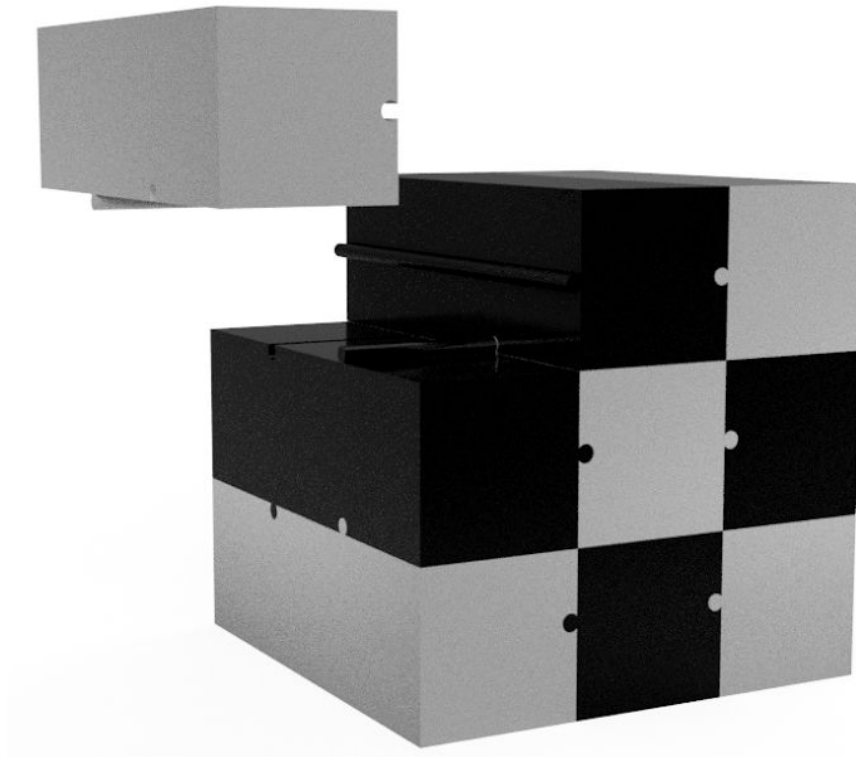


The Puzzler

User's Manual



Media Computing Project (WS 20/21)
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Plugin Description

The Puzzler is an add-In for Autodesk Fusion 360. It allows you to convert any 3D model into 3D puzzle pieces. Once a 3D model is imported to Fusion 360, you can select the model, specify the complexity of the puzzle and the plugin generates the corresponding puzzle pieces.

Installation

This section describes how to install and run The Puzzler as a plugin in Autodesk Fusion 360 for MacOS and Windows.

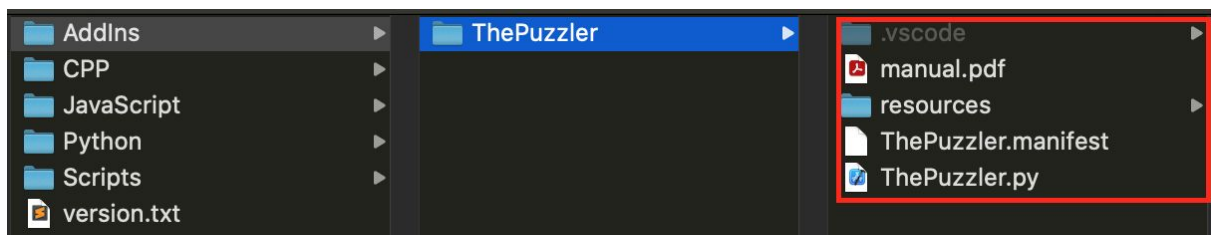
- **MacOS**

Once downloaded the plugin zip, follow the next steps to install the plugin for MacOS.

1. Copy the plugin zip.
2. In **Finder**, navigate to the following path:
`/Users/{Username}/Library/Application
Support/Autodesk/Autodesk Fusion 360/API/AddIns/`

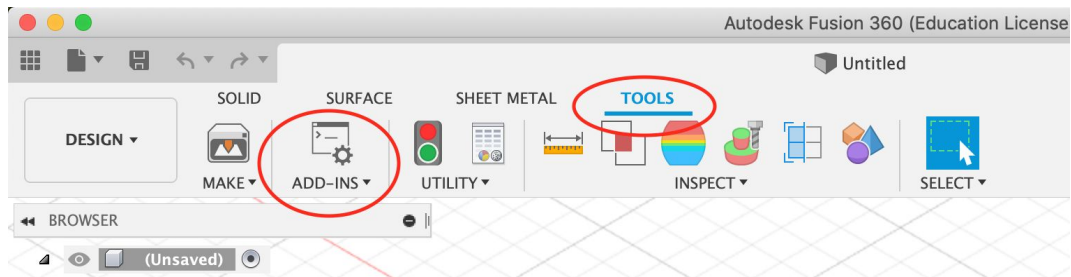
Note: If the folder 'Library' is not visible, use the keys combination **Cmd + Shift + . (dot)** to view the hidden files.

3. **Paste** the plugin zip inside the **AddIns** folder.
4. **Unzip** the plugin. This zip will contain the folder 'ThePuzzler' containing four files:

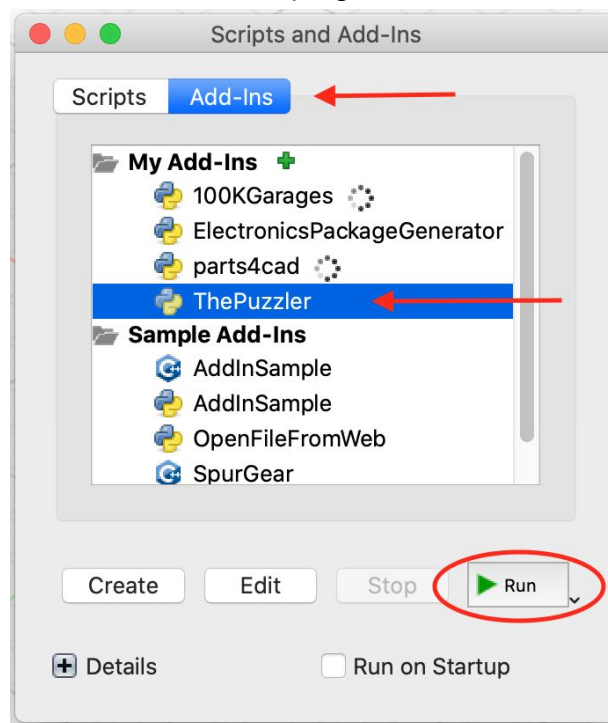


5. **Open** Autodesk Fusion 360.

