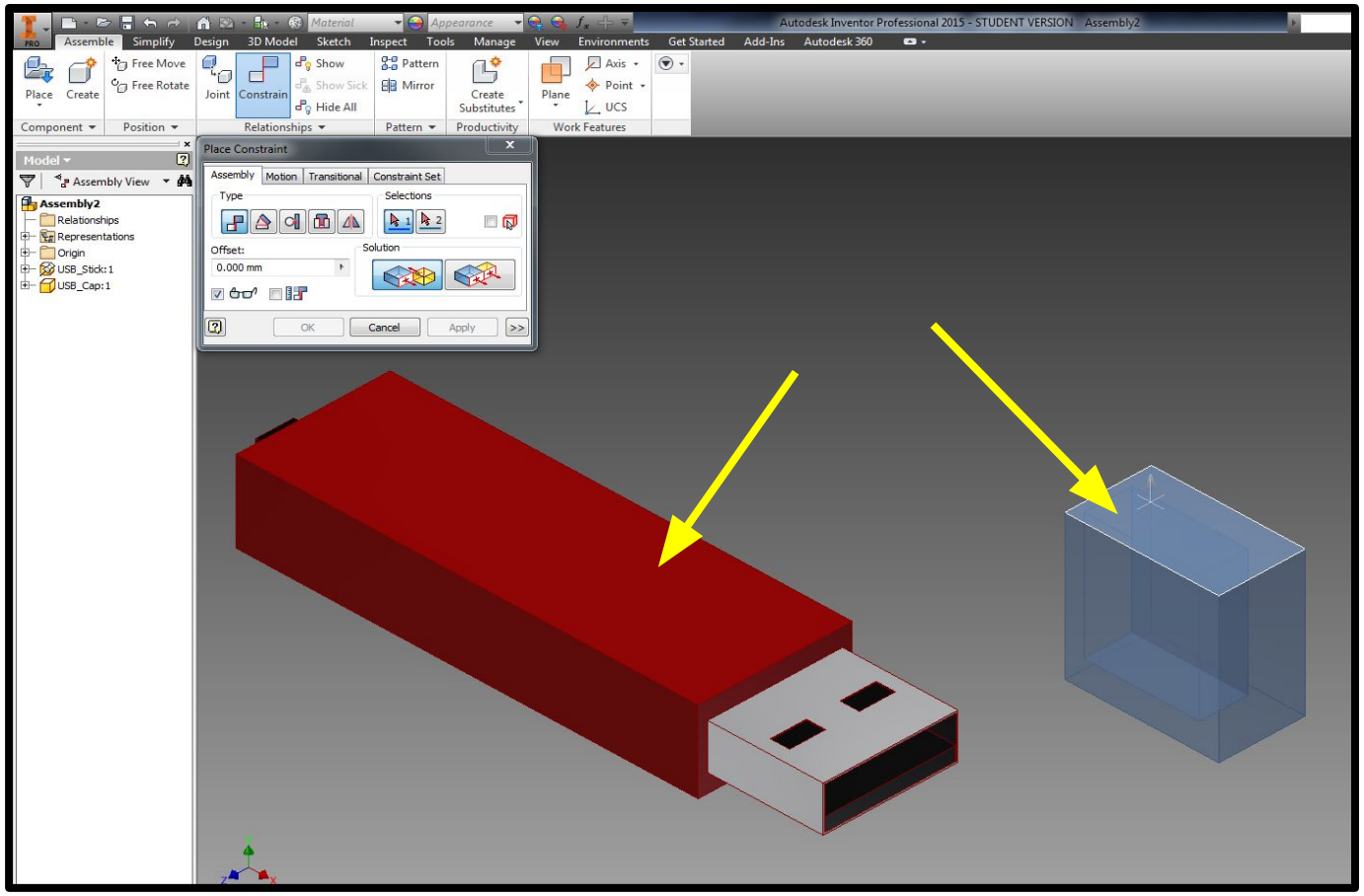
SELECT THE CONSTRAINT SURFACES

- Select the surfaces of the stick and the cap that you want to constrain.



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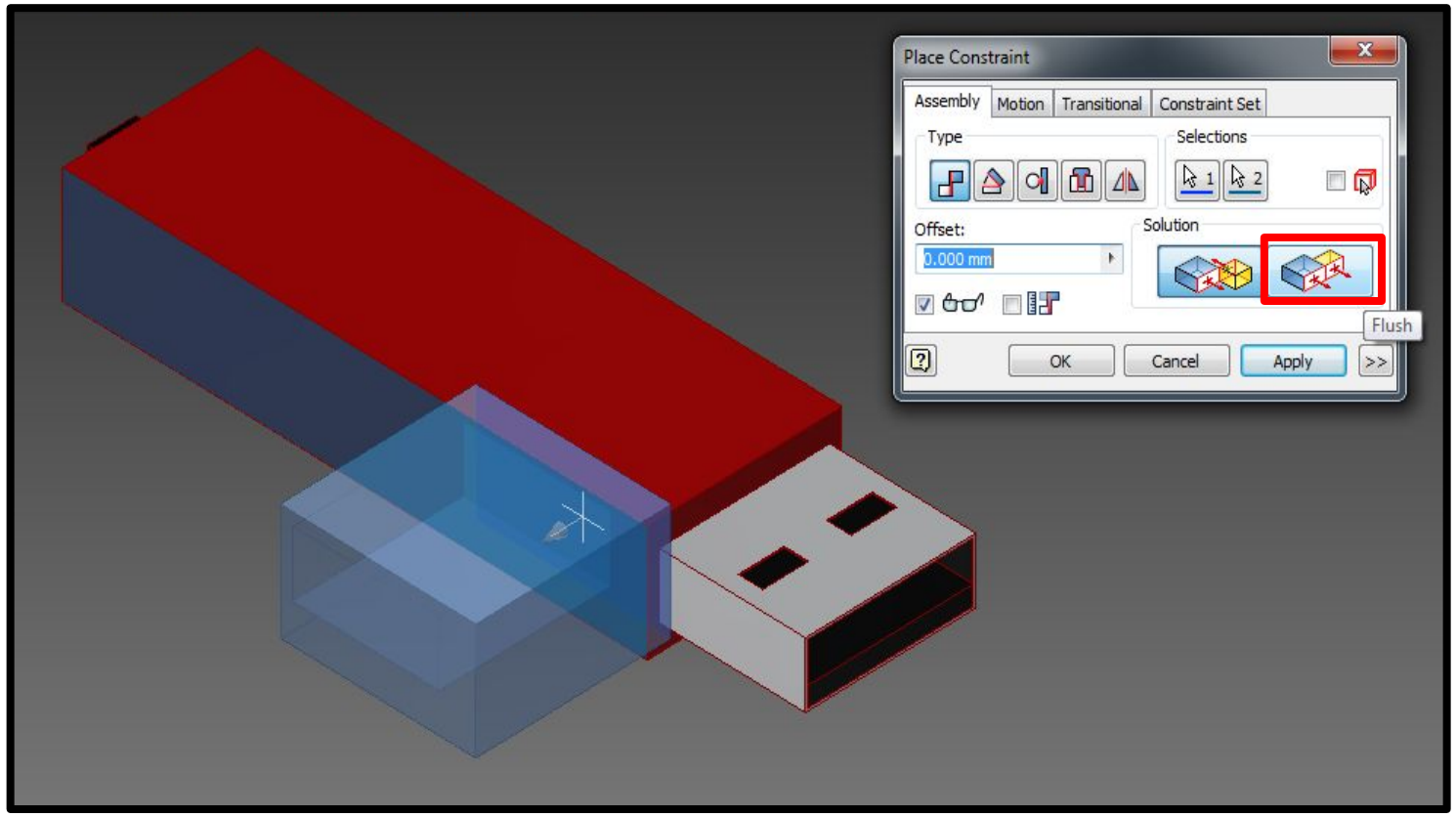
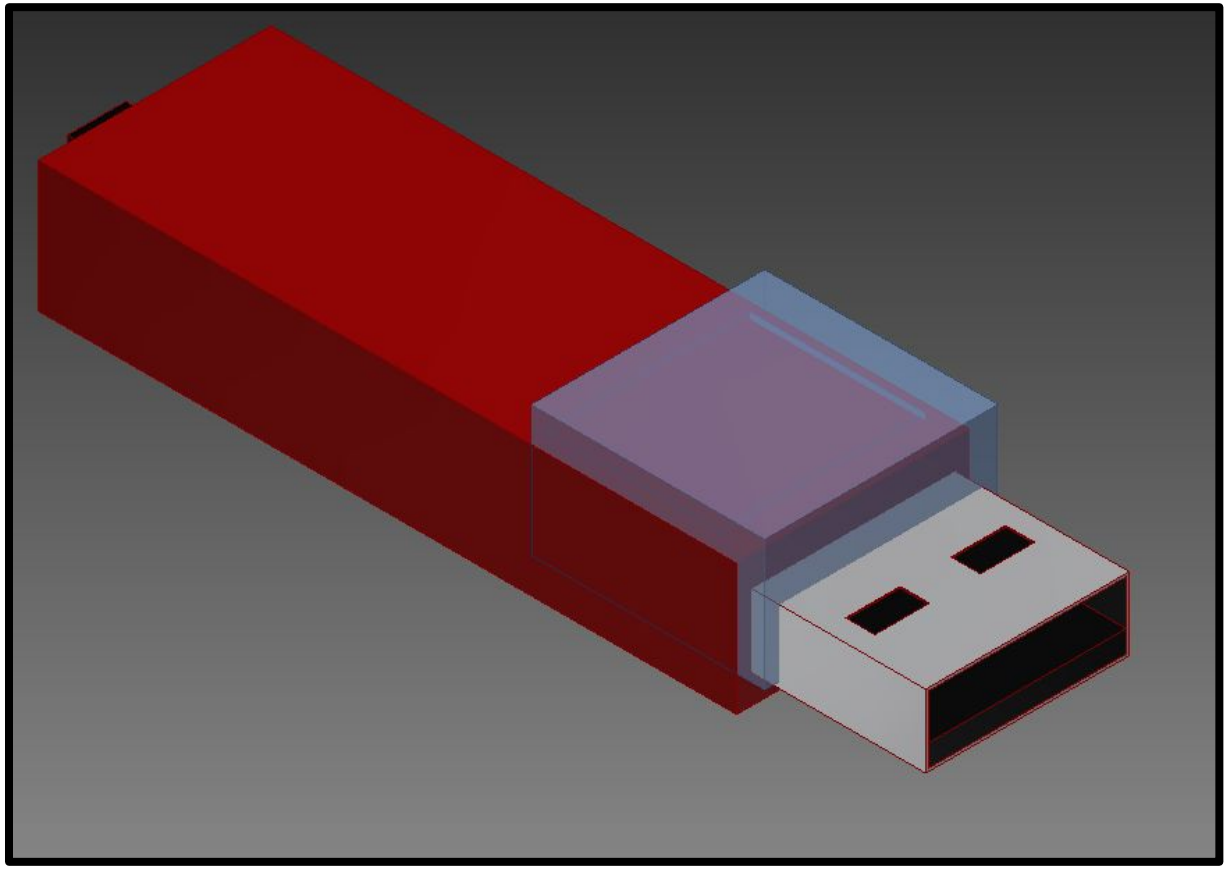
SELECT THE FLUSH CONSTRAINT

- Select the **flush** constraint to have both surface normal pointing in the same direction.



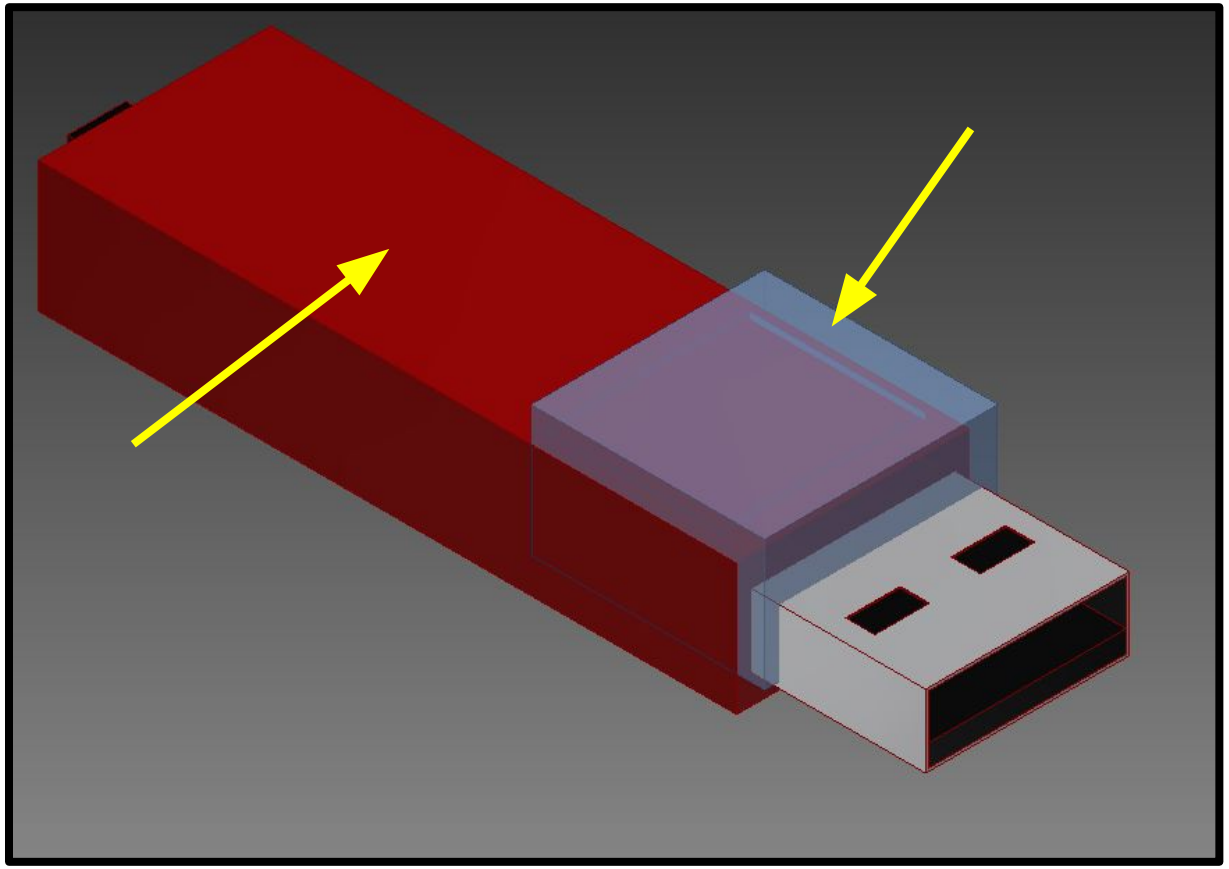
FLUSH CONSTRAINT

- You should now have both surfaces constrained on the same plane. Because of this your parts have over-lapped, *you can move the cap around if you want*.



