

MFG468283-L

Design Focused For Additive Manufacturing

Alexander Jones
Johnson & Johnson

Anthony Muzzillo
Autodesk Inc

Learning Objectives

- Understand How to Lightweight a Part: *Level 1 – Hollow Existing Part*
- Understand How to Lightweight a Part: *Level 2 – Using Lattice Structures*
- Understand How to Lightweight a Part: *Level 3 – Using Generative Design*
- Understand Part Orientation and its Effects on 3D Printing Processes

Description

The layer-by-layer process in additive manufacturing (also known as 3D printing) allows for many complex and unique designs that are difficult or impossible with other manufacturing techniques. In order to make 3D printing a worthwhile manufacturing method over other methods like machining, it is key to design the part for 3D printing and include many of design features that can enhance part functionality.

This hands-on class focuses on general design practices that apply to all types of additive manufacturing including metal and polymer materials. This handout is focusing primarily on the case studies that are presented in the class with more details on the workflows followed.

Authors

Alexander Jones is an engineer that supports the Johnson & Johnson 3D Printing Team and leads the 3D printing training and education efforts. He has created and led several in-person and virtual workshops, self-paced trainings, and other educational resources for all in JNJ to understand and utilize 3D printing capabilities. He has also been part of the development process of several 3D printed medical devices and manufacturing tools, jigs, & fixtures.

Anthony Muzzillo is a Principal tech consultant in the GCD team at Autodesk, Inc. He has been with Autodesk for 6 years after it acquired his former company, Magestic Systems. Muzzillo has working in the manufacturing industry for 14 years in total. His current focus is additive manufacturing primarily polymer and metal 3D printing

Understand How to Lightweight a Part

Level 1 – Hollow Existing Part

Lightweighting a part by hollowing an existing part is the most basic approach. It involves simply converting an existing design to be replicated on the 3D printer. Automated infill options are available for lightweighting and improving build quality.

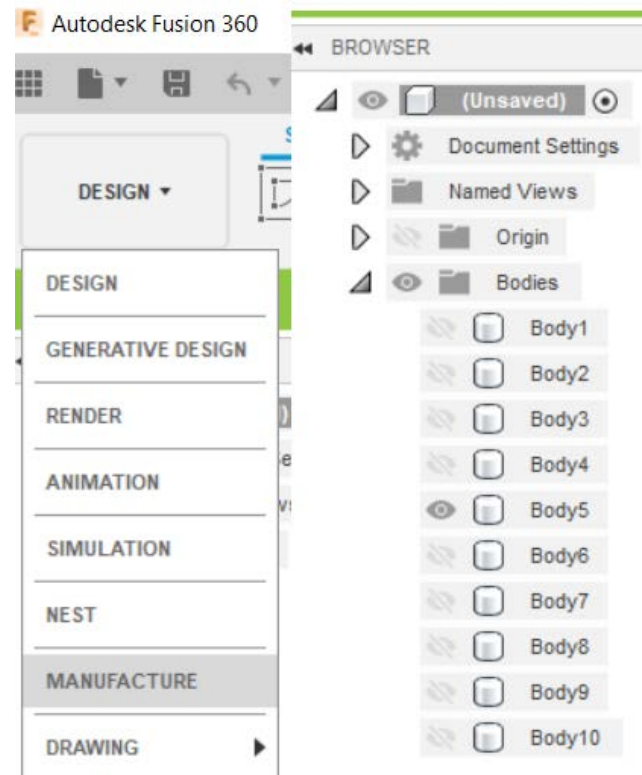
Note: The first 4 steps are completed prior to the video clip