6. Navigate to tab **Tools** → **ADD-INS**:

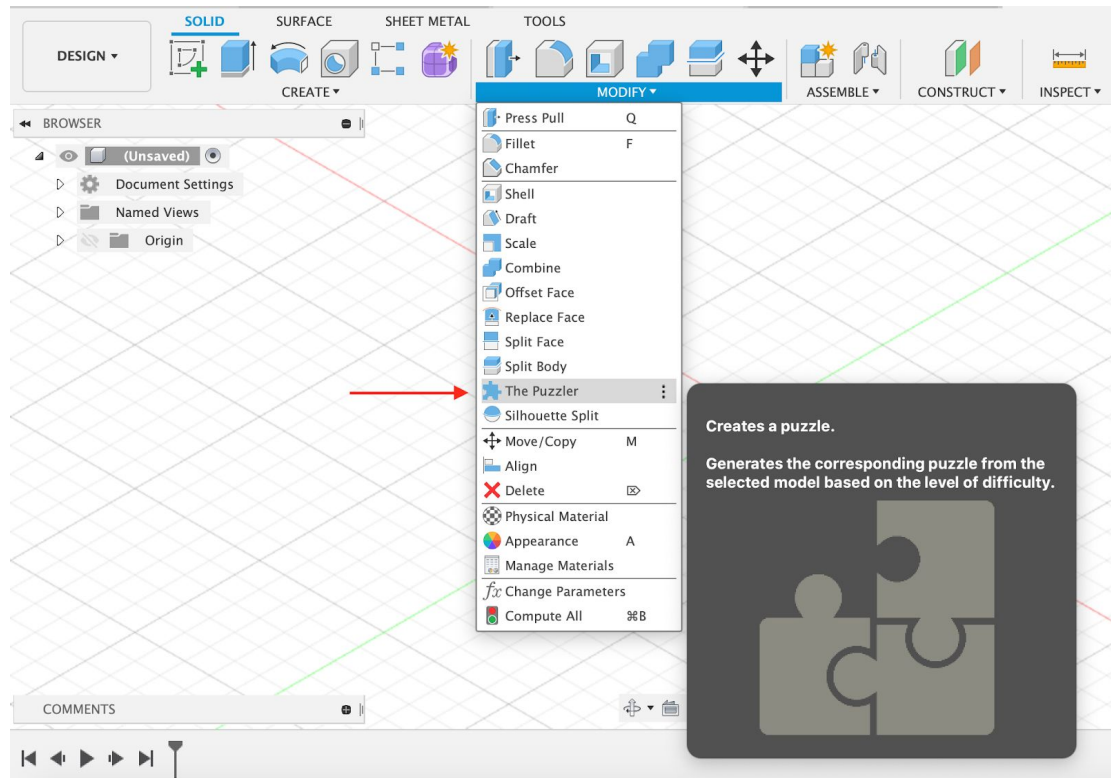


7. In the **Add-Ins** tab select ThePuzzler plugin and click on **Run**.



Note: In case the plugin is not available in the list of Add-Ins, restart Fusion360, so the program can pull the updated list of Add-Ins from the folder.

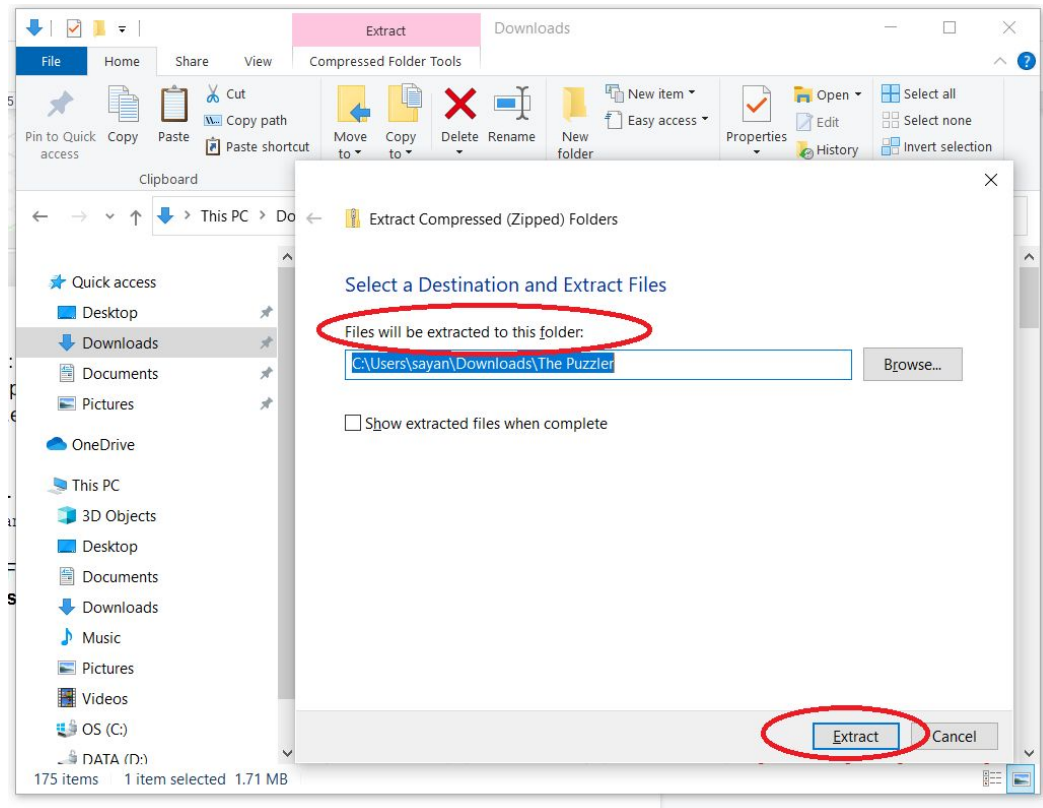
8. Once successfully loaded, the plugin it will appear in **Solid** → **Modify** → **ThePuzzler**:



- **Windows**

1. **Unzip** the Plugin:

Right click on the zip folder → Extract All... → Select the destination folder as the current folder (i.e the zipped folder) → Extract



2. **Copy** the Folder- ThePuzzler and **paste** it to the file location:

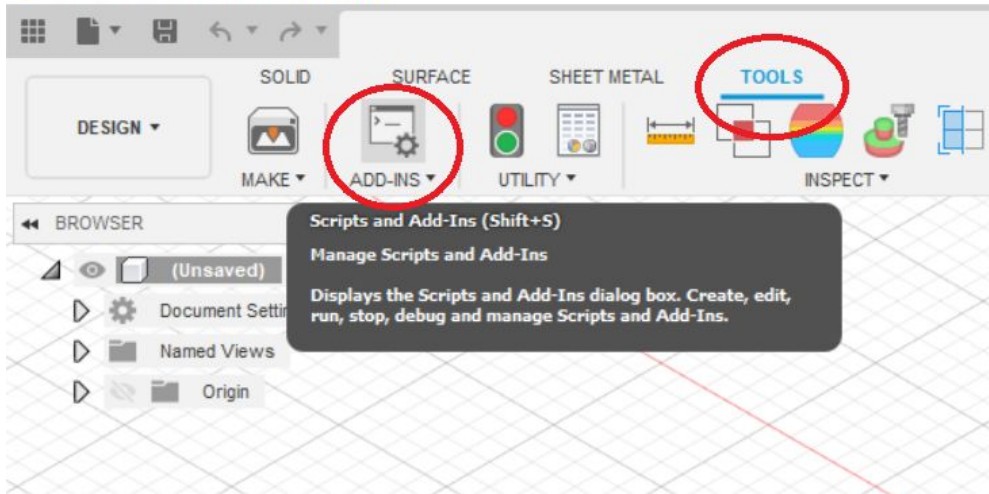
C:\Users\{username}\AppData\Roaming\Autodesk\Autodesk Fusion 360\API\AddIns

Note: The pasted folder should contain **resources**, **manual.pdf** and **ThePuzzler.py**

3. **Open** Autodesk Fusion 360.