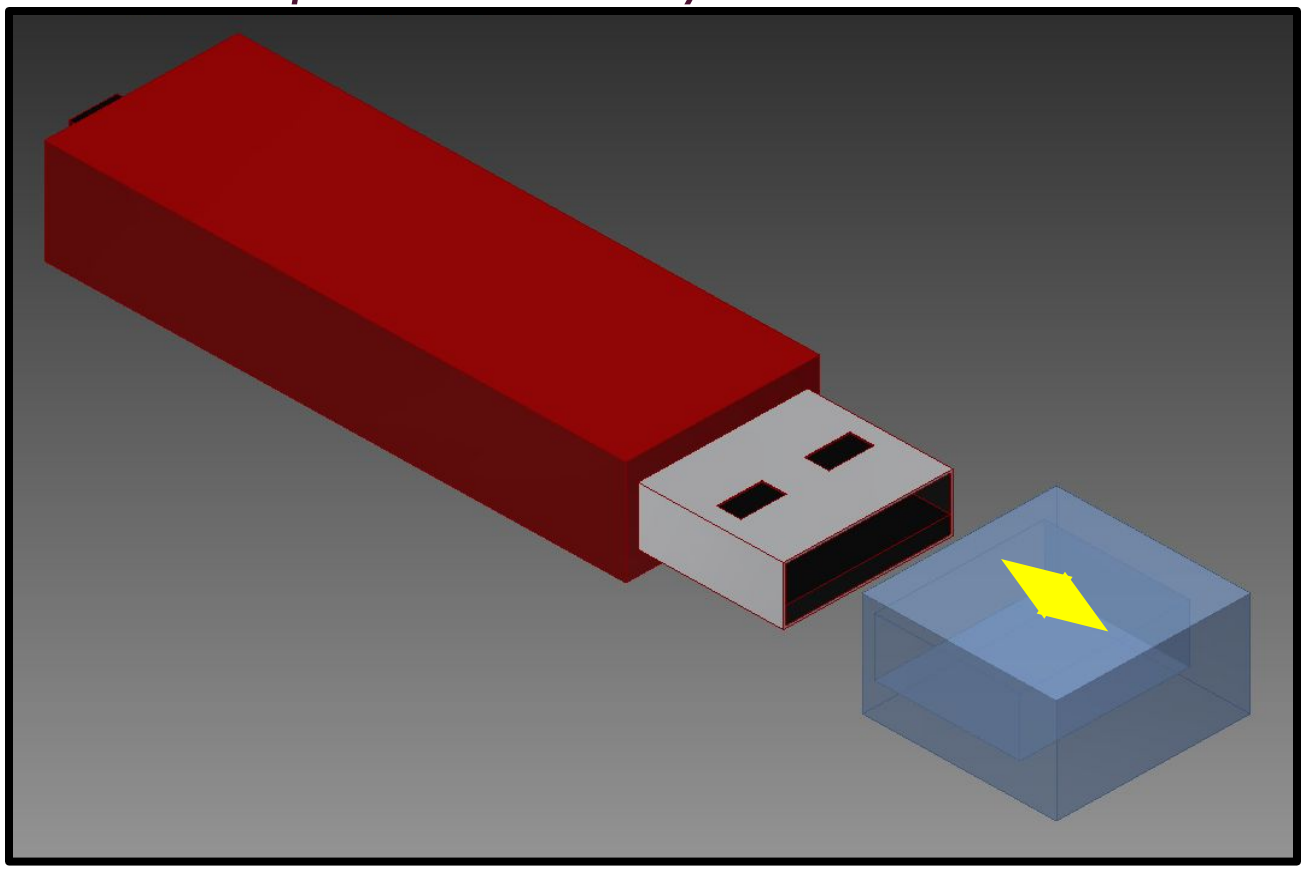
REPEAT FLUSH CONSTRAINT

- Repeat the **flush** constraint for the top surfaces.



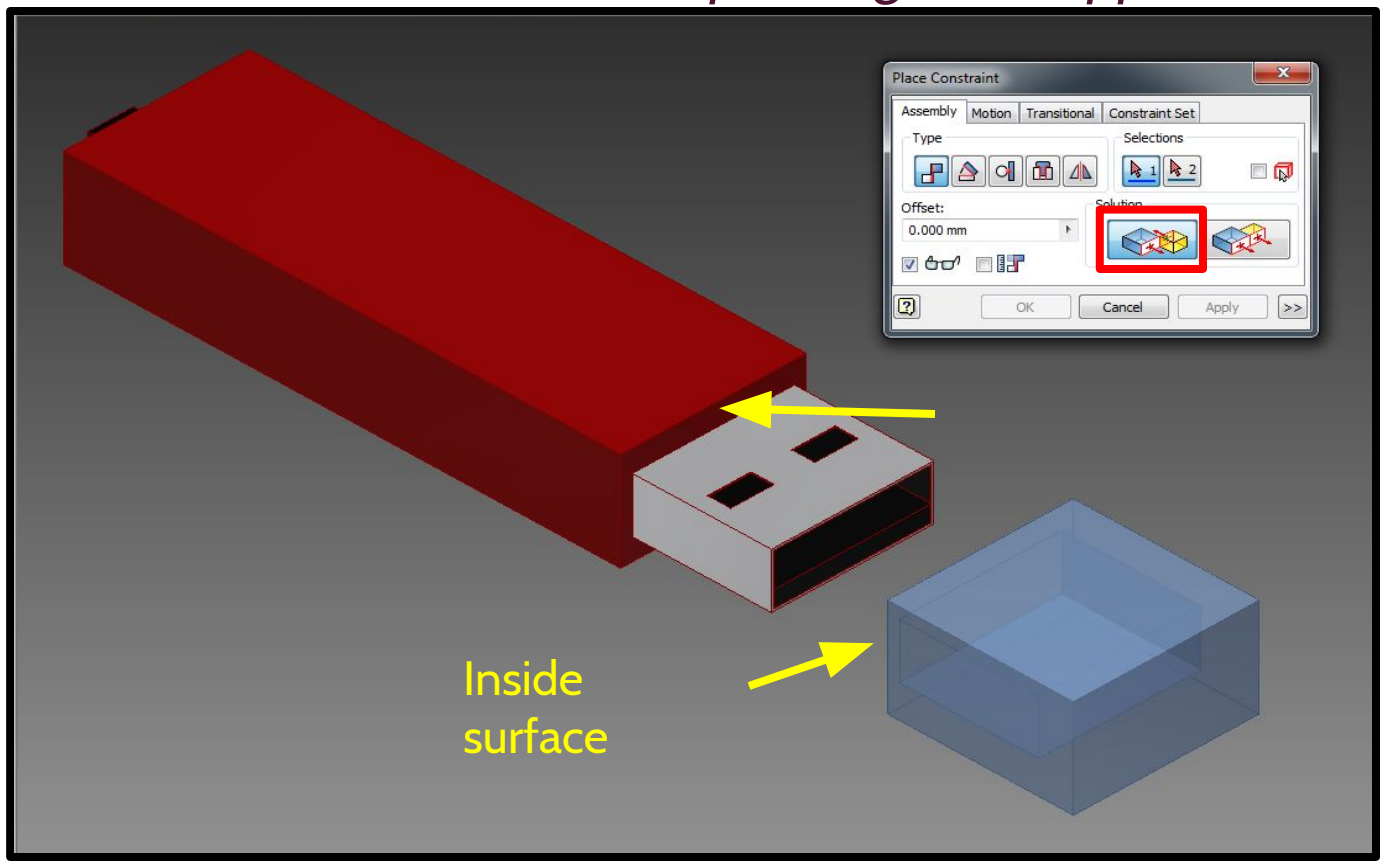
REPEAT FLUSH CONSTRAINT

- Both parts should now be constrained in two surfaces which has limited it to only one degree of freedom. *The cap can slide in only one direction*.



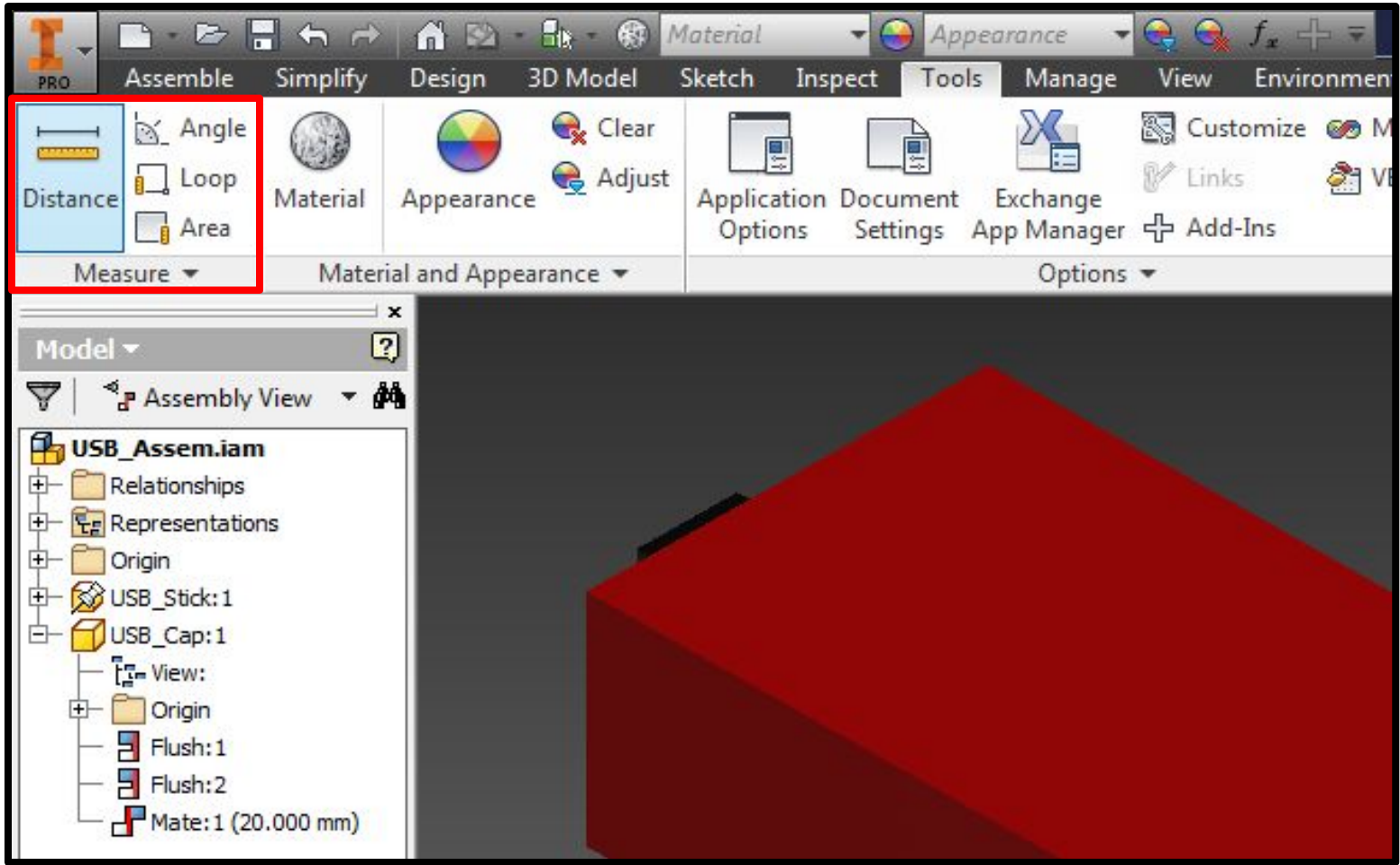
APPLY CLOSING CONSTRAINT

- Apply a closing constraint that will lock the cap onto the stick. *You will need to use a **mate** constraint that will have the surface normal pointing in the opposite directions.*



ANALYSING ASSEMBLIES

- The **measurement** tools in the assembly module that enable you to examine your design and ensure that it has been put together accurately.
- You can measure: **distances, surface areas** and **angles.**



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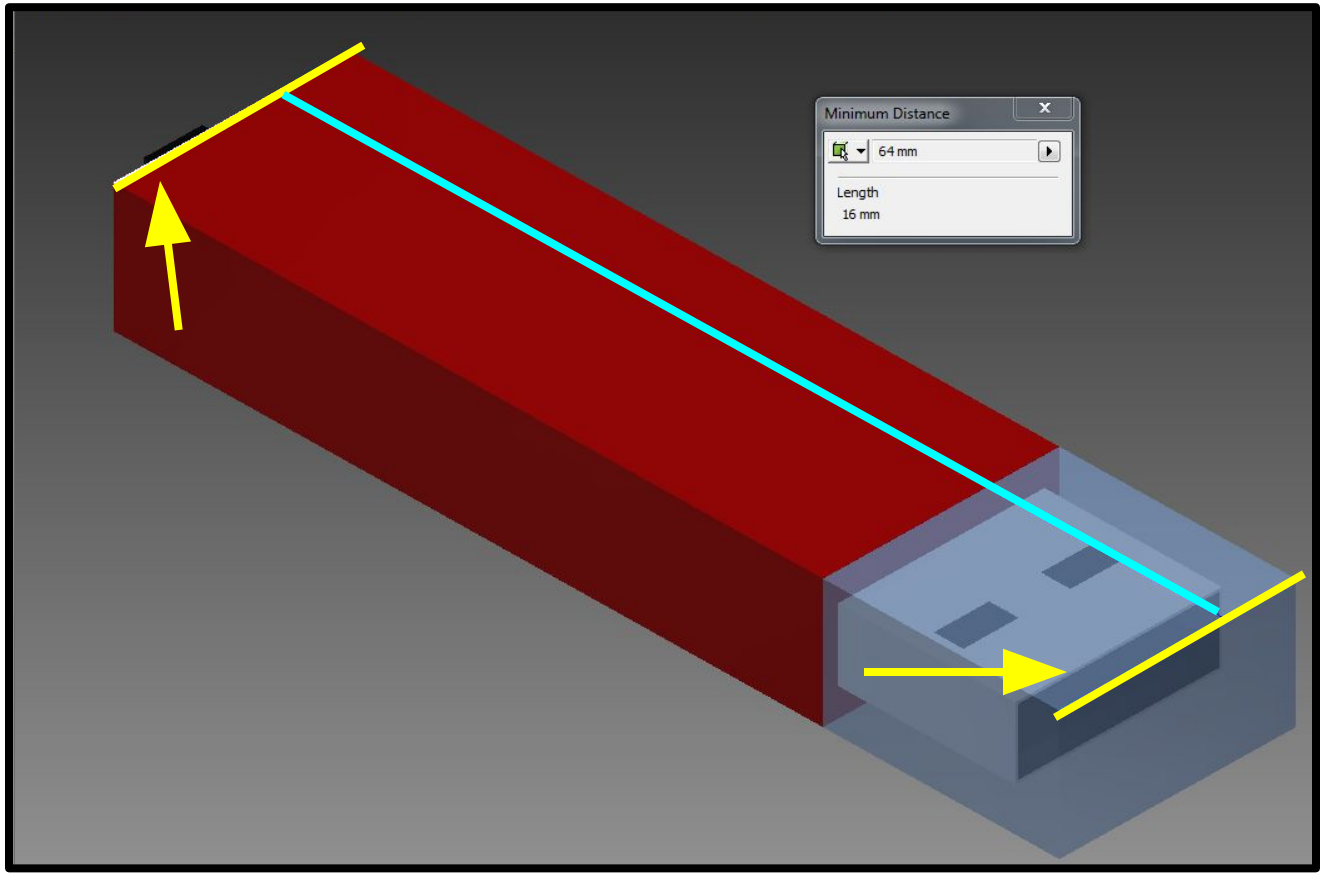
USING THE DISTANCE TOOL