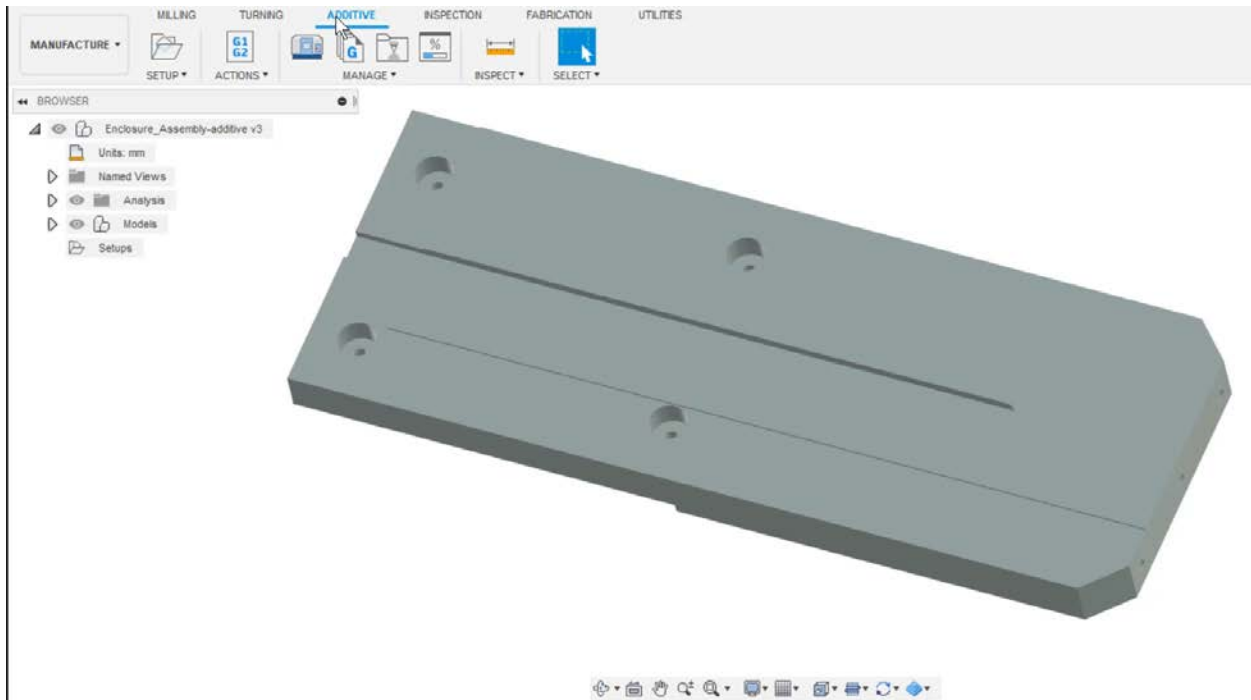
Open existing design

1. Open Fusion360 and sign in
2. Open Assembly that came with this document called
Enclosure_Assembly_100mL.stp
3. Hide all the bodies except for **Body5**
4. Change from Design to **Manufacturing Workspace**