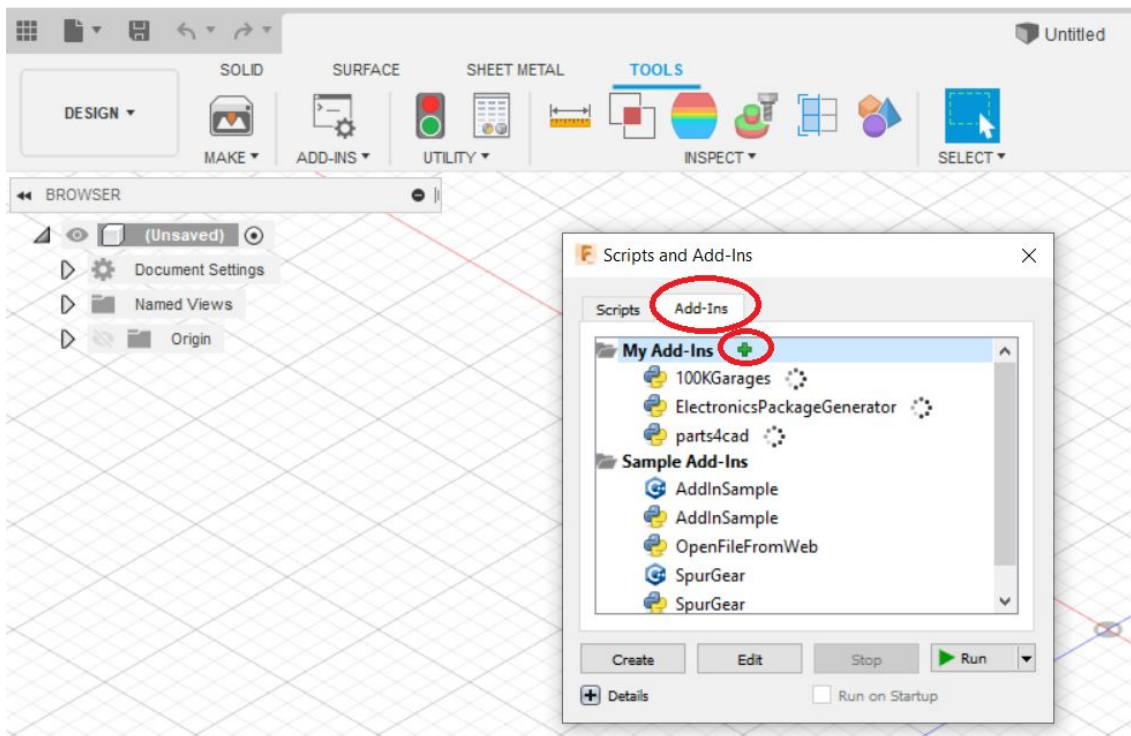
4. Navigate to **Tools** → **ADD-INS**

Autodesk Fusion 360 (Education License)

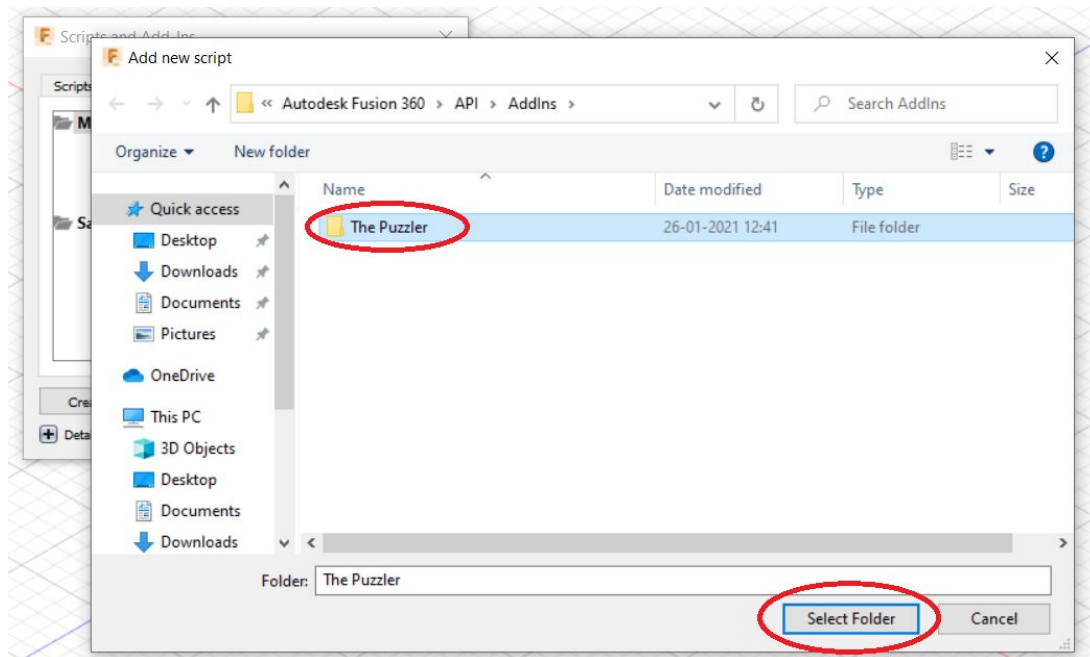


5. In the **ADD-INS** tab, Click on + in **My Add-Ins** to add **The Puzzler** plugin.

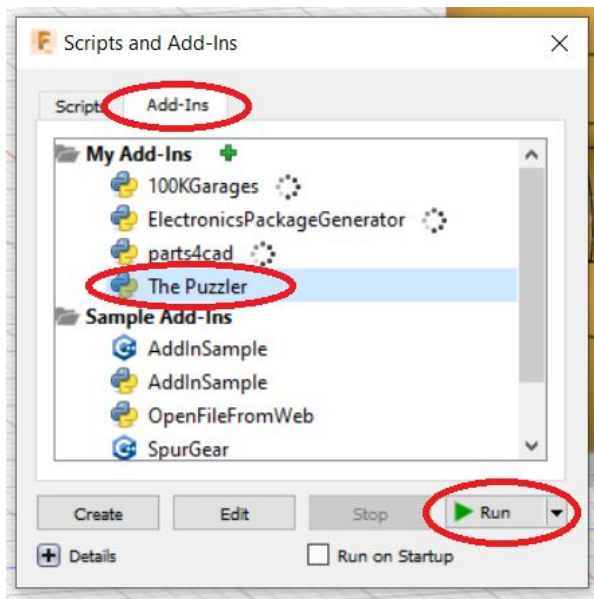
Autodesk Fusion 360 (Education License)



