

How to 3D print a surgical guide

Netfabb Tutorial
for SolFlex 150|170|350|650

This short tutorial seeks to offer basic information concerning the 3D CAD software Netfabb in regards to printing surgical guides on SolFlex 3D printers. After completing the tutorial, you should be able to successfully print your first surgical guide and have a good impression of the digital workflow with Netfabb.

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This tutorial was created using Autodesk Netfabb 2017 Premium on Windows, other Versions might behave slightly different.

Used stl-file: *Surgical_Guide.stl*

All settings shown are referring to our SolFlex 350 printer. Settings for all other printers can be found in the appendix.

1. PREPERATION

To start off preparing the print, the W2P machine workspace has to be initialized using the **Load Machine Workspace** button located at the top-left of the window (Figure 1). After choosing **W2P SolFlex** from the drop-down menu, a **3D model** of a SolFlex printer should show up in the main view window.

The next point of interest is the so-called **Build Job** tab, where you can find some of Netfabb's main functionality (Figure 2).

1.1. SETTINGS

There, the first thing to do is to adjust your **Machine Settings**. This is done by clicking the **Settings** button on the **Build Job** menu to open a small window called **Machine Settings** (Figure 3) where you can adjust the general settings of your build job.

- For **Machine Type**, select the printer that you are going to use for the print.
- The **Layer Thickness** determines the level of detail of the print. For this application a layer thickness of **100 µm** is recommended.
- The **Support Wall Thickness** determines the strength of the support structures. For smaller prints, a thickness of **200 µm** is recommended.
- For the **Export Type** option select **PNG Image Export**.
- In terms of **Material** it is important to select the **exact** material you will be using for the print. For surgical guides, it is recommended to use the **SolFlex Surgical Guide** material.

Once you are done, hit the **OK** button to continue.

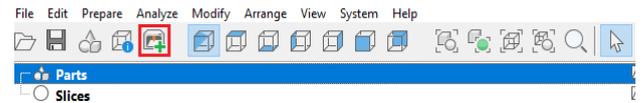


Figure 1: Load Machine Workspace

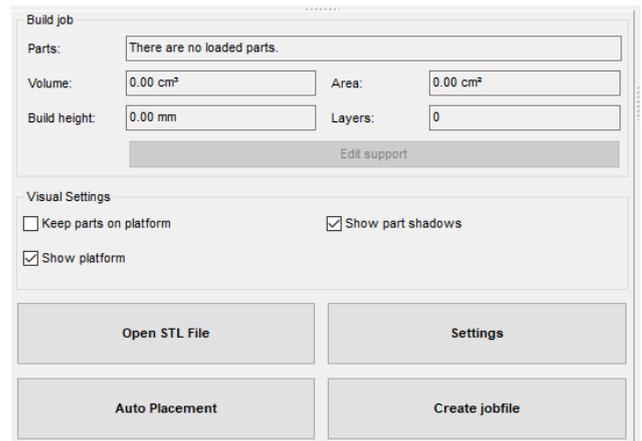


Figure 2: Build Job Menu

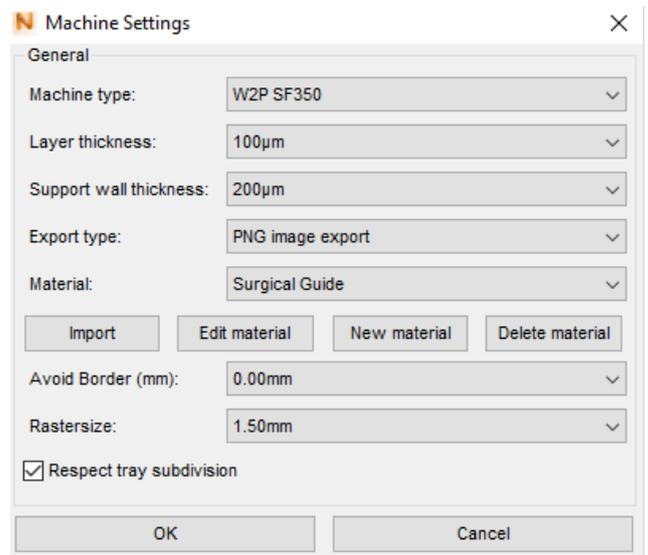


Figure 3: Machine Settings

1.2. IMPORT A STL FILE

The object to be printed will be stored as a **STL-file** and needs to be imported into Netfabb, which can be done in two main ways:

- **Drag and Drop:** Simply drag and drop your STL-file from the file-explorer into the Netfabb-window.
- **Opening via File-Explorer:** Hit