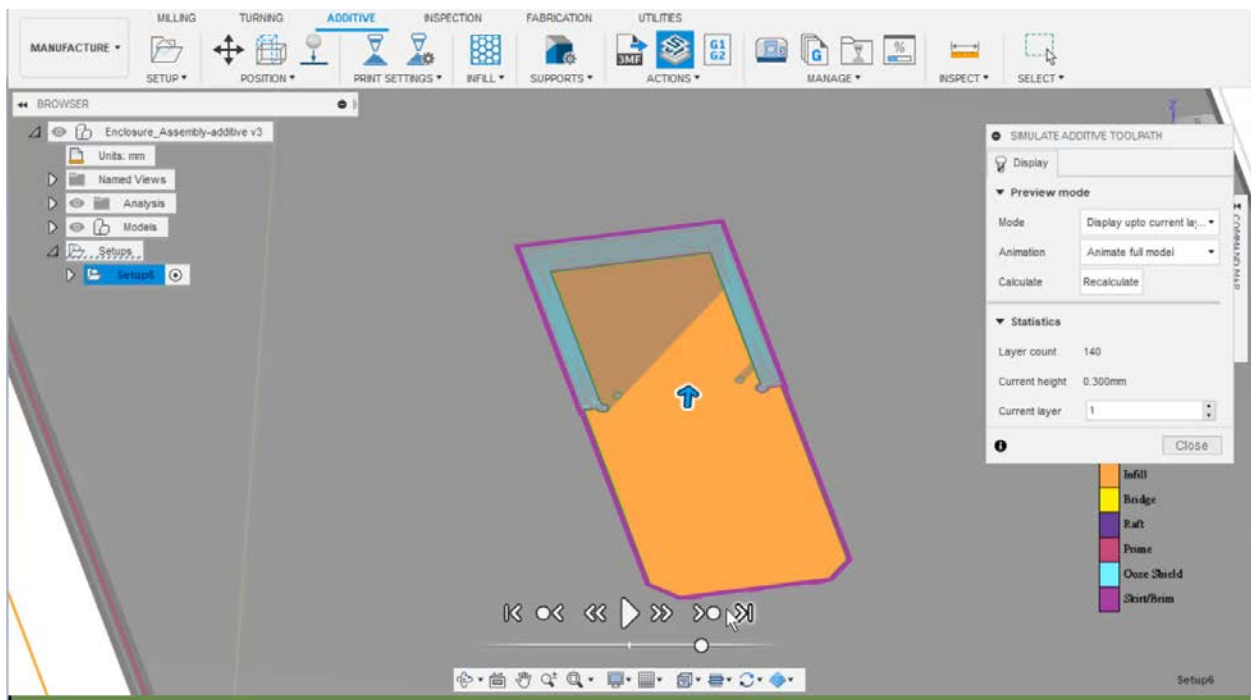
Prep design for printing

1. Change to the **ADDITIVE** tab
2. Click **New Setup**
3. Select **Body5** if not already preselected
4. Select **Machine** from list. *Filters are your friend. Don't freak out if your exact machine is not there. You can edit the settings later*
5. Select **Print Settings**. *Filters outstanding. Just as before, you can customize any of the settings later*
6. Create your setup
7. Move part to center of build plate if necessary
8. Open **Edit** under **PRINT SETTINGS**. *This is where you change any of the settings from step 4 or 5.*
9. Modify any settings you need for your specific printer
10. Now click on your **FFF infill** under **INFILL**. *This is where to set up the magic **Gyroid** pattern*
11. Choose your pattern and infill density then click **OK**
12. Click **Generate** under **ACTIONS**
13. *Go get a cup of coffee while the toolpath completes*
14. Click **Simulate Additive toolpath** under **ACTIONS**
15. *Watch the cool gyroid pattern layer by layer*
16. If you were actually going to print this, you could export the GCODE by clicking **Post Process** under **ACTIONS**





[Click here to view video](#)



[Click here to view video](#)

Understand How to Lightweight a Part Level 2 – Using Lattice Structures

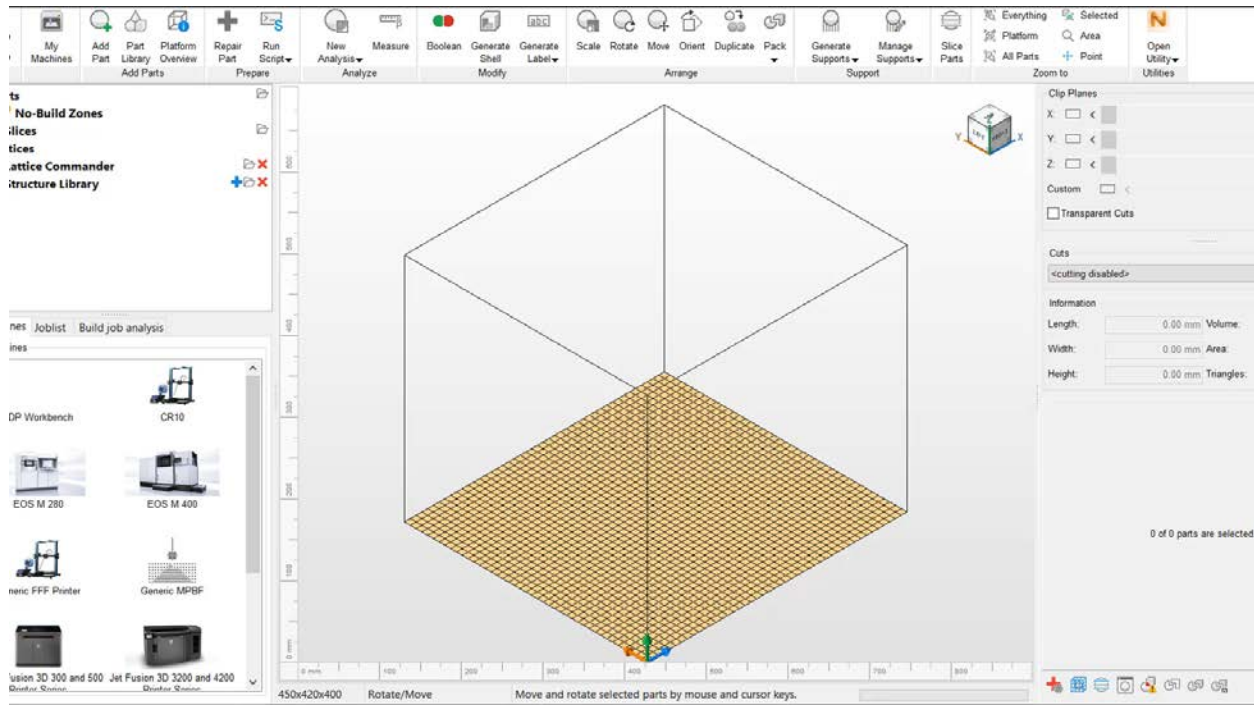
The next level of lightweighting a part adds onto the process of level 1. It is completed before level 1 where applicable. It involves hollowing and lightweighting the part using the creation of a lattice and optional variable thickness lattice bars and skin thickness within Netfabb Optimization utility.