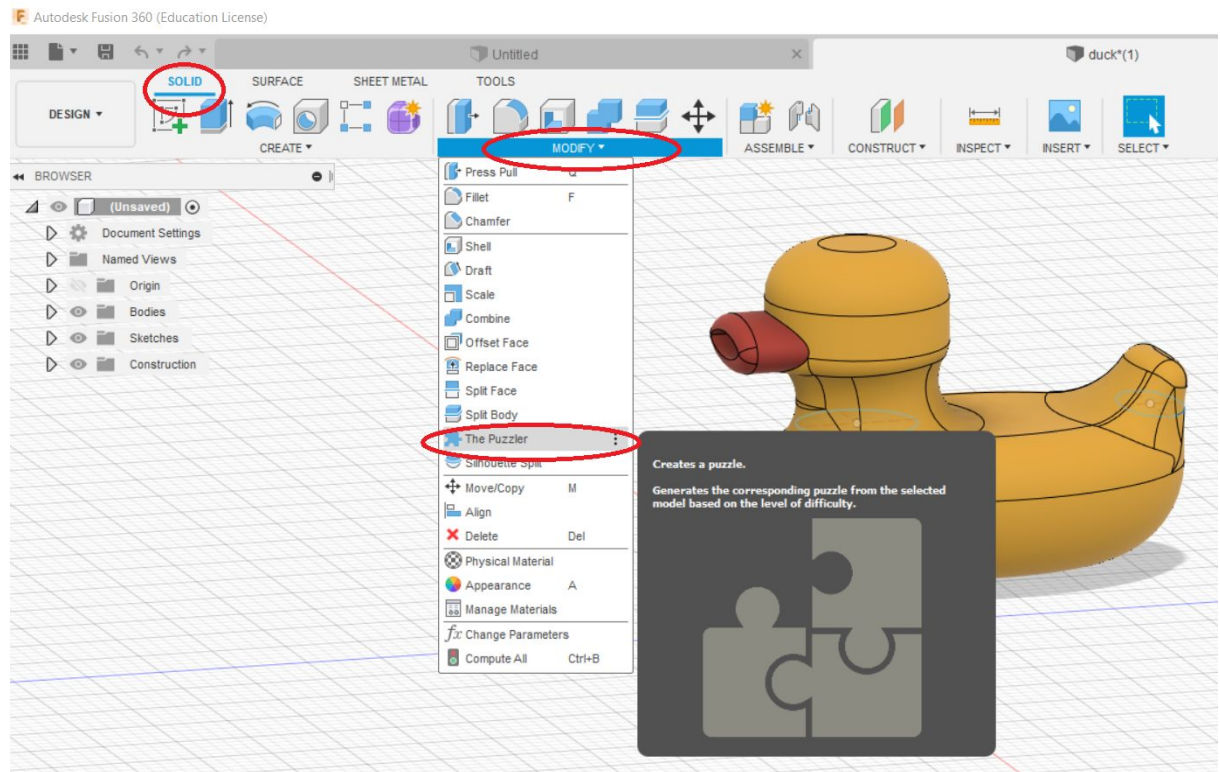
6. Select the pasted folder and click on **Select Folder**.



7. The plugin would now appear in the **Add-Ins** tab under **My Add-Ins** section, select **The Puzzler** plugin and click on **Run**.



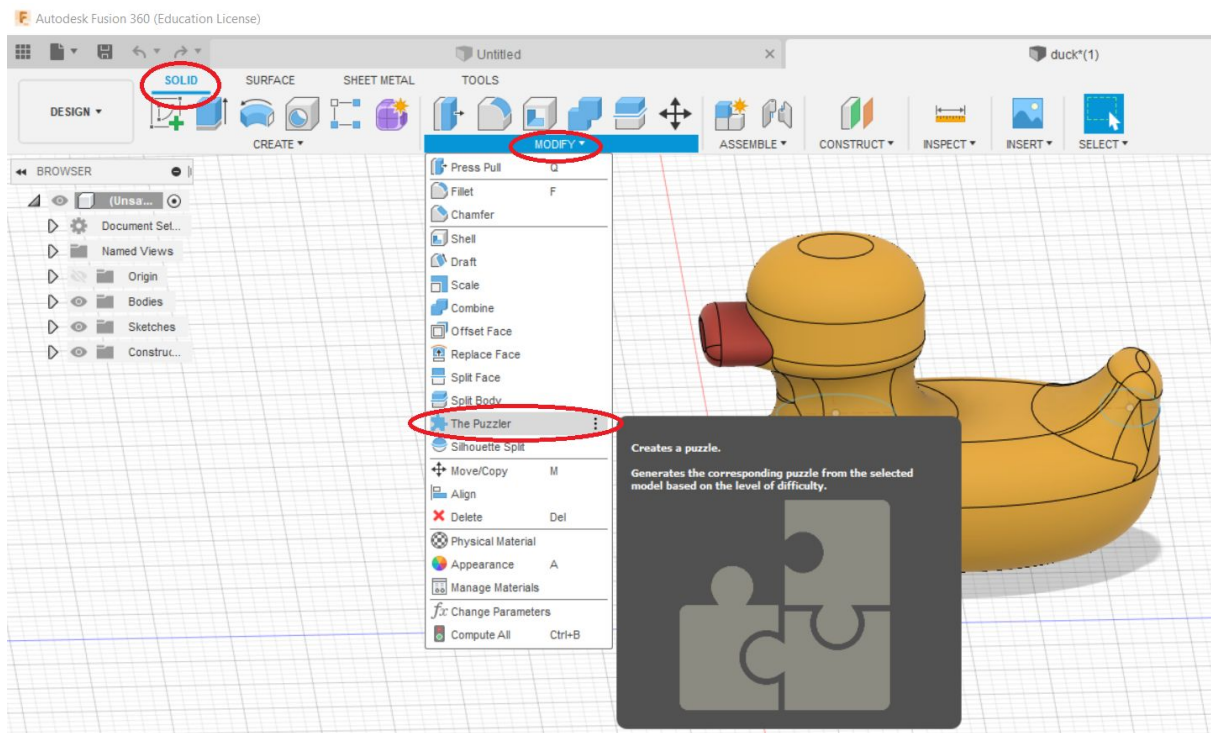
8. Once the plugin has been successfully loaded, it should appear in the **Solid** → **Modify** → **The Puzzler**



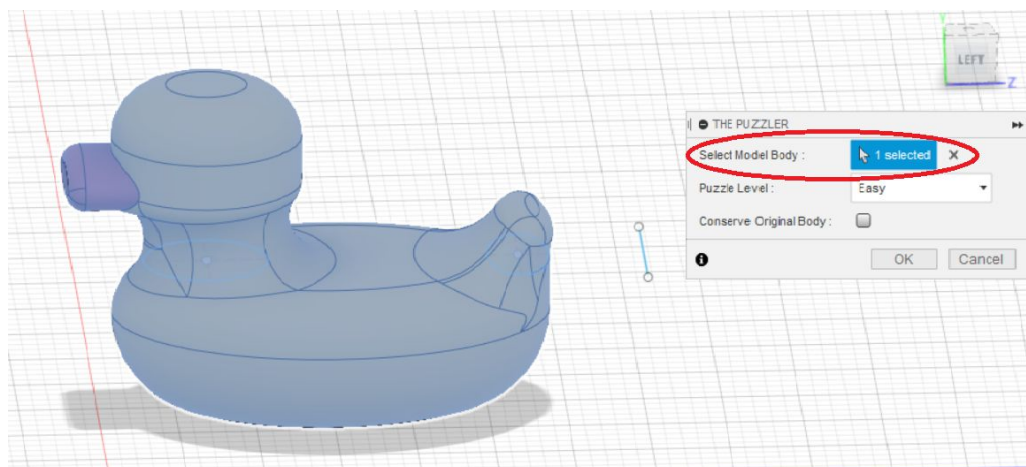
Usage

After the plugin is successfully installed and running, it is ready to be used. An example 3D model of a duck is used in the description as a reference.