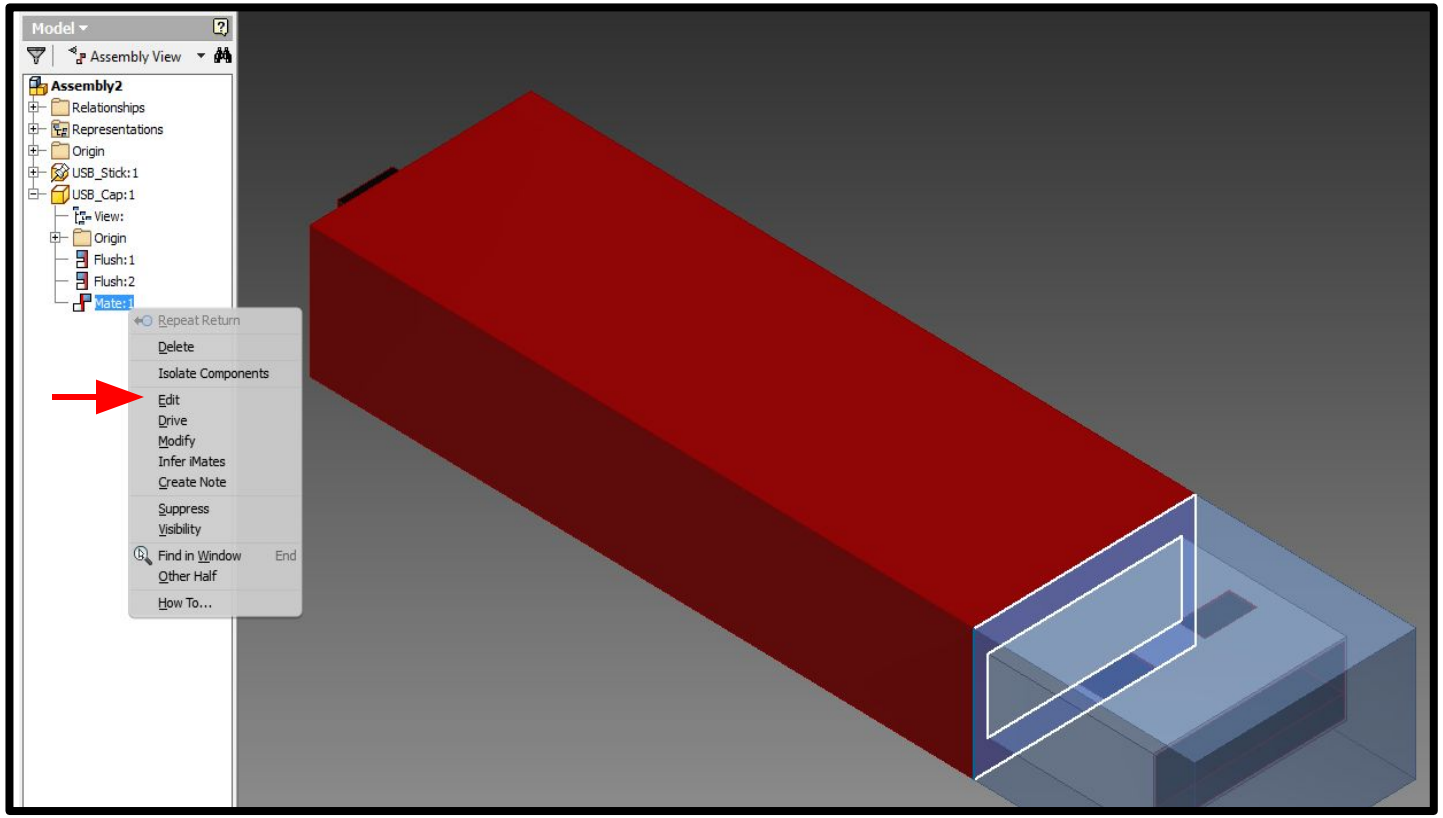
- Select two edges to get the minimum distance.



Distance of edges: 64cm
Length of edge: 16cm

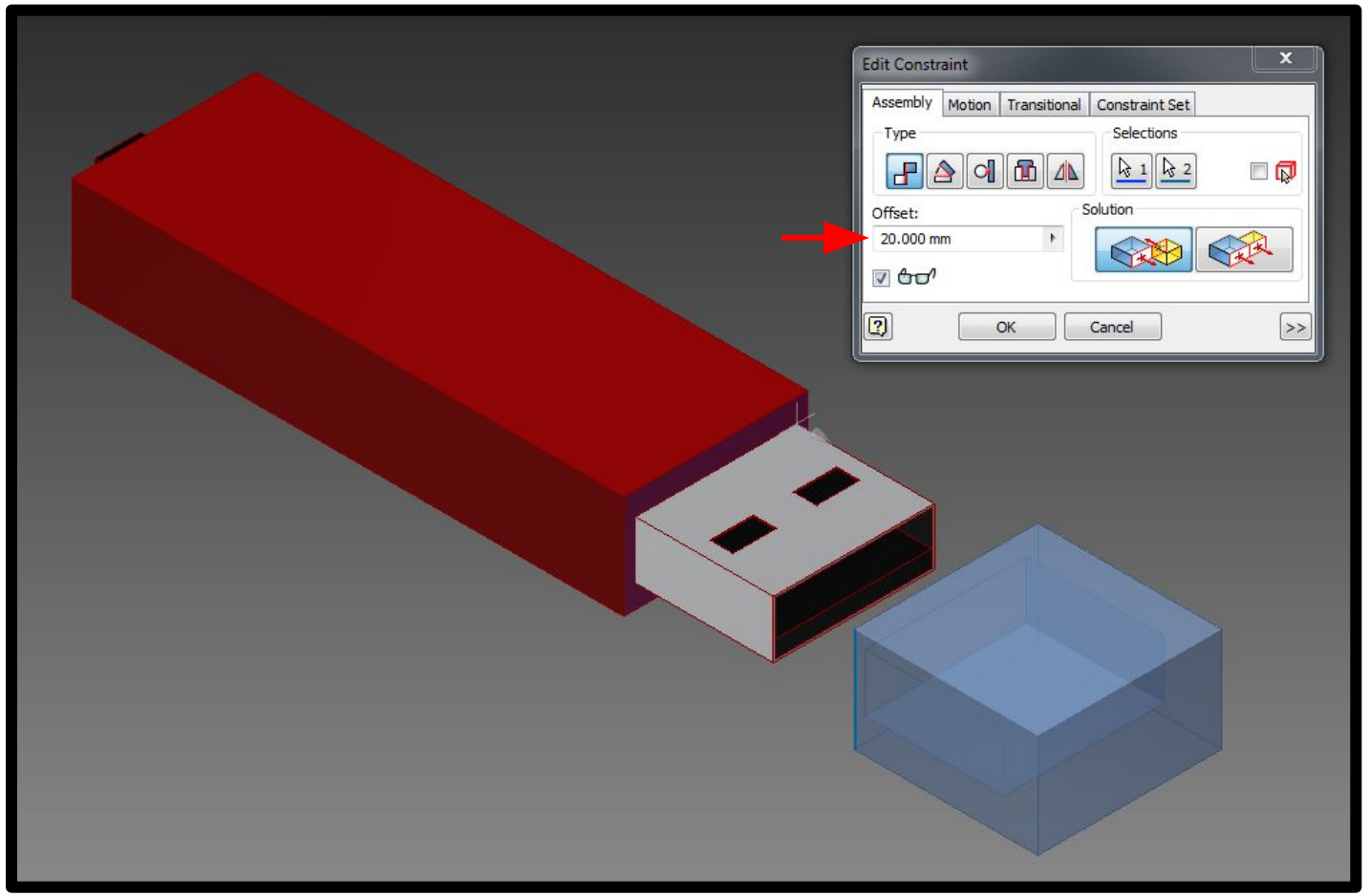
EDITING CONSTRAINTS

- So if we were to measure the distances and find that this is not what we wanted for out design, we will need to go back and edit our constraints.
- Let's edit the closing mate. *Right-click on **Mate:1** in the model browser to edit.*

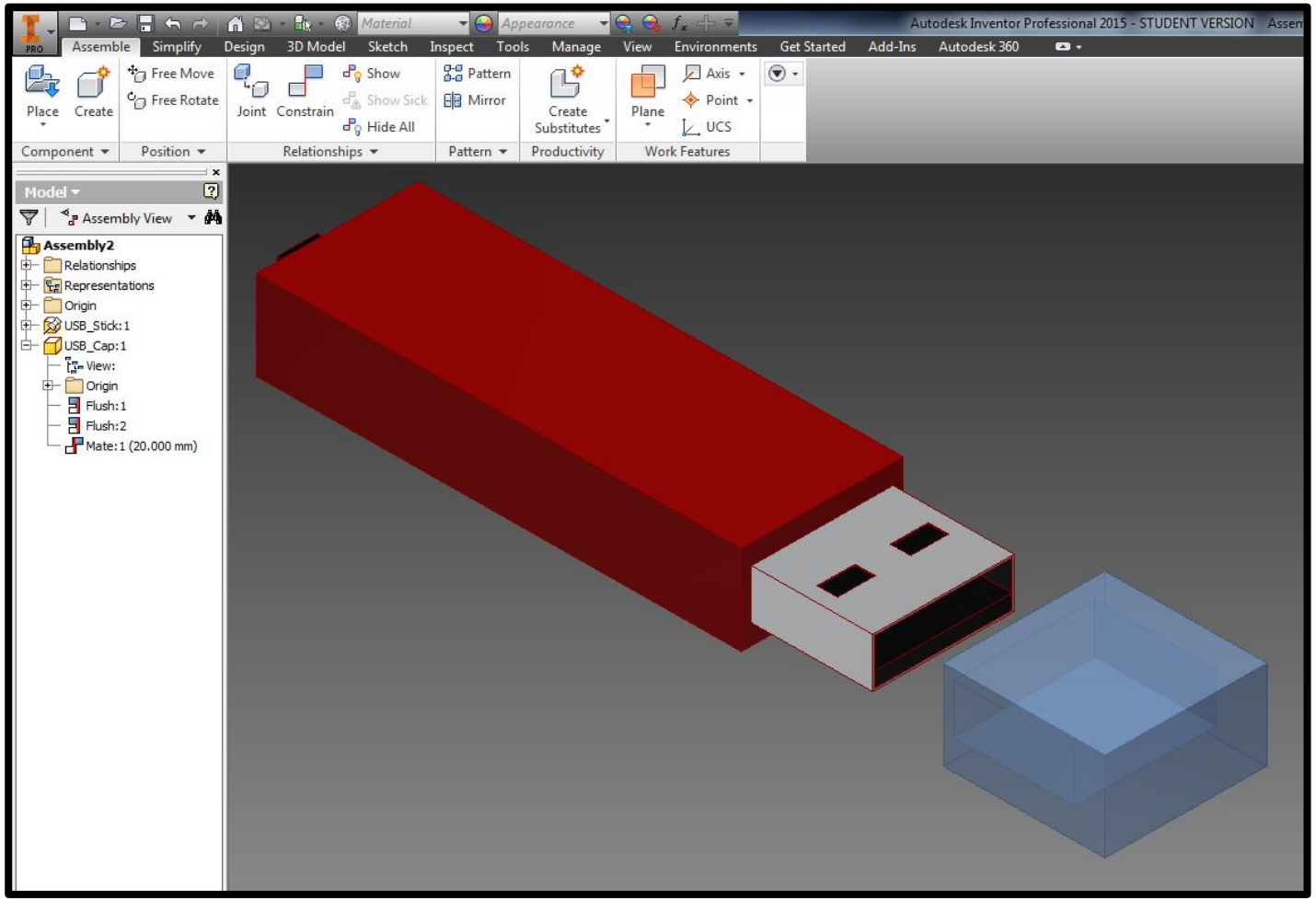


EDITING CONSTRAINTS

- Apply a 20mm **offset** to the mate.



SAVE YOUR PROGRESS!



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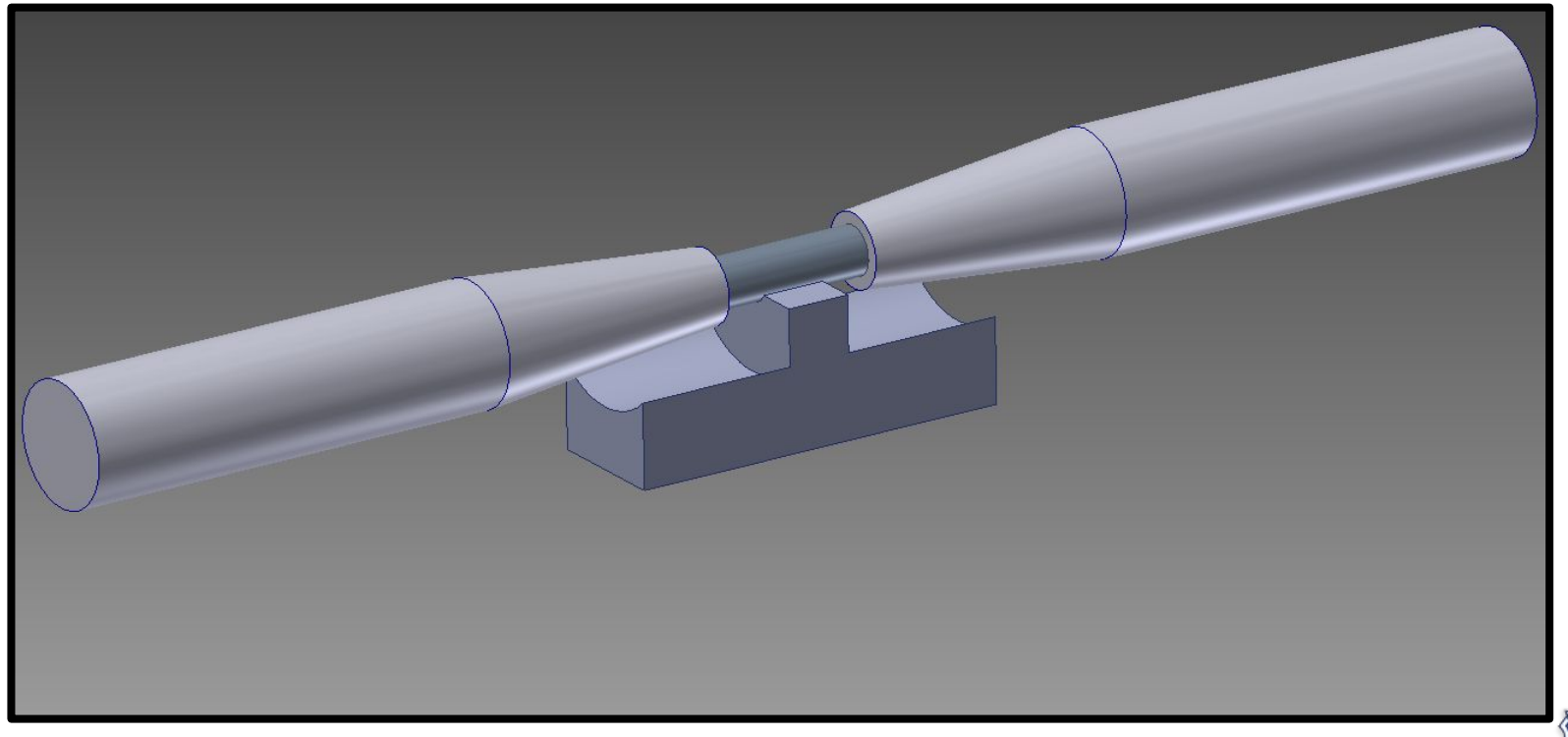
WORKSHOP CHALLENGE 1