Open existing design

1. Open Netfabb and sign in
2. Open Assembly that came with this document called [Enclosure_Assembly_100mL.stp](#)
3. Hide all the bodies except for [Enclosure_Assembly_100mL_5](#)

Lattice Commander

1. Click and Drag [Enclosure_Assembly_100mL_5](#) into the **Lattice Commander** portion of the project tree
2. Click **Volume Lattice**
3. Change Unit Topology to **Star** to match mine, or choose your own
4. Change lattice settings to match part dimensions
 - a. Unit size X = **14mm**
 - b. Unit size Y = **7mm**
 - c. Unit size Z = **14mm** (you can also try 21, 28, ect)
5. Change **Thickness** to match your printer extrusion thickness (in this case 0.4mm extrusion thickness). You can try **1.2mm** to start
6. Click **Generate**
7. **Optional:** To generate Skin, click your original [Enclosure_Assembly_100mL_5](#) in the project tree under **Lattice Commander**, then select **Hollow**
8. Once you have everything you need you can click **Generate Component**
9. Now you can pick up with the workflow from Level 1
 - a. Fusion360 OR Netfabb.
 - b. If you choose Fusion360 you can follow along the steps in this document.
 - c. To move the file over to Fusion360, just click **Export to STL**
 - d. Open the STL in Fusion360



[Click here to view video](#)

Understand How to Lightweight a Part Level 3 – Using Generative Design

Level 3 of lightweighting a part can be used in conjunction with level 1 and / or 2. It is completed before level 1 and/or where applicable. It involves a complete redesign or potentially reimagining the part altogether. This can include part consolidation, and you are encouraged to try to combine all the parts in this assembly yourself. However, for the purpose of this document, we will simply optimize one of the existing parts to keep the initial example most simplistic and easy to follow