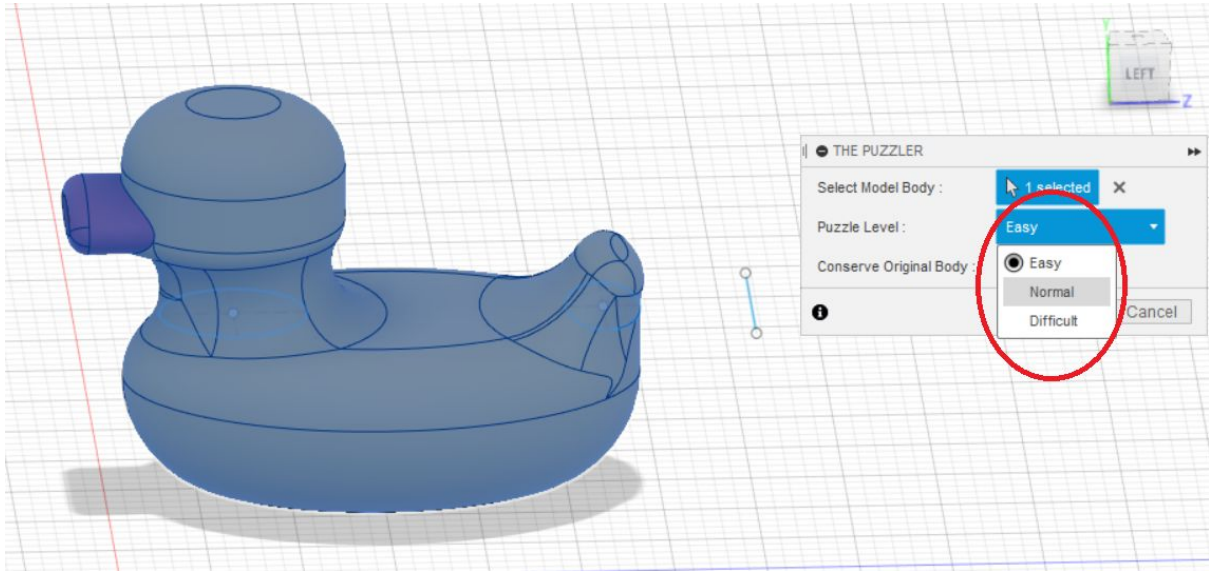
1. Open the model that needs to be puzzled into the workspace.
 - a. **File** → **Open** → Select the .f3d file of the model → **Open**
2. Once the model is opened in the workspace, select **SOLID** → **MODIFY** → **The Puzzler**



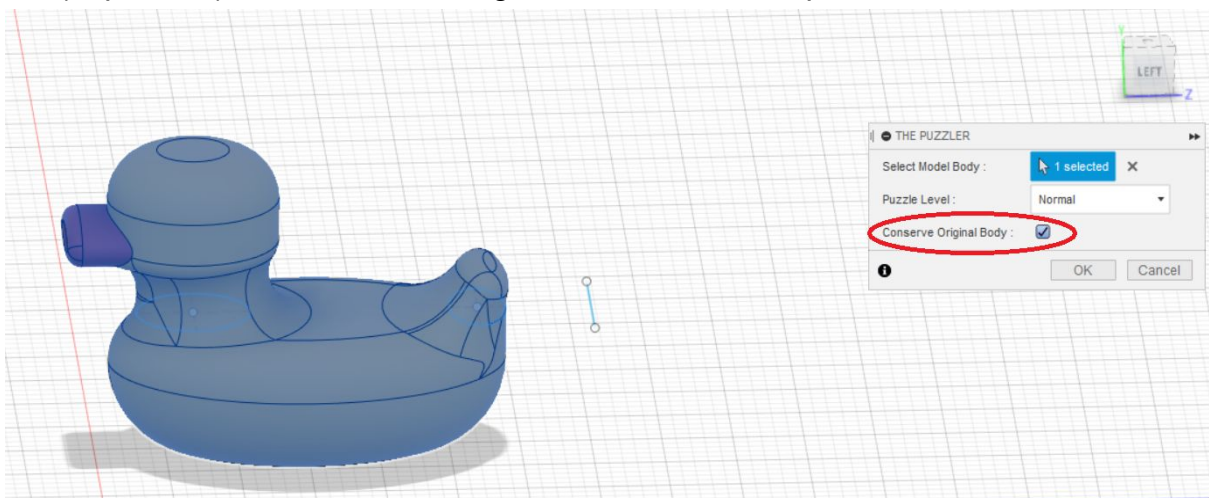
3. Select the model to puzzle. A maximum of 3 elements can be selected at a time.



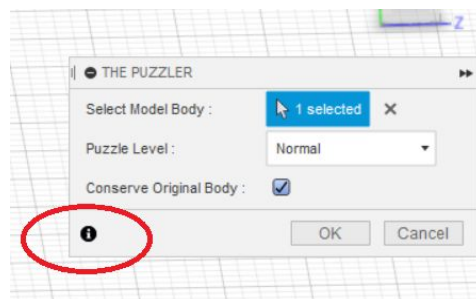
4. Select the difficulty level- **Easy**, **Normal** or **Difficult**. The number of puzzle pieces generated depends on the level of difficulty.



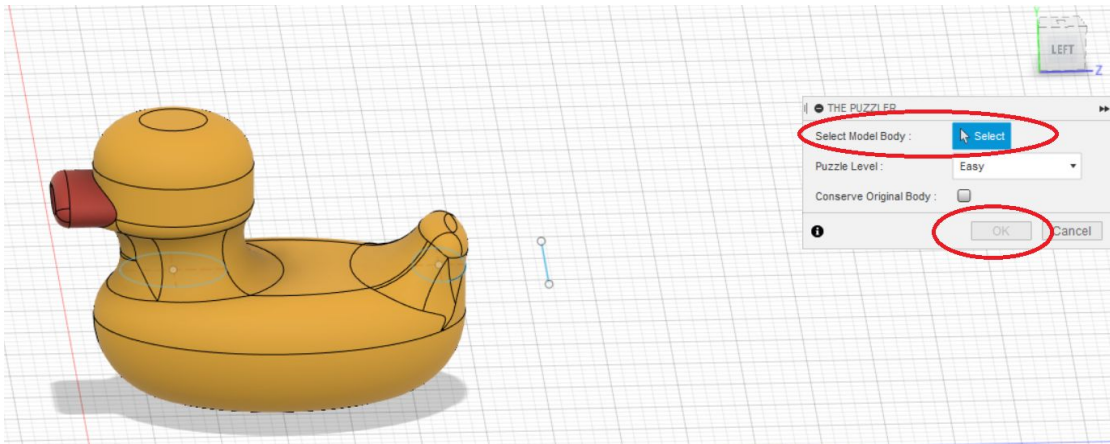
5. Enable **Conserve Original Body** option to keep a copy of the original (unpuzzled) model after the original model has been puzzled.



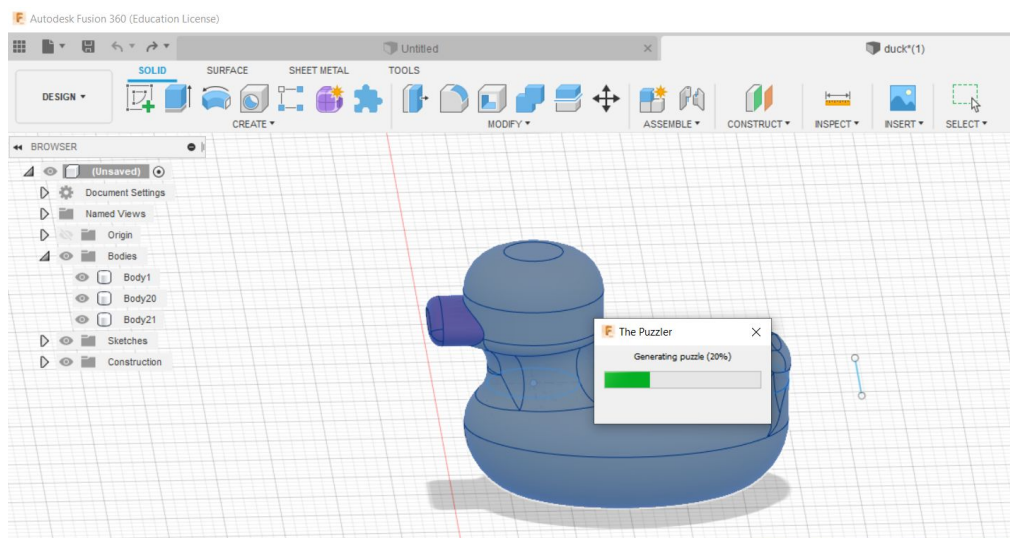
- **Note:** The **information** icon opens the manual of the plugin to get more information and a step by step guide on how to use the plugin.