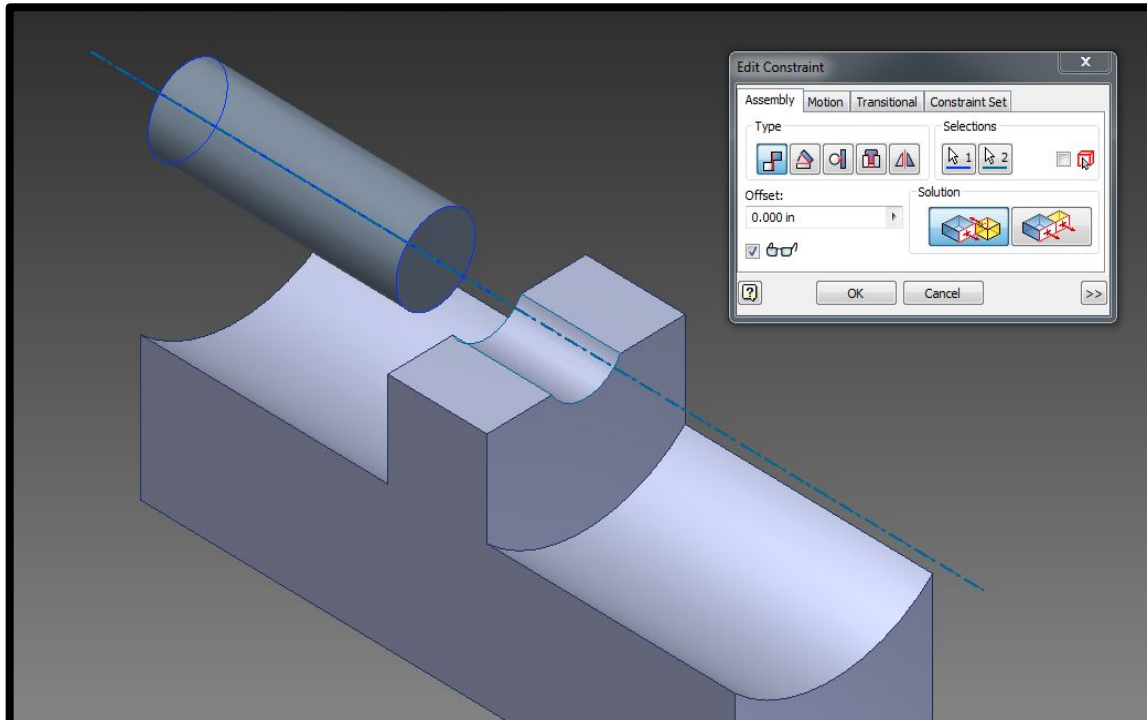
- Try to assemble the experiment example we presented before.
- *All part files can be found in "05_Assembly" folder of the downloaded materials.*



WORKSHOP CHALLENGE 1 REVIEW

- We will do a demonstration of how to assemble this design.
- It is possible to constrain **axis** by selecting **curved** surfaces, *because these are surfaces that will not have a distinct surface normal.*

- A few tips that can be helpful:
  - Think about the design first, and determine which part file you will import first as your grounded component.
  - The grounded component should be the **centre piece** of your design, i.e. you will assemble other components around your grounded component.
  - Maybe import one part file at a time, and fully constrain them when possible to remove clutter from your work space.



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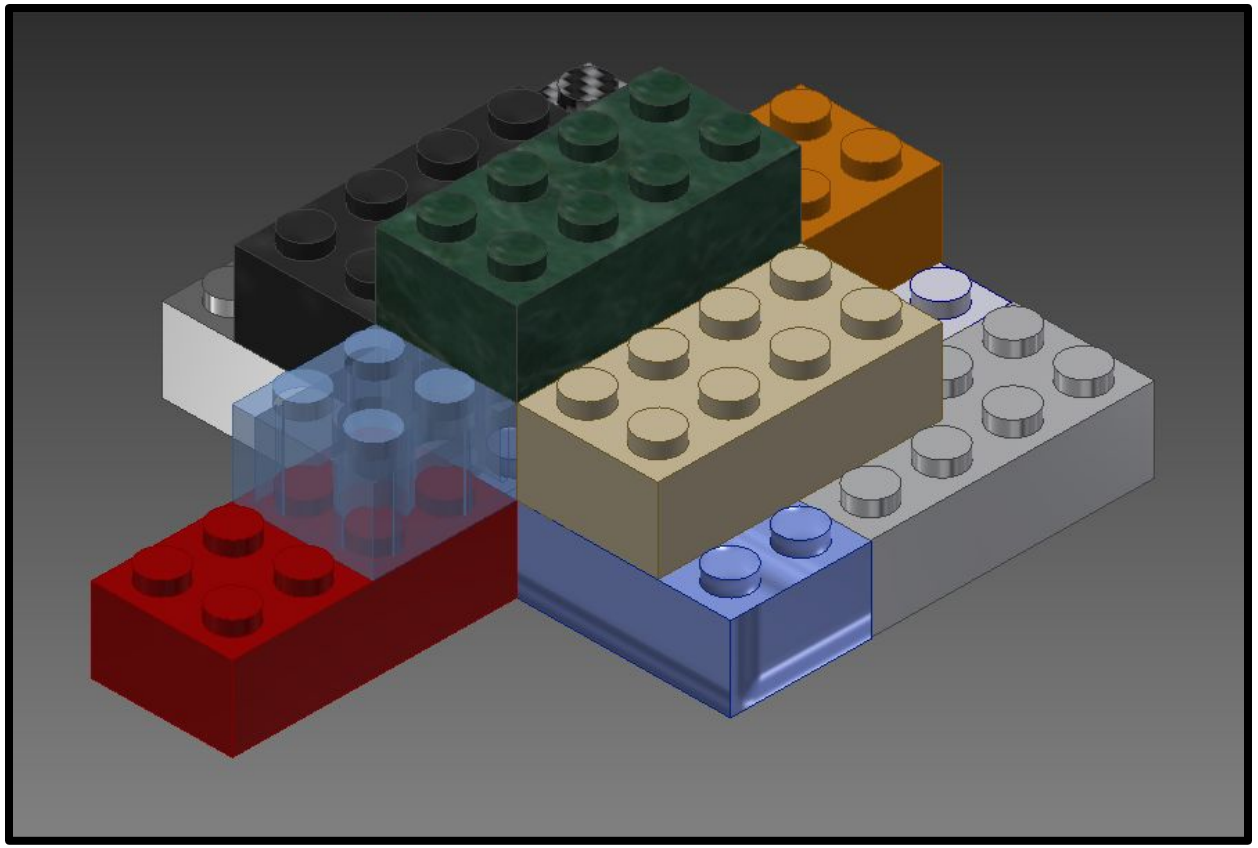
WORKSHOP CHALLENGE 2 (OPTIONAL)

- If you finish early, or want some extra practice. Start working on a creation with Lego blocks.
- *All part files can be found in "05_Assembly" folder of the downloaded materials.*



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CONCLUSION

- You have taken the first steps towards putting together design projects.
- We covered the basics for how to put together your design.
- We used an example of a USB which only had **two** parts, but think about a more complex design which you could be doing.
  - How many constraint relationships would you need to apply?
  - Would using joint relationships be better?
- Something to think about:
  - In our USB example we looked a little bit at **offsets**, if we were to fabricate these designs could we realistically get an **offset of zero**?
  - Should you consider the **tolerance** when you fit two parts together.

ADVANCED ASSEMBLIES

LESSON 8

MOTIVATION

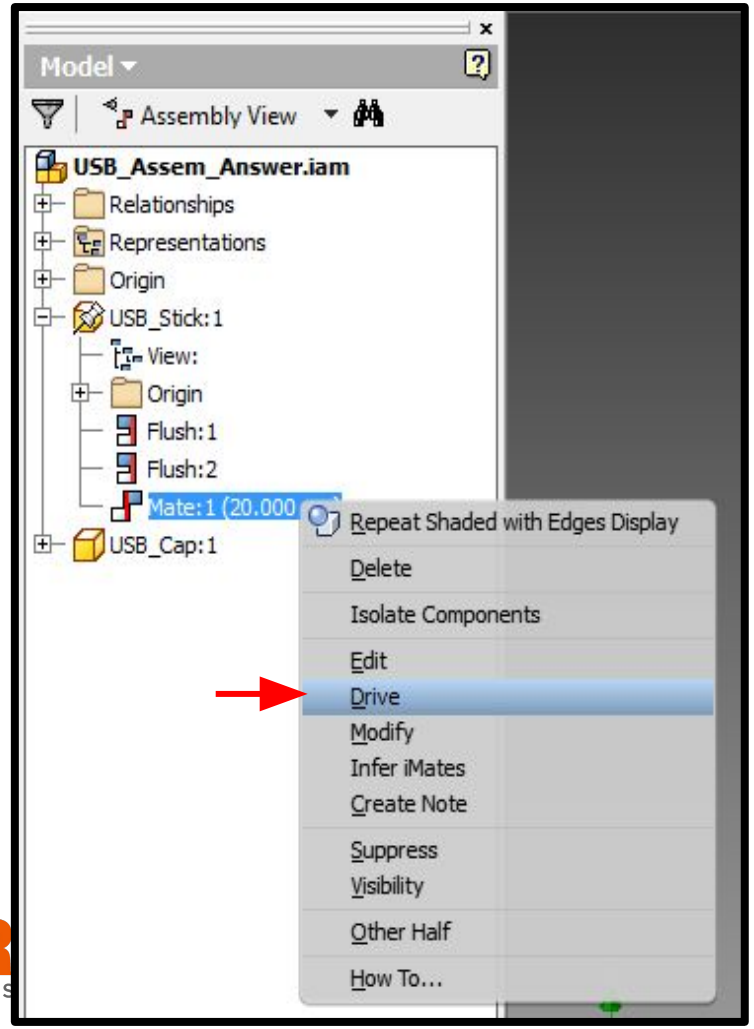
- Outside of assembling our design, we might also need to understand how well crafted our model is.
- One measure of this is to simulate the motion of components and test their limits.
- We will also explore other added features of the assemblies module, and how we can work simultaneously in the assemblies and part modules to integrate our design.

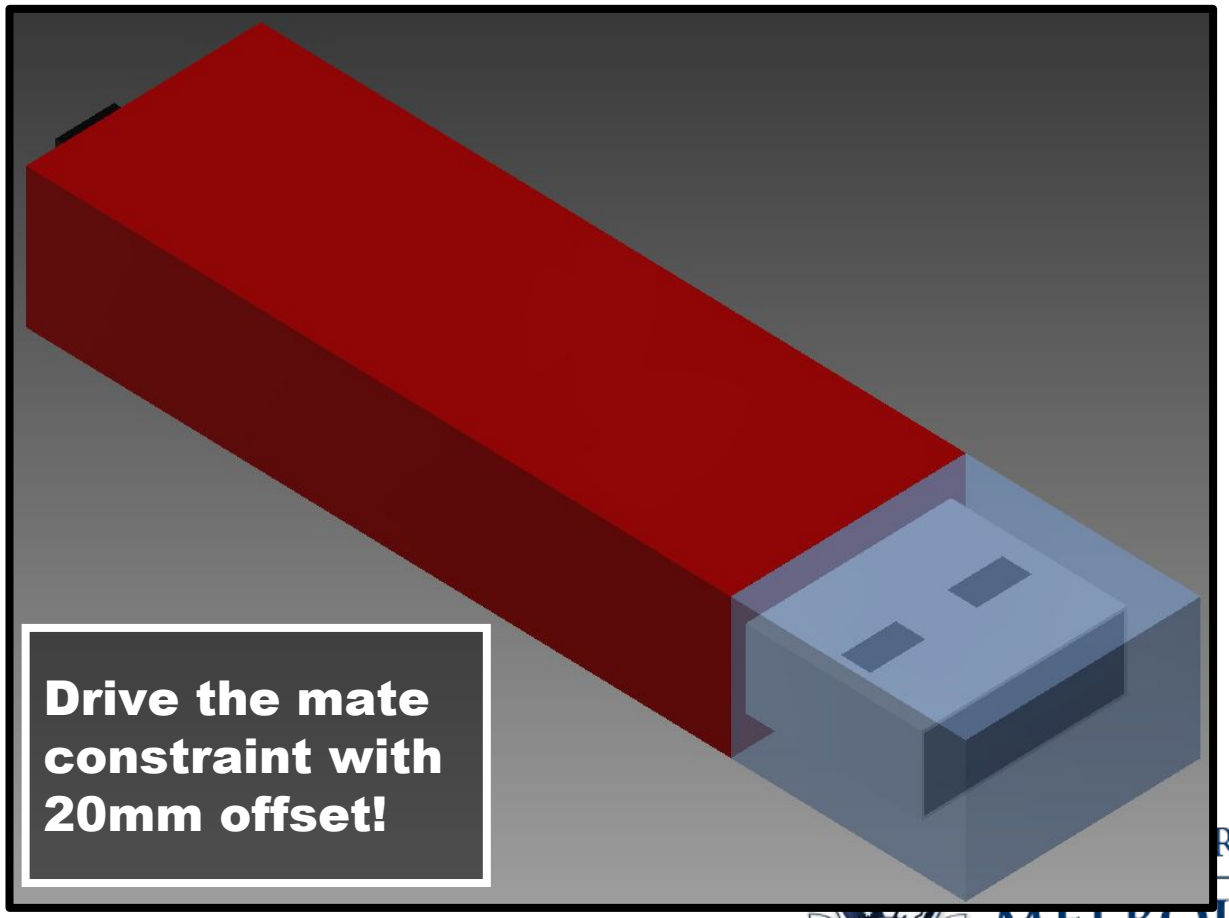
DRIVEN ASSEMBLIES

- To simulate function assemblies can be **driven.**
- Simulating the motion between two components by driving can also be used for collision detection.
- The driven constraints command can be found by right-clicking the constraint from the model browser and selecting the **drive** option.