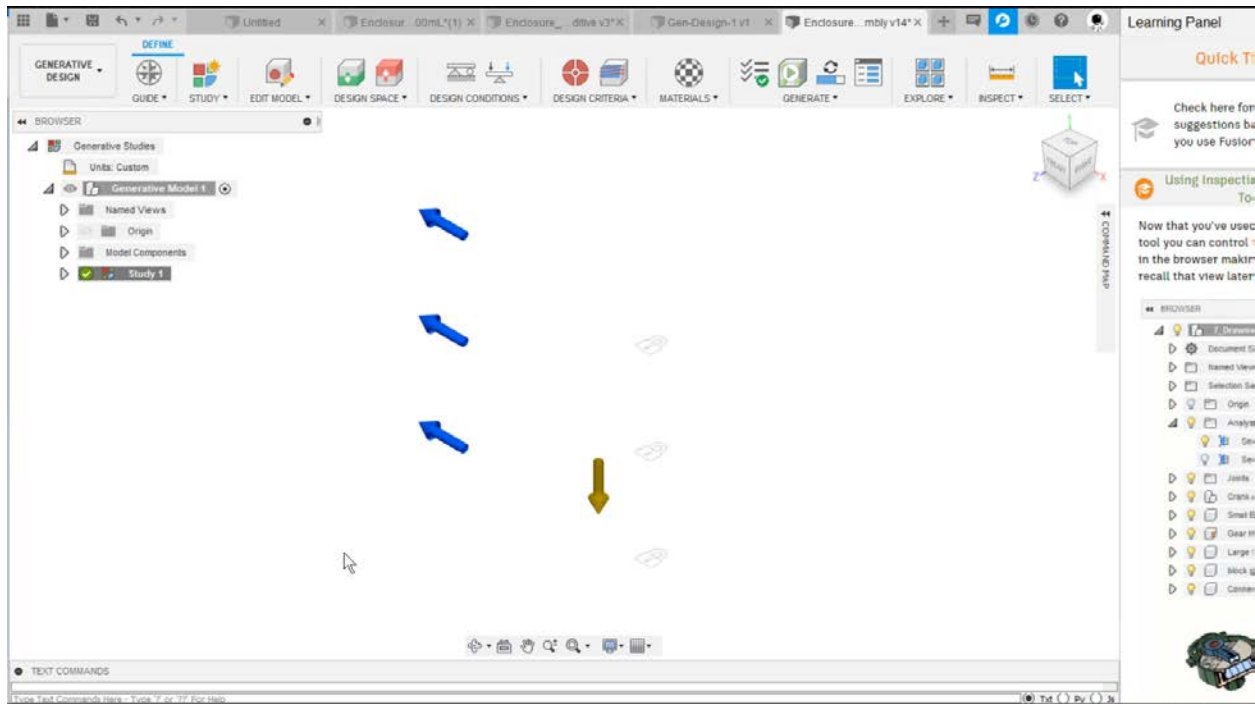
Note: Opening the design and prepping for generative design are completed prior to video clip

Open existing design and prepare for generative design

1. Open Fusion360 and sign in
2. Open Assembly that came with this document called [Enclosure_Assembly_100mL.stp](#)
3. Delete all the bodies except for **Body5**
4. Create **5mm offsets** around all 6 holes. Save those as individual bodies
5. Create “**mould**” of original part by extruding a prism around its extents in all directions. Then use the original part to cut out it’s shape from the solid block
6. Click help and turn on the **Learning panel**
7. Change material of model to Nylon (or choose many different materials for study)
8. Change to the **Generative Design** workspace

Create Generative Design study

1. Create **Preserve Geometry** with the **5mm offsets** from step 4. Select all 6
2. Create **Obstacle Geometry** with the **mould** from step 5
3. **Optional:** Create starting shape with the original **Body5**
4. Create a **Fixed constraint** on the RIGHT three **5mm offsets**
5. Create 3 Individual **Linear Forces** going in negative X direction with **50 N** on each
6. Modify Study parameters
 - a. Objectives
 - b. Manufacturing – Additive / Unconstrained
 - c. Study Settings – keep slider at least 2/3 of the way to coarse **NOT FINE**
7. Click **Generate preview** to be sure the study is ready to run
8. *If the preview works, generate your study!*
9. See results in real time through the results viewer



[Click here to view video](#)

Understand Part Orientation and its Effects on 3D Printing Processes

Orientation is crucial to effective 3D printing. The effects are as far reaching and varied as amount of material to support the build, to significantly different part when different orientations are used. As such it's never too early to evaluate the best orientation of a single part or collections of parts on a build plate.