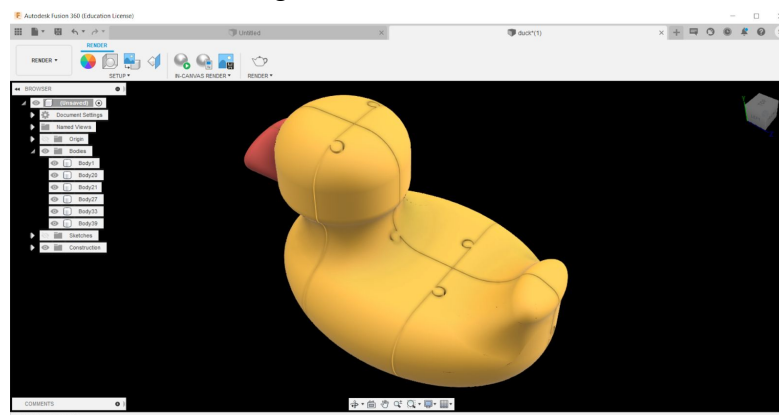
- **Note:** The tool keeps the **OK** button disabled to prevent progressing without providing the **Select Model Body** input.



6. After providing the inputs, click **OK** to start processing. A progress dialog appears to give an estimate of percentage completed.



7. The model gets sliced into puzzle pieces which can then be 3D printed and assembled to form the original model.



Working Procedure

This section provides a detailed stepwise description of how the plugin works internally.

Step 1: Sketch of cutting pattern.

The cutting pattern sketch is created using arcs and planes to give the puzzle shape as shown in Fig. 1. The number of arcs and planes generated will depend on the difficulty selected by the user. These planes will slice the model to generate the pieces. The higher the level of difficulty, the more pieces are generated.

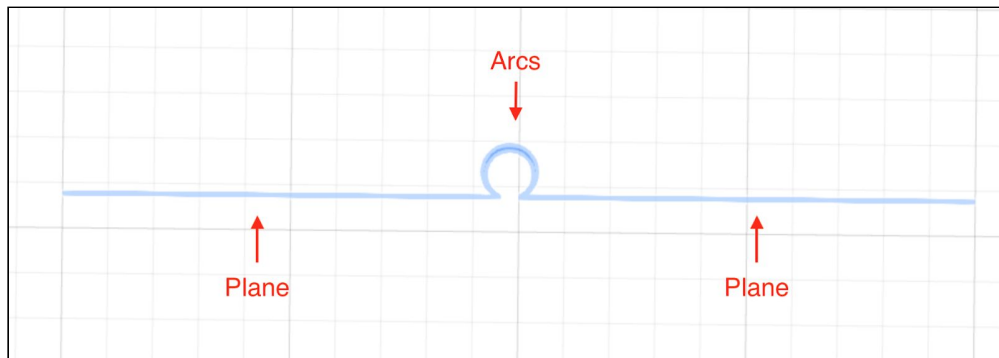


Fig. 1

Step 2: Extruding the sketch.

Once the design of the cutting pattern has been generated, the tool will then extrude the shape. The width and length of the cutting pattern will depend on the size of the model.

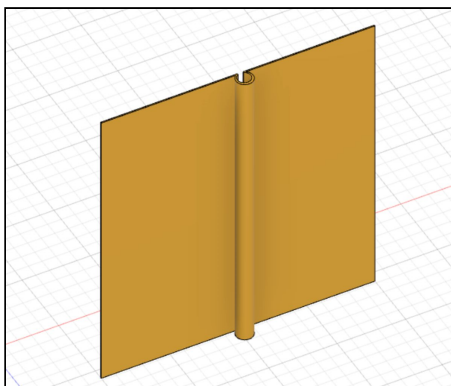


Fig. 2

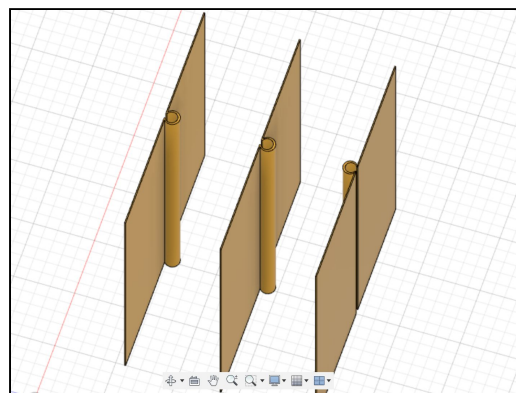


Fig. 3

Step 3: Cutting the model

The cutting pattern shapes generated will intersect with the model and perform a cut operation on the model thereby generating puzzle patterns.

The tool will then perform a cut of this pattern on the model and create corresponding puzzle pieces.

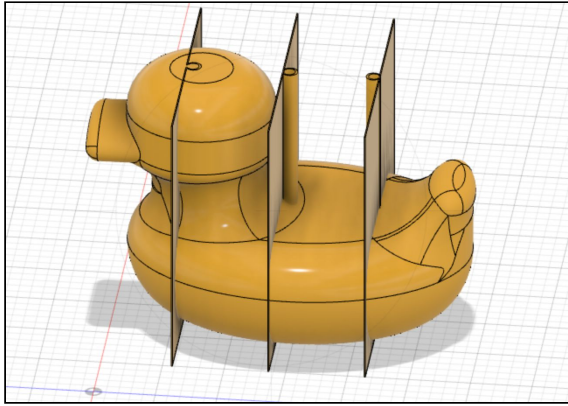


Fig. 4

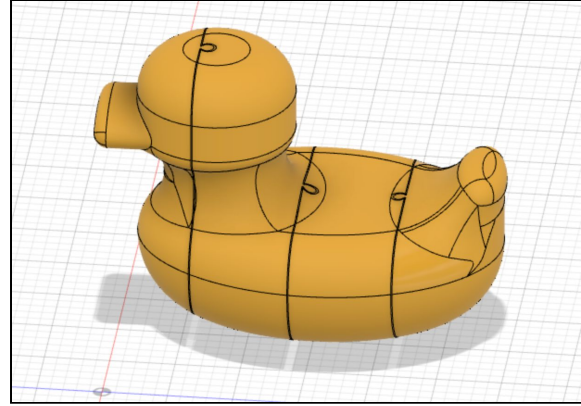


Fig. 5

Additionally, to define the difficulty of the puzzle, the cutting is applied in different planes (XZ, YZ, XY). In the **Easy** level, the cut is just performed in one plane, while in **Normal** and **Difficult** levels the cut is performed in two planes. This ensures the pieces fit together when the user assembles them.

For the **Normal** and **Difficult** levels, to prevent the intersection between the arcs of the cutting pattern in different planes, the cut on the model is performed one after the other. When performing the first cut, this will create the first pieces, then each of these pieces will be cut again in another plane as shown in Fig. 6.