- To demonstrate this, open the **USB_Assem_Answer.iam** file, *found in "05_Assembly" folder of the downloaded materials.*
- The constraint we will be driving is the closing mate, **mate:1.**

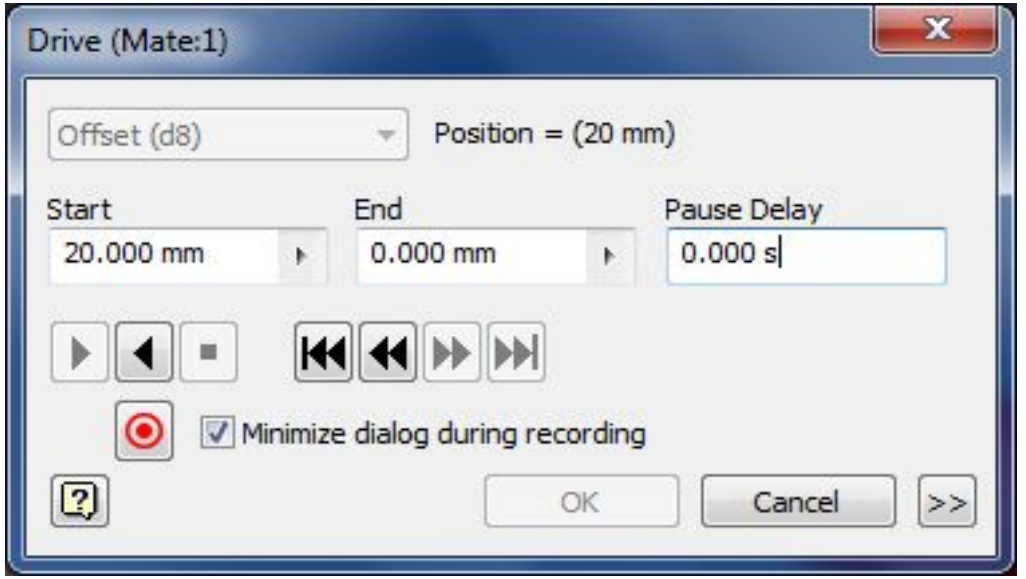
EXAMPLE: USB


Model
Assembly View
USB_Assem_Answer.iam
Relationships
Representations
Origin
USB_Stick:1
View:
Origin
Flush:1
Flush:2
Mate:1 (20.000
USB_Cap:1
Repeat Shaded with Edges Display
Delete
Isolate Components
Edit
Drive
Modify
Infer iMates
Create Note
Suppress
Visibility
Other Half
How To...


Drive the mate constraint with 20mm offset!

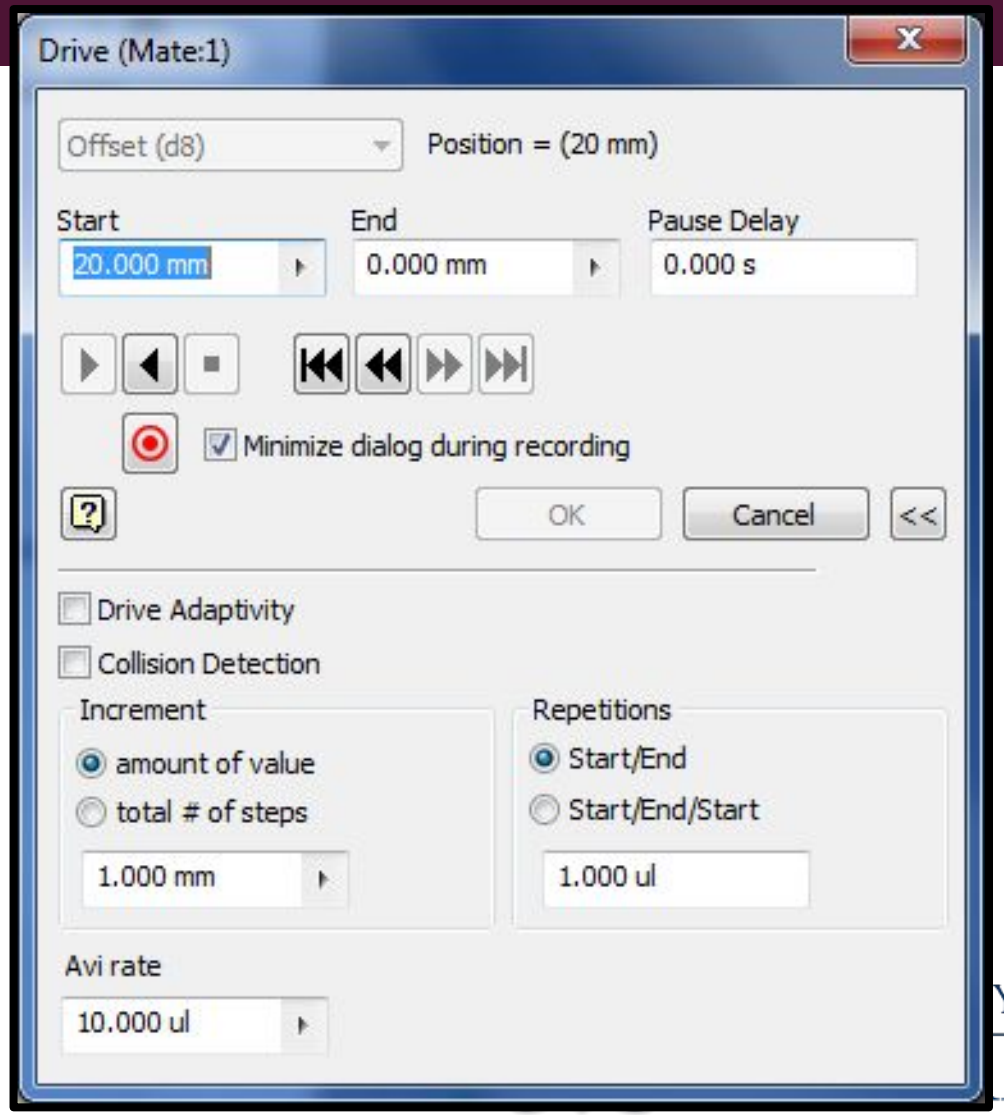
DRIVEN CONSTRAINTS

- Constraints can be driven in the **forward** or **reverse** direction, moving the components between a **start** and an **end** position.
- A pause delay can be added to slow down the motion if needed.
- The simulation motion can also be recorded to produce videos.



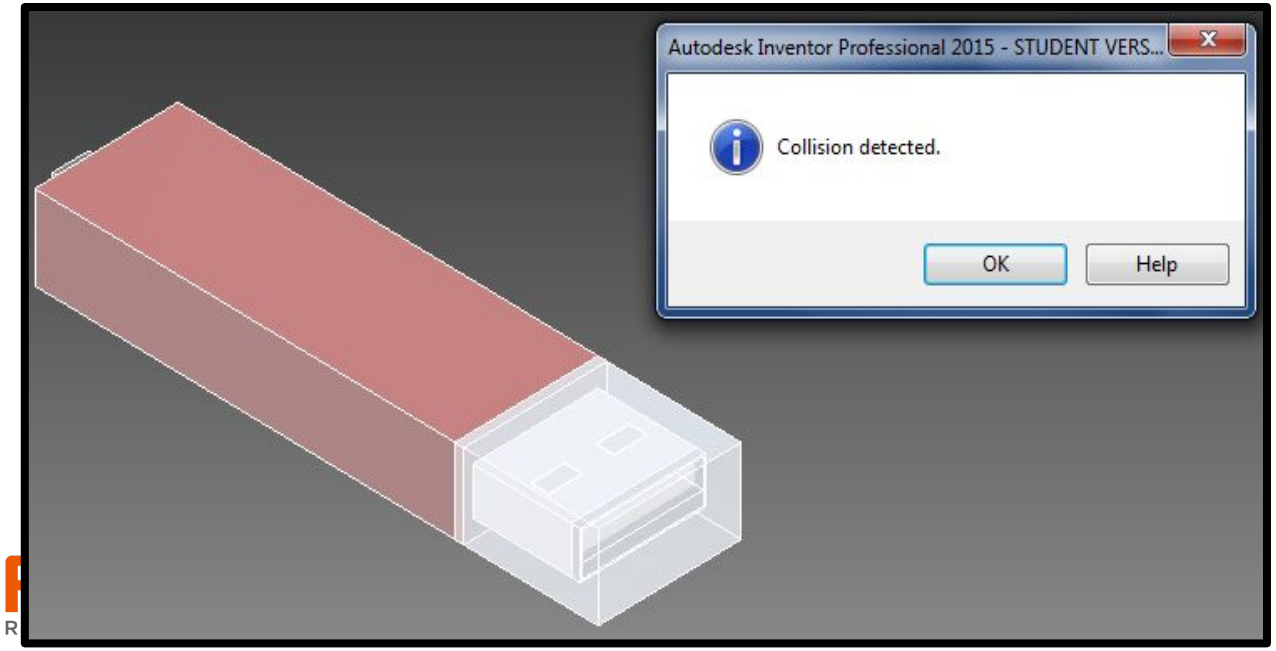
DRIVEN CONSTRAINTS CONT.

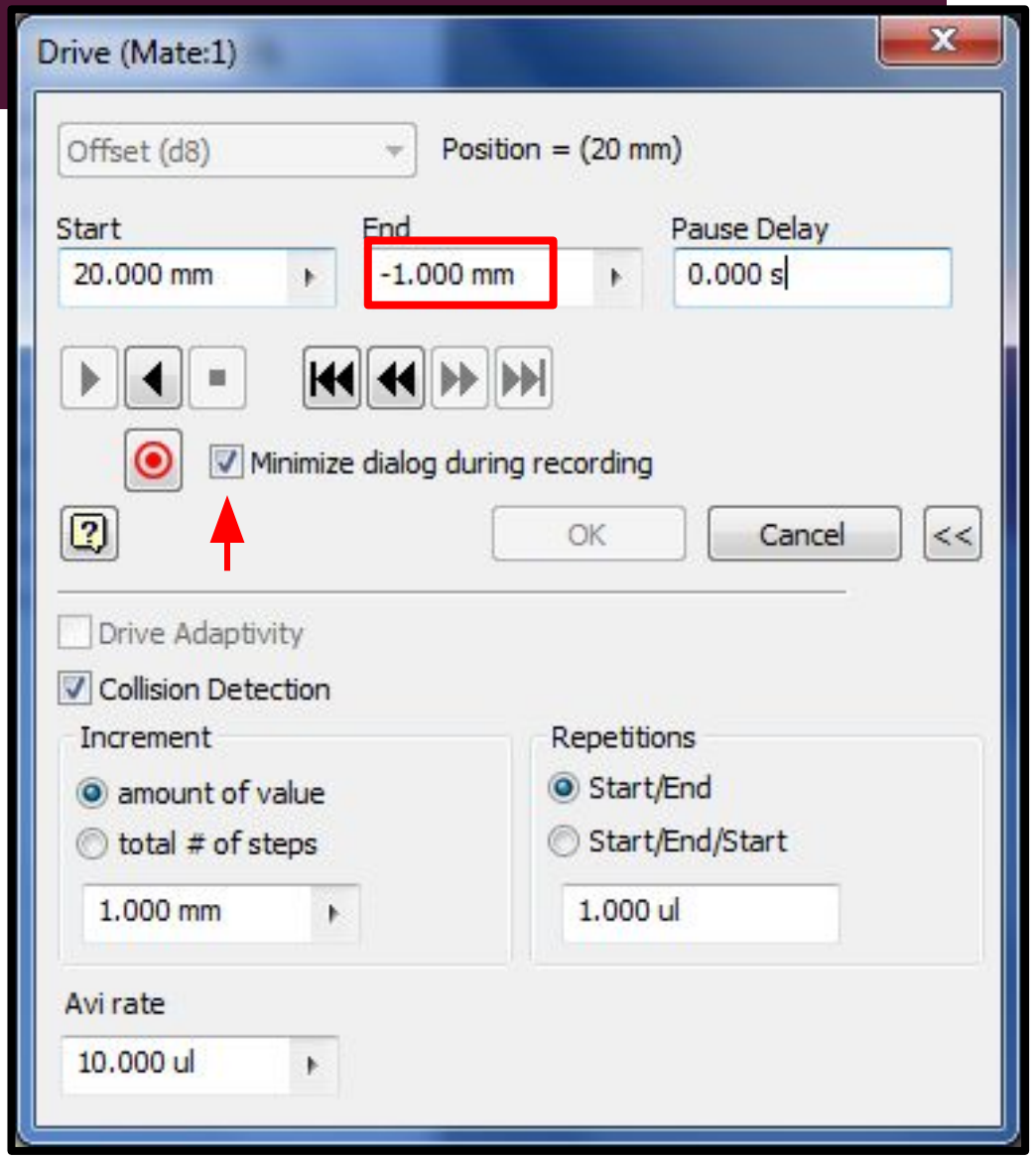
- In the advanced settings you have more control over the **time intervals** and **increments** of the driven motion.
- And can repeat the drive, to put the simulation on a repetitive loop.
- **Drive Adaptivity**: adapts components while maintaining the constraint relationship.
- **Collision Detection**: drives the assembly until a collision is detected. When an interference is detected, it is displayed and its value shown.



EXAMPLE: USB

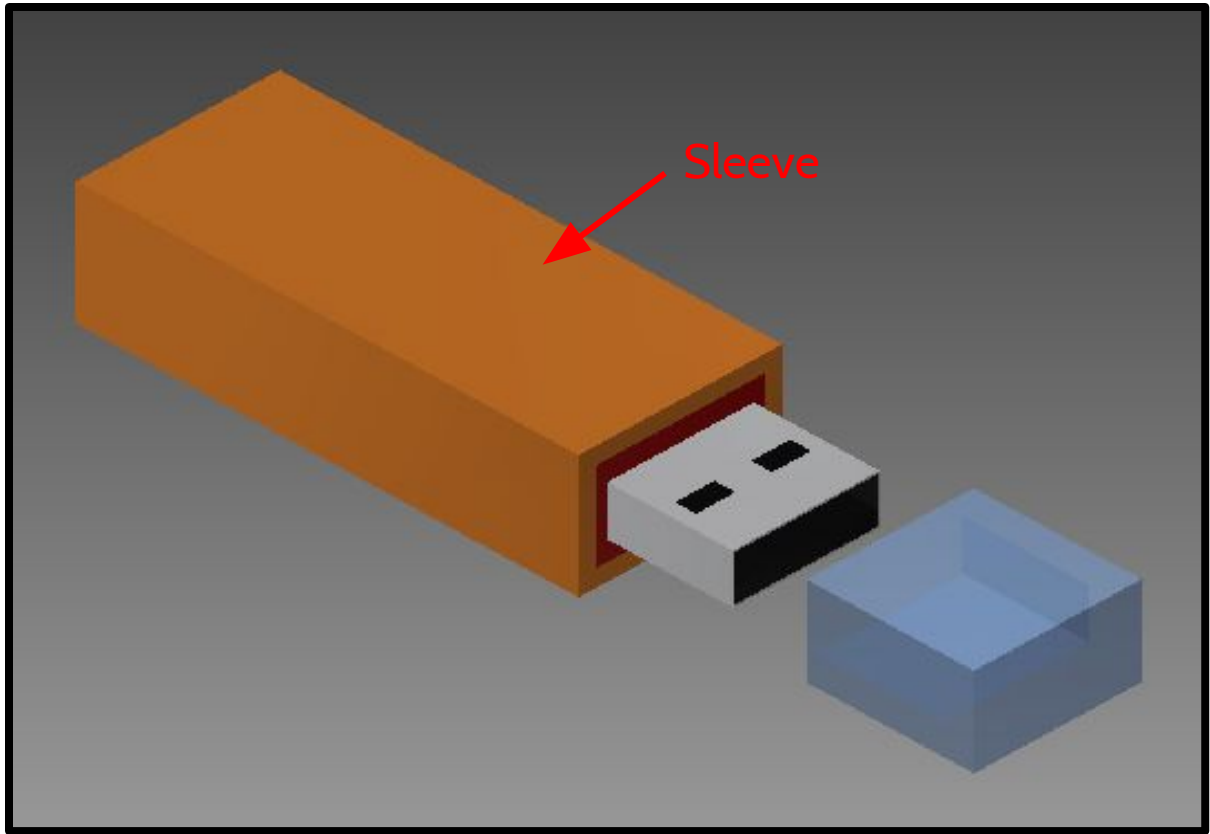
- Change the **end** displacement, and turn on the **collision detection** before driving the constraint.
- The interference should cause the collision detection to appear as shown.