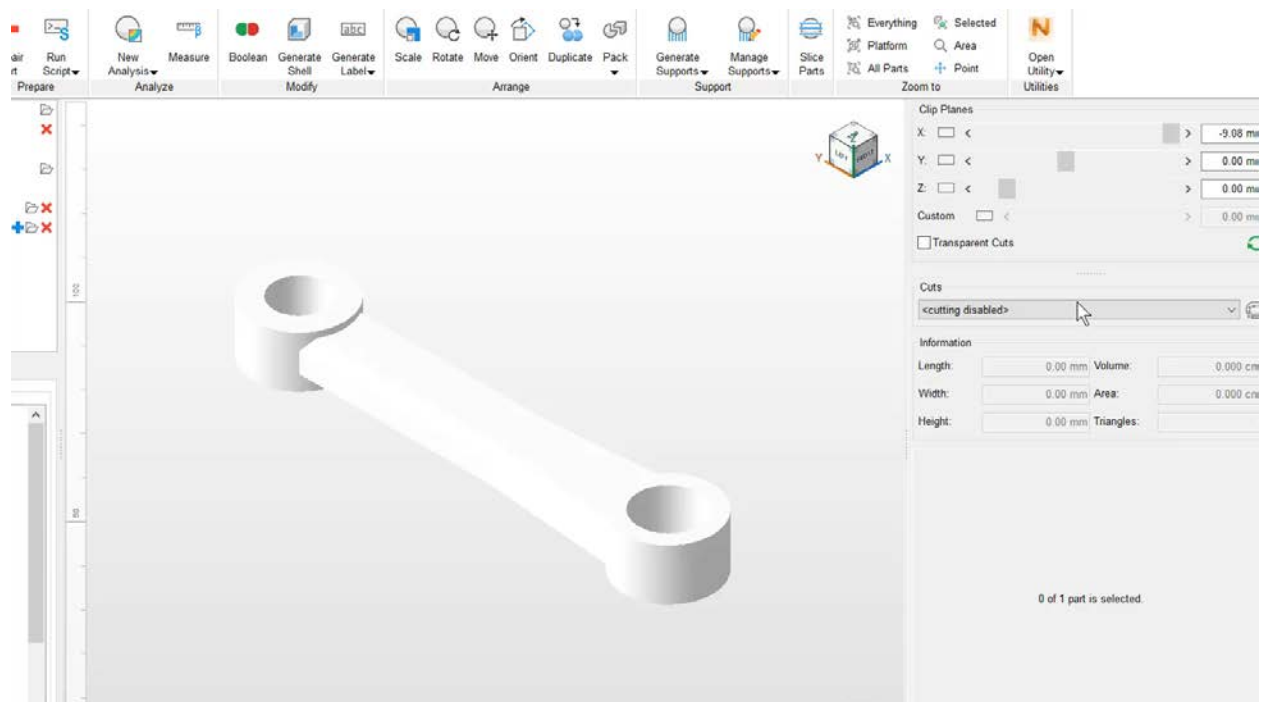
Note: Opening the design and prepping for generative design are completed prior to video clip

Open existing design

1. Open Netfabb and sign in
2. Open Assembly that came with this document called [Engine Con Rod.x_t](#)

Orient part

1. Select con rod and click **Orient**
2. Click **Edit Ranking** and change settings as you see fit
 - a. Change **Supported area** to **5**
 - b. Change **Supported volume** to **0**
 - c. Change **Outbox volume** to **5**
 - d. Change **Part Height** to **0**
 - e. Change **Center of Gravity Height** to **0**
3. **Generate** new results
4. Go over each result and note the different values for different orientations
5. **Accept** the vertical orientation
6. **Duplicate** the part in the vertical orientation to fill the build volume



[Click here to view video](#)

Appendix A: Additional Learning Resources

Lightweighting Level 1: Hollowing Existing Part Resources

1. Learning panel accessed through help
2. [Online Traditional support](#)
3. [Fusion Design Academy](#)

Lightweighting Level 2: Using Lattice Structures Resources

1. [Netfabb Workflow](#)
2. [Lattice Commander](#)
3. [Netfabb Optimization Utility](#)

Lightweighting Level 3: Using Generative Design Resources

1. Learning panel accessed through help
2. [Fusion360 Support](#)
3. [Fusion360 Learning Academy](#)

Netfabb / Fusion orientation support

1. [Netfabb search Orientations](#)
2. [Fusion Automatic Orientation](#)