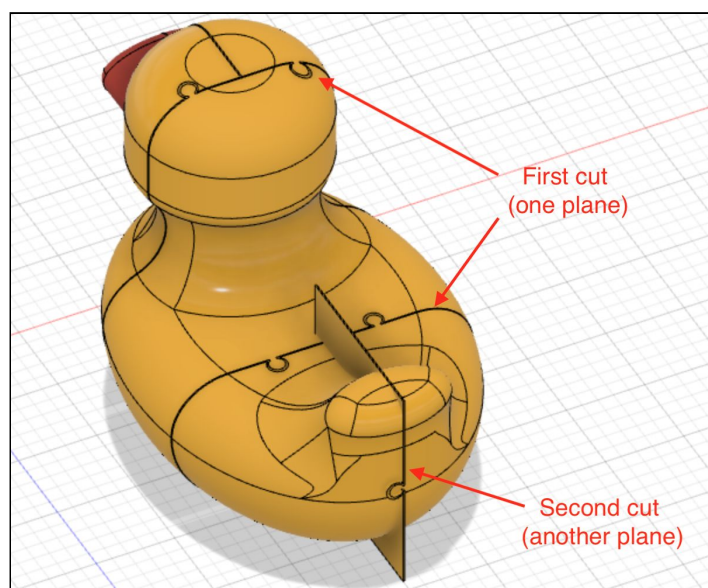
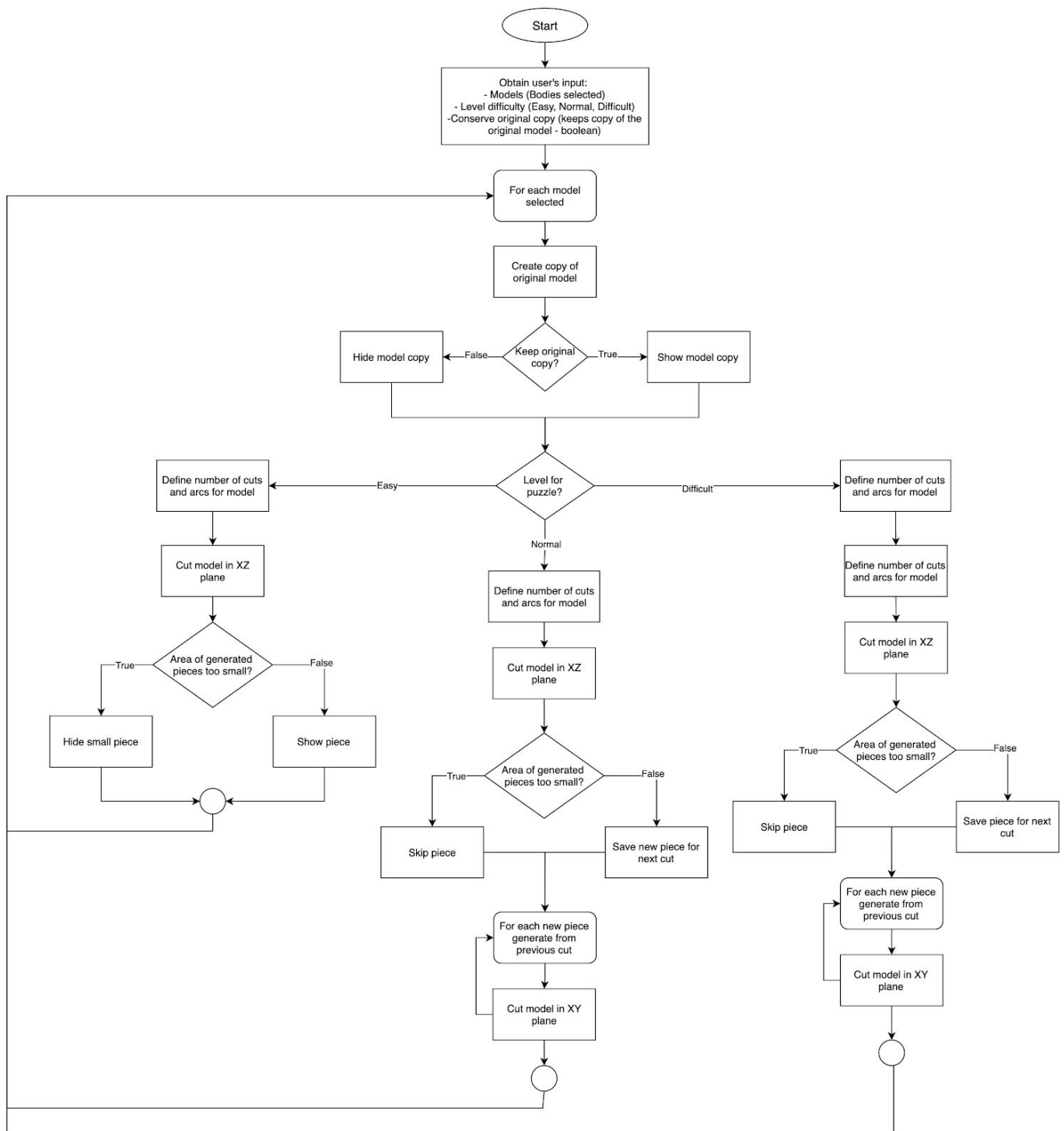