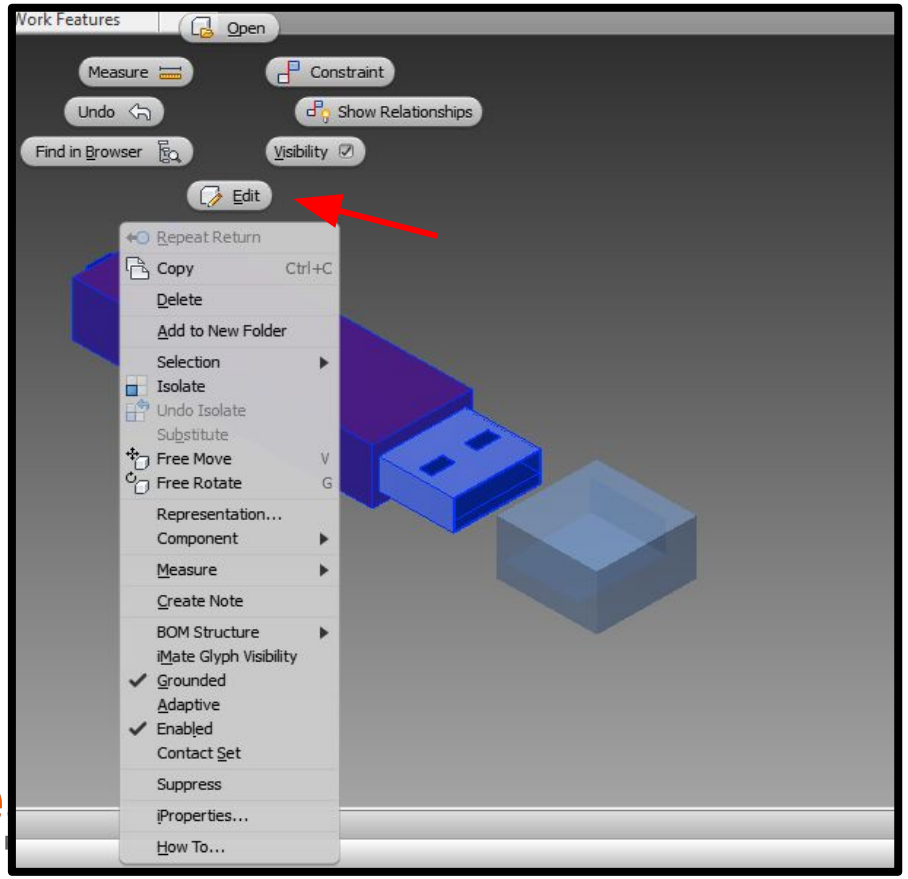
CREATING AND EDITING PARTS

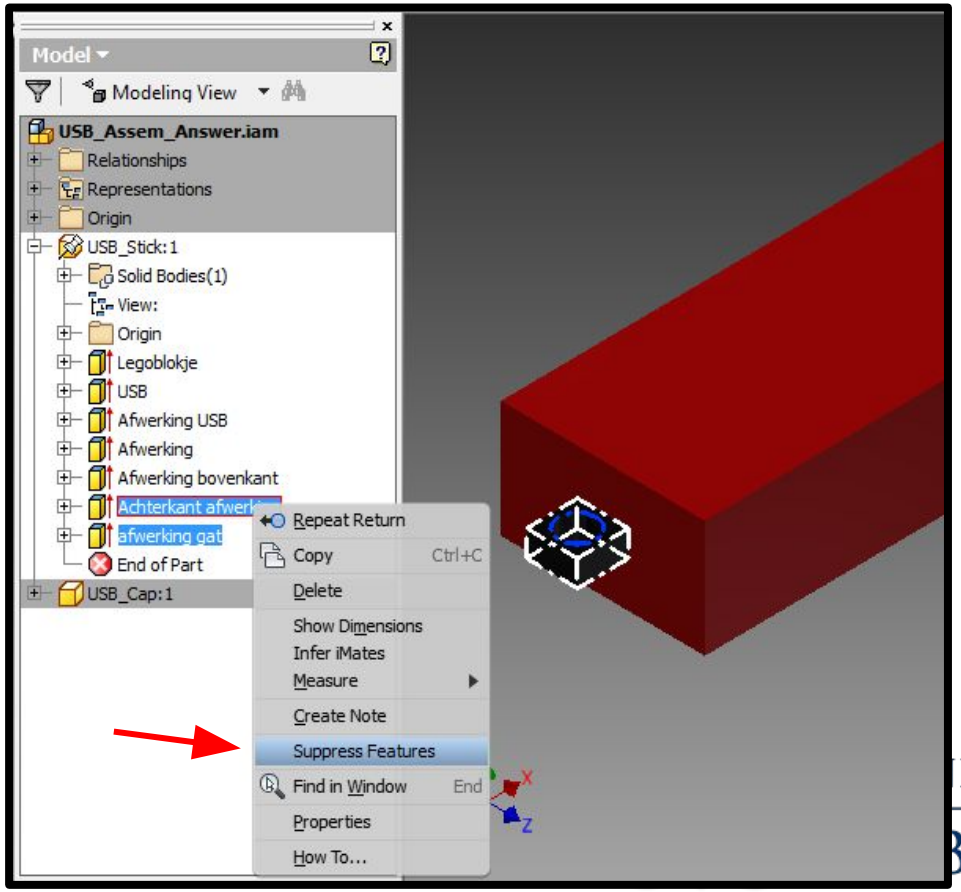
- We have already seen how was can access an individual part file in the assembly module, now we will **editing** parts within assemblies.
- Edited changes can be saved such that the changes propagate back to their original part files.
- It is also possible to create completely **new parts** in the assembly module.
- In the USB example we will create a new sleeve component.



EDITING PART FILES

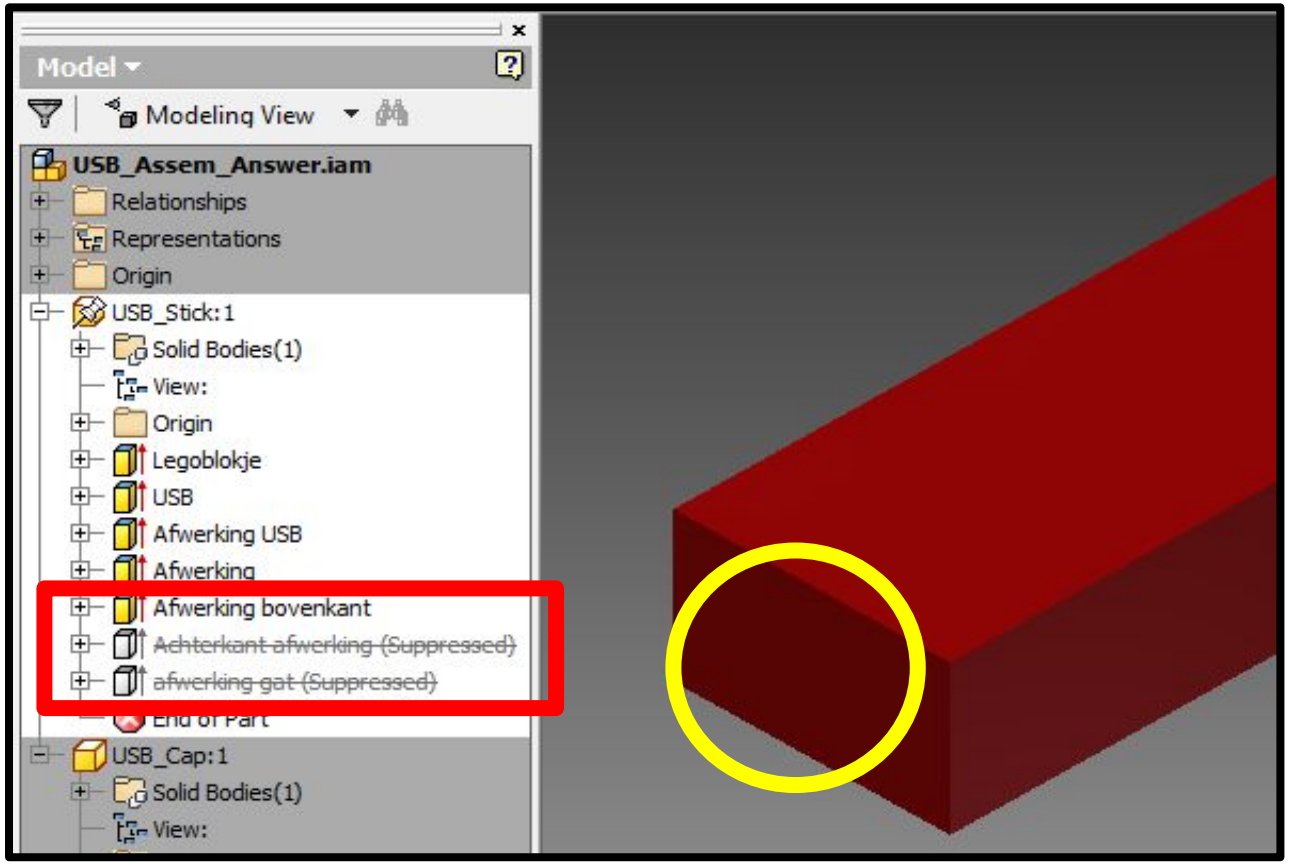
- Right-click on the assembly and click edit. Suppress the USB holder feature, (the originals were made in German I think...?)





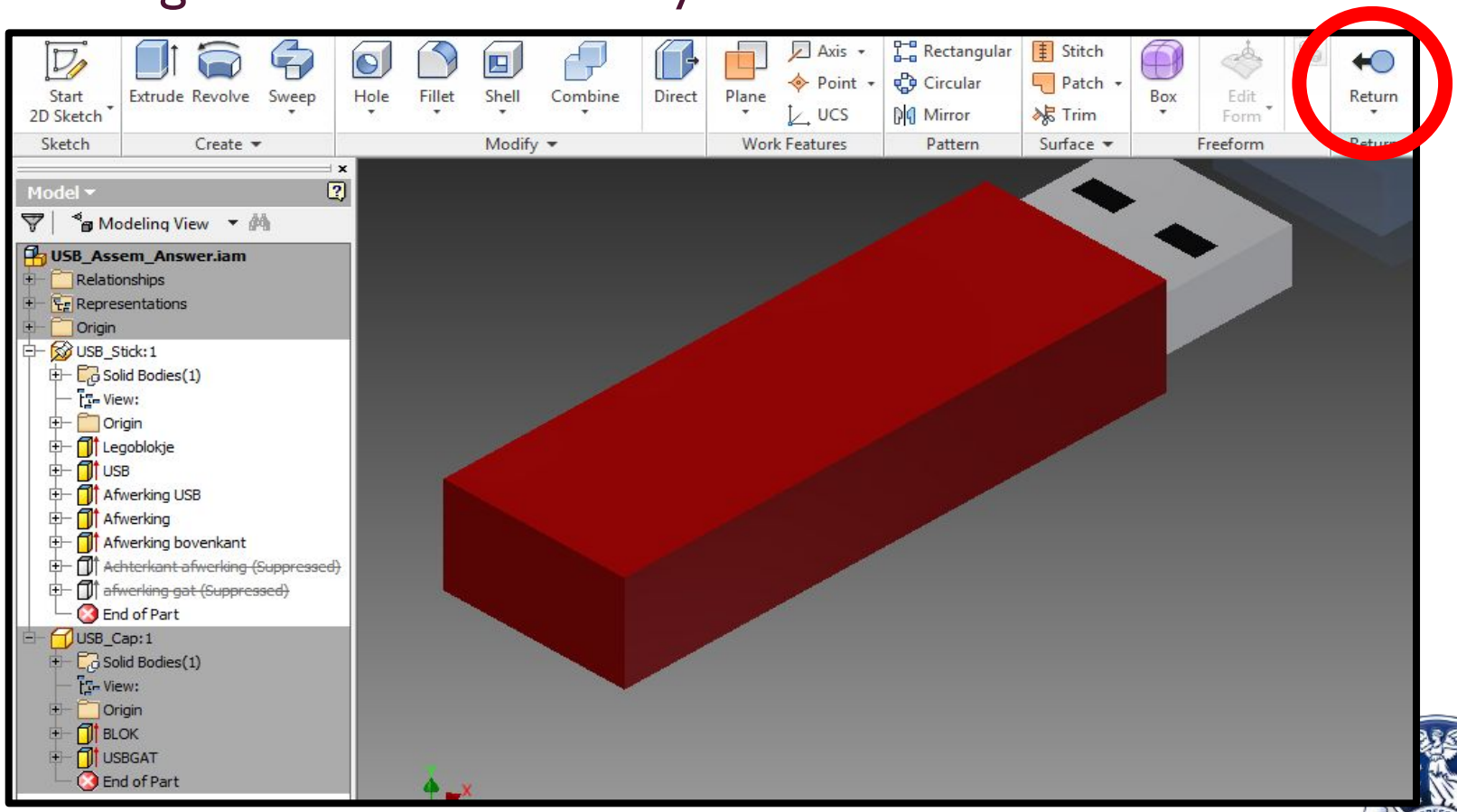
EDITING PART FILES

- The USB holder feature is now suppressed.



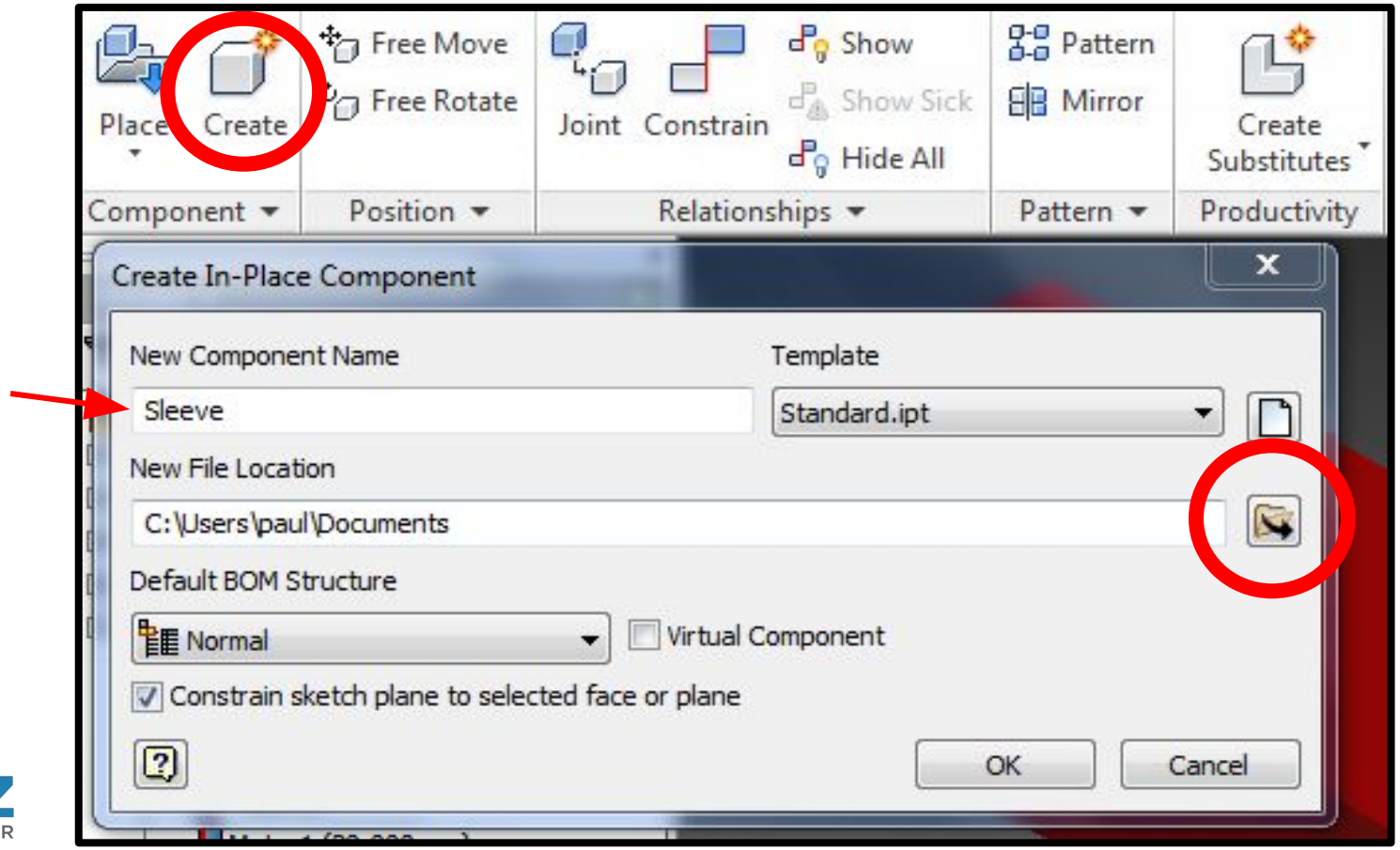
EDITING PART FILES

- Select **return** to go back to the assembly environment.



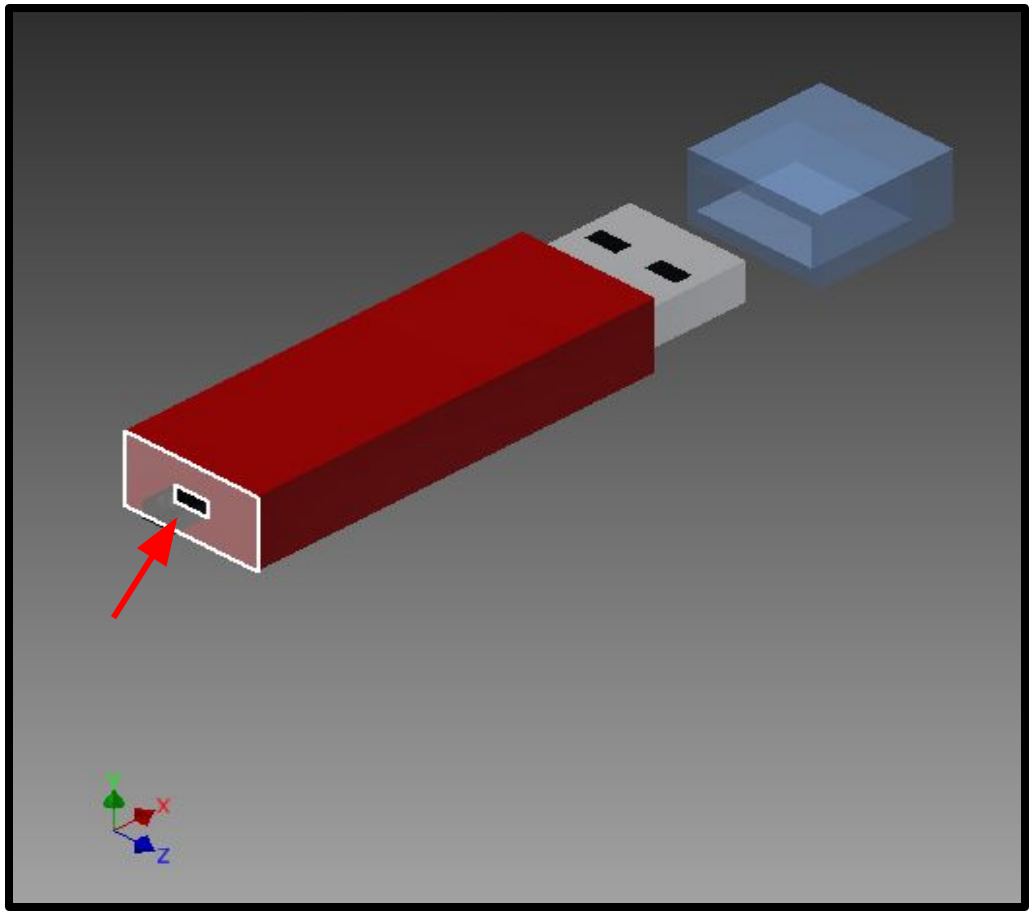
CREATING PART FILES

- Select the **create** command to make a new part, named ‘sleeve’. And save it to your files.



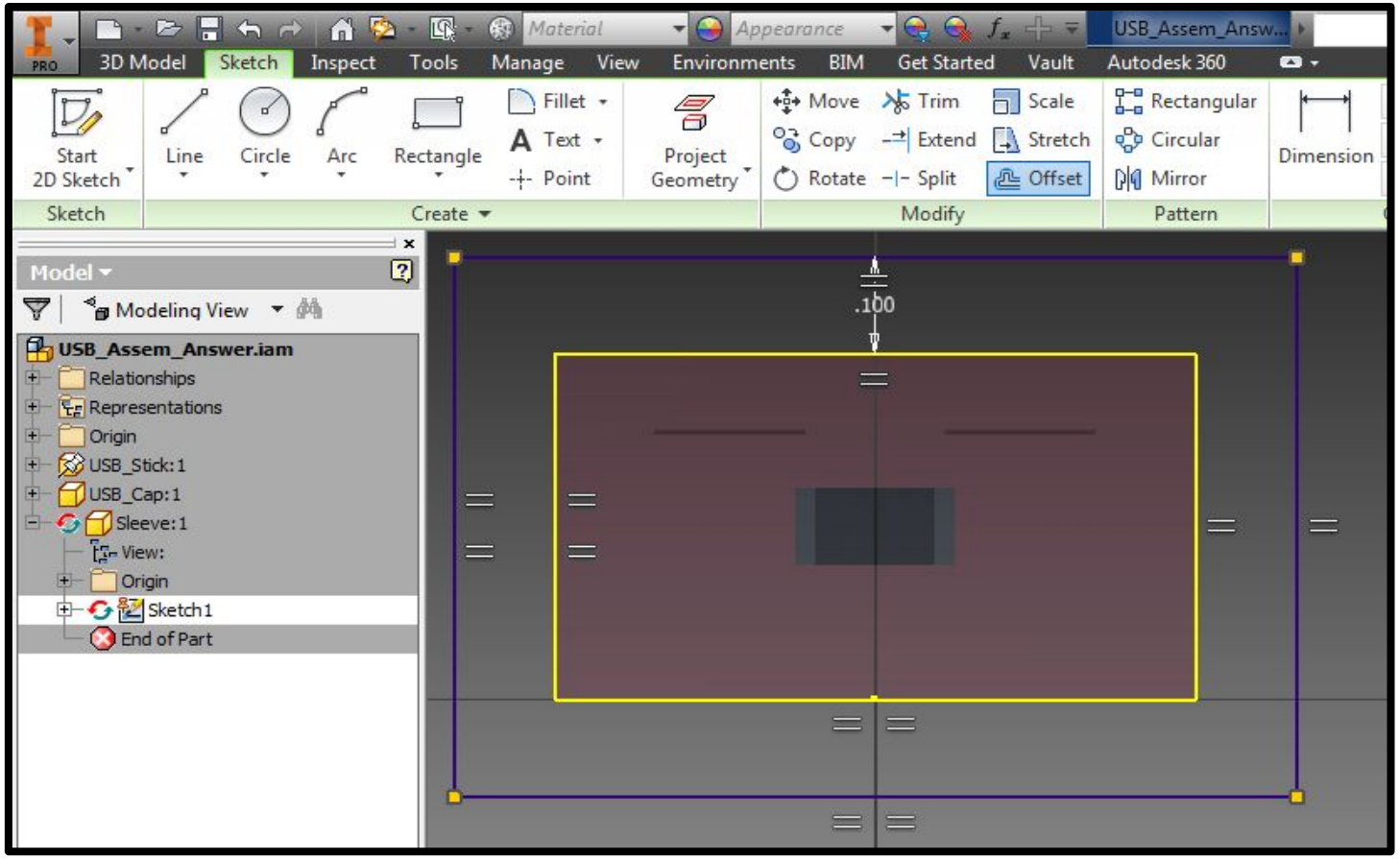
CREATING PART FILES

- Select the back face of the USB stick as a sketch plane for a base feature.



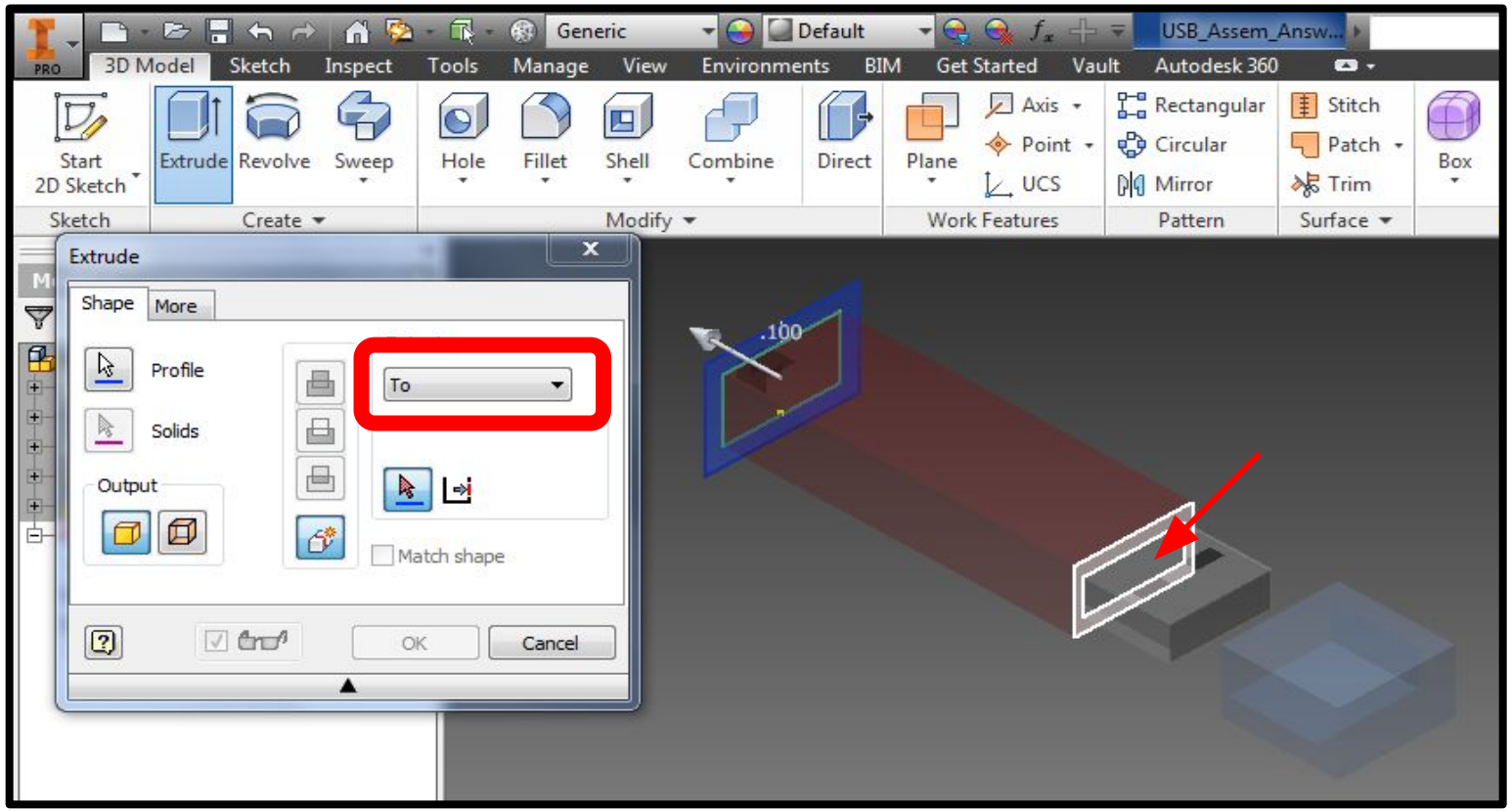
CREATING PART FILES

- Sketch a profile around the USB stick by projecting and offsetting the geometry of the USB surface..