Fig. 6

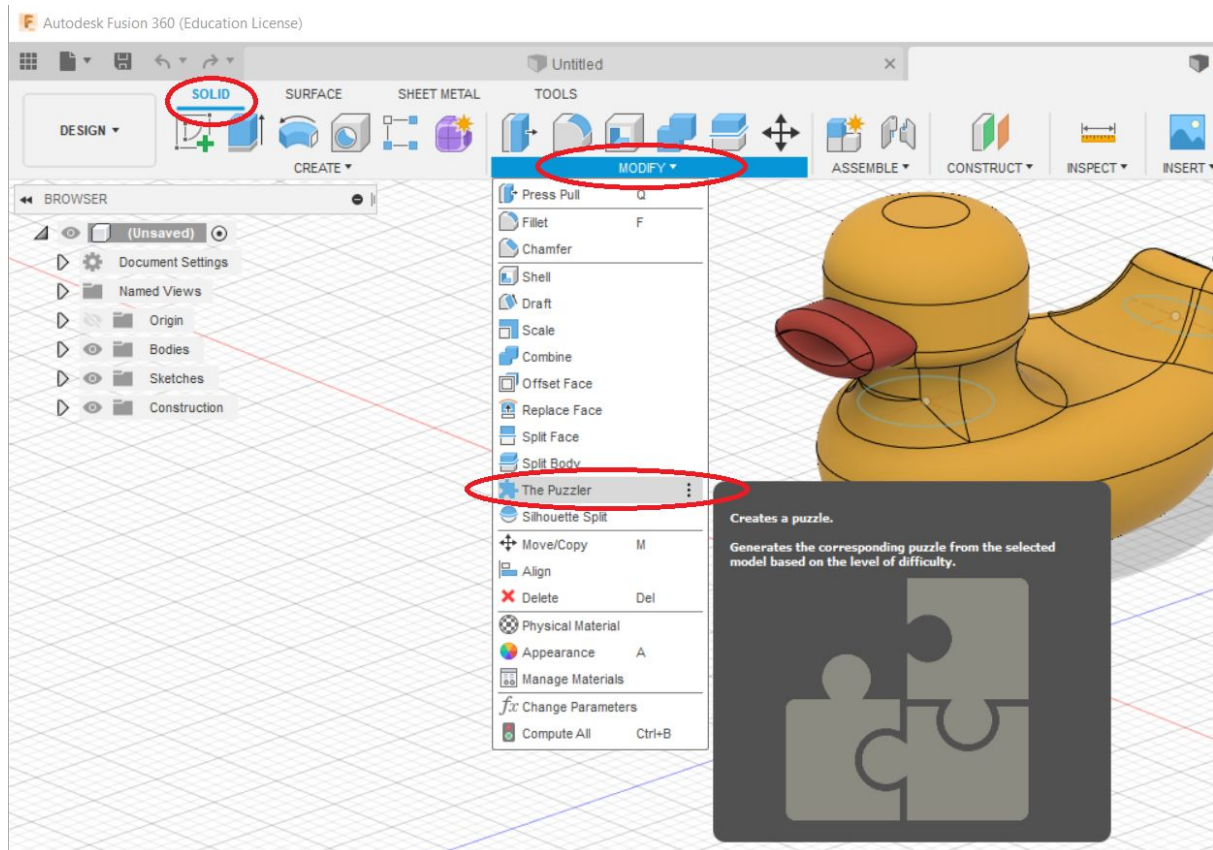
Flowchart - Code Execution Overview



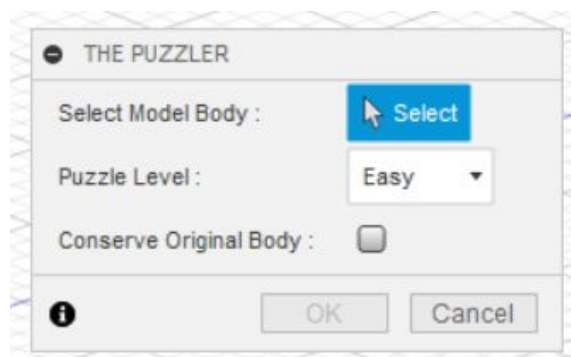
Design Choices

This section highlights the design choices and the reasons behind them.

- **Placement of the Plugin:** The Puzzler Add-In is placed in the **Modify** option (below 'Split Body') of the Solid panel. As it is used to modify 3D models and split them into puzzle pieces.

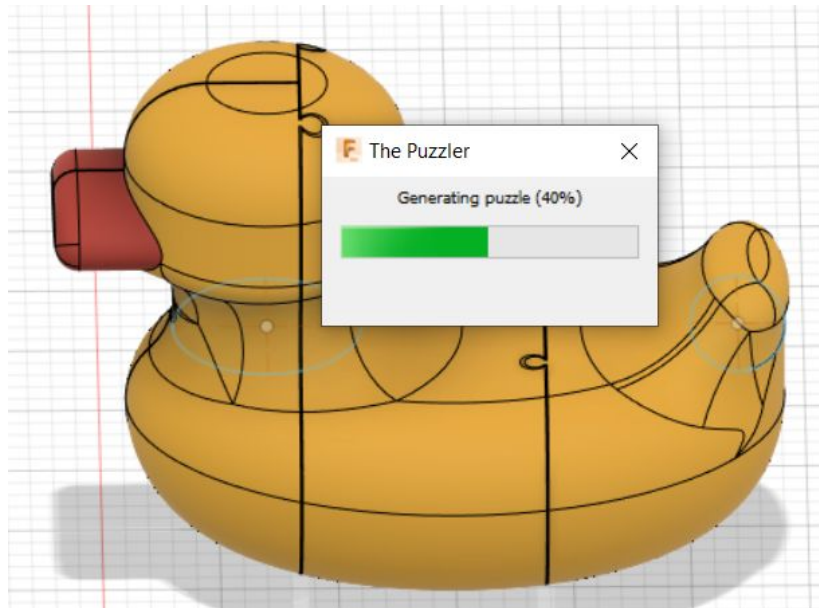


- **User Friendly UI Elements:** The user input fields are easy to understand and prevent confusion. **Information icon** is added in the user input dialog box which links directly to the manual in case of additional support. The **OK** button is kept disabled until all the required inputs are provided to avoid running into issues.

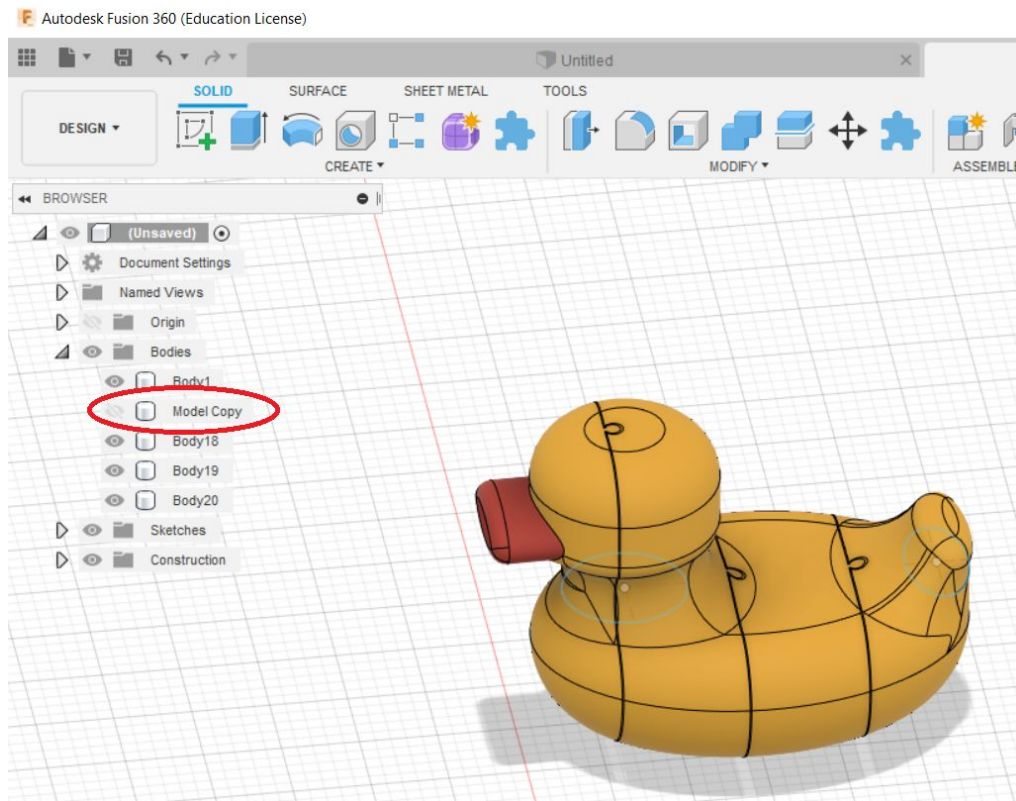


- **Better User Experience:**

The processing status is shown via a progress dialog to provide an understanding of percentage completed.



A copy of the selected model body is preserved and hidden even when the **Conserve Original Body** option is not selected. This provides an option to make the model copy visible from the list of **Bodies** and see the unpuzzled model if desired.



- **Combining the puzzle pieces:** Since the puzzle generated is in 3D, the puzzle pieces need to be put together in a specific order (section-wise) for the pieces to fit together. For example: A duck has 3 sections, front head, mid-body and back tail. Each of these sections have multiple puzzle pieces, so the pieces conforming each section need to be combined first and then the complete sections can be assembled together.

Limitations

This section lists the limitations of the plugin.

- For 3D models containing curves and grooves, the arcs of the puzzle pattern might get stretched on those areas.
- Re-puzzling of an already puzzled body is not possible. Instead, run the plugin again and adjust the level of difficulty.
- Depending on the complexity of the 3D models, the plugin might generate small bodies which cannot be joined as a puzzle piece. However, these small bodies are hidden to avoid confusions.
- The plugin limits selection up to 3 bodies at a time. This is by design to control the waiting time and avoid performance issues.