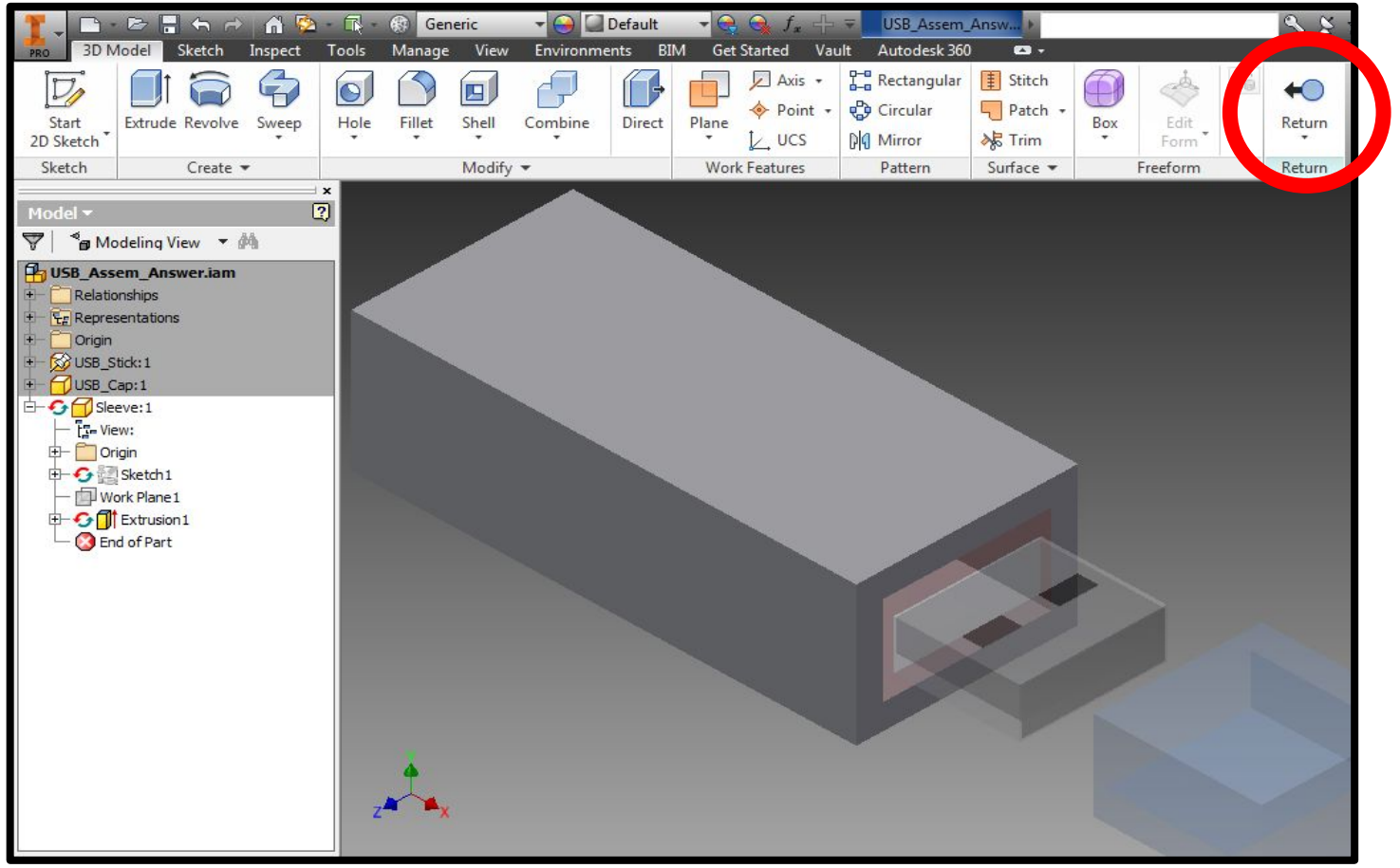
CREATING PART FILES

- Extrude the profile to the front of the USB stick.



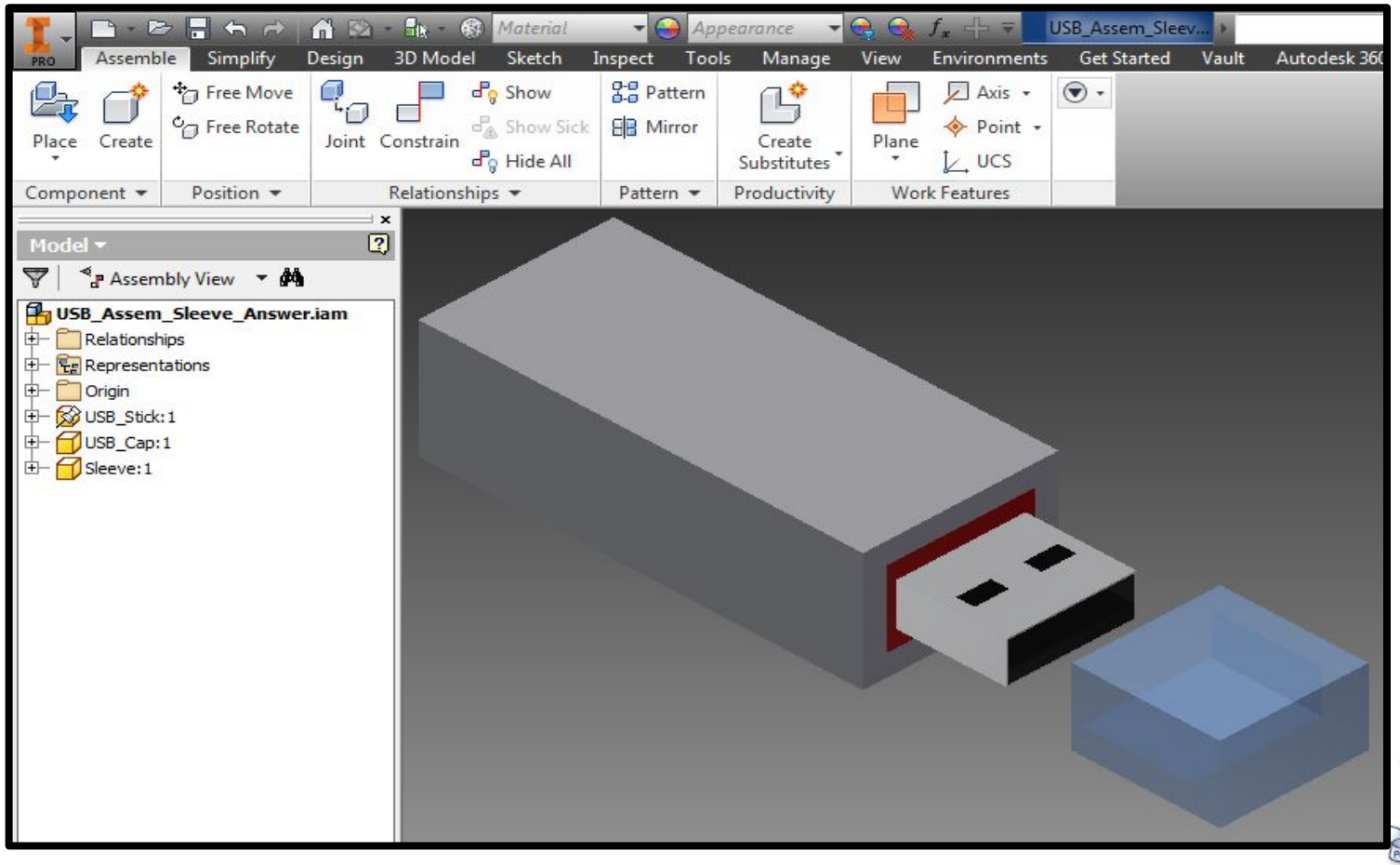
CREATING PART FILES

- Select return to go back to the assembly environment..



SAVE YOUR PROGRESS!

- Round out the edges of the USB sleeve part, then select a material texture.



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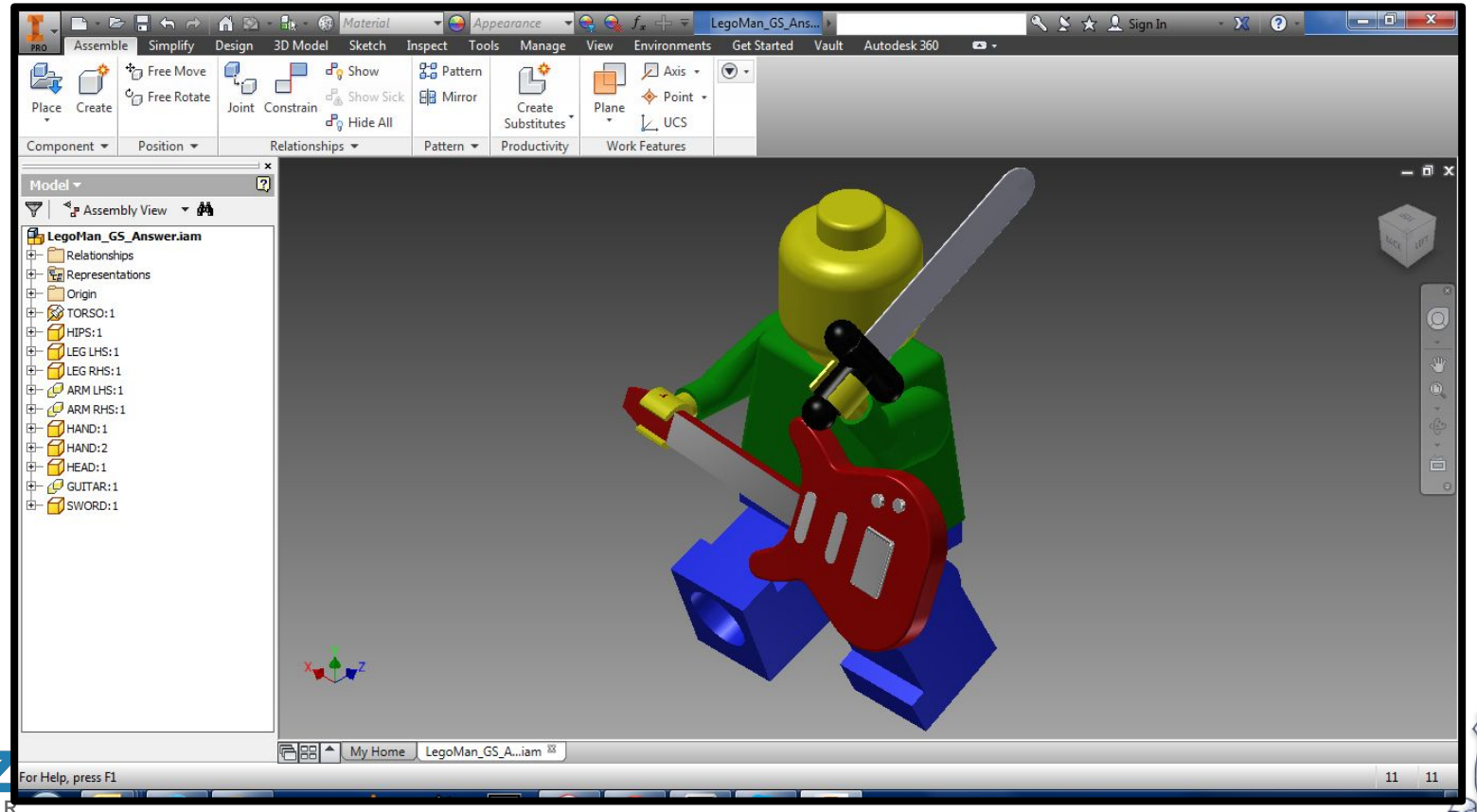
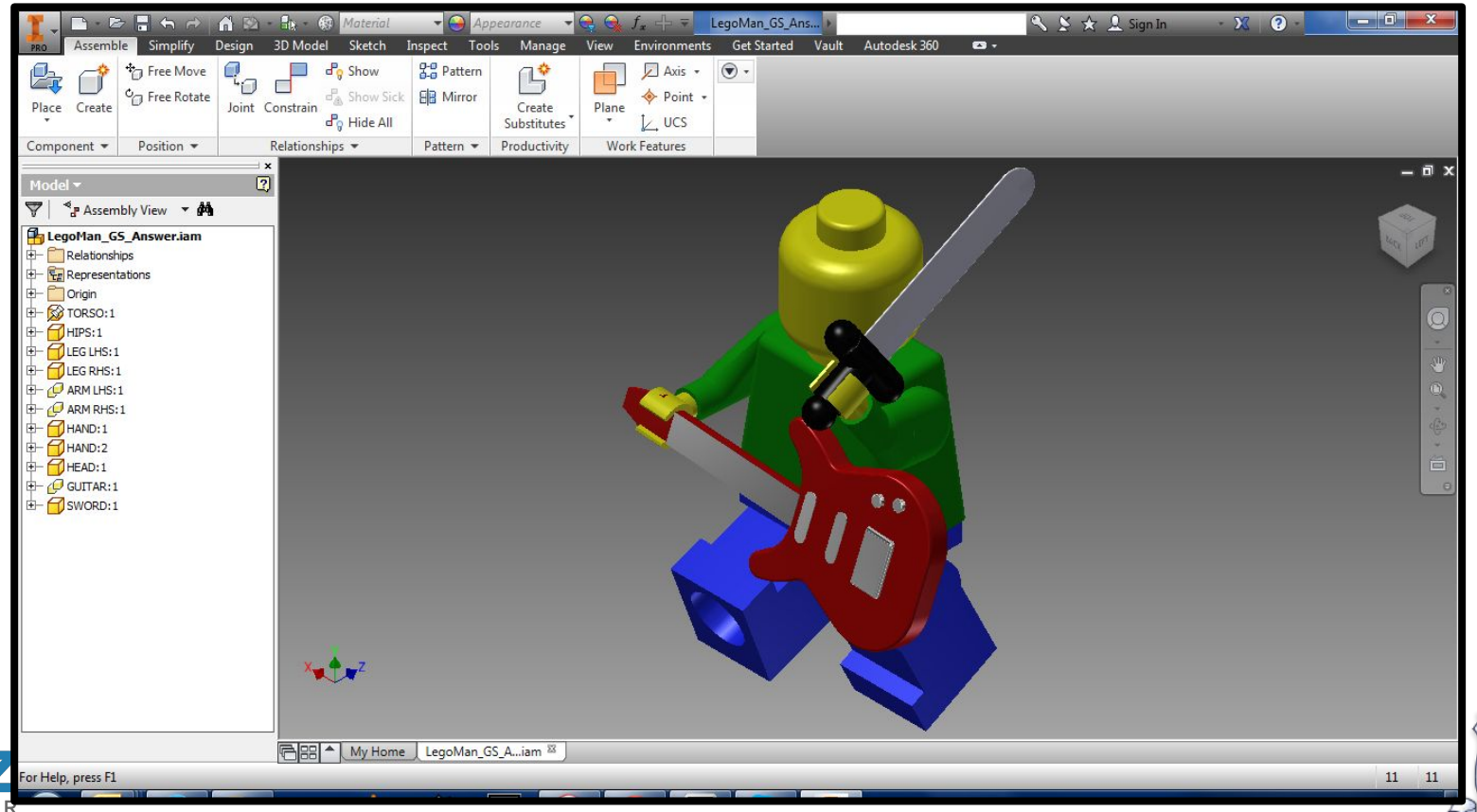
WORKSHOP CHALLENGE 3

- Assemble the lego-man from the parts provided, make sure to **accessorise**.
- *All part files can be found in "06_Assembly" folder of the downloaded materials.*



WORKSHOP CHALLENGE 4 (OPTIONAL)

- If you finish early, try to create your own part files to add to your design.



CONCLUSION

- You learnt how to **drive** constraints to simulate the motion of components.
- We looked at the **edit** and **create part** commands in the assembly module, that allows us to work in a parts module environment whilst still in the assemblies module to quickly allow us to **iterate** our design.
- Another method to iterate design, which will also allow you to simultaneously work in the parts and assemblies module, is to have open the parts and assembly files.
  - Make and save your changes in the part file, they will **propagate** through to the assembly file in real-time.

ANY COMMENTS ABOUT THE COURSE? ~5MIN BREAK

- Let's take a 5min break to do a quick survey about the course so far.
  - *AutoDesk (Drawing and Printing 3D Objects)*
- Please fill out the form below:
  - https://goo.gl/forms/bxkzXXKihs1PRrhx1
- It's completely anonymous, any feedback really helps us to create better content for you all!
- Here's a table for what the number mean:

Score	Score Conversion (according to test...)	What that means...?
1 - 6	Detractor (Negative Reaction)	I thought the workshop was a waste of time. I would tell people **not to go** to this workshop.
7 - 8	Neutral (Passive)	I did not find the workshop that useful (didn't learn anything new). I would not say anything good or bad about it.
9 - 10	Promoter (Positive Reaction)	I found the workshop helpful and learnt something new. I would tell people **to go** to this workshop.

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THANK YOU FOR ATTENDING!!

If you are interested in more trainings or events: *http://melbourne.resbaz.edu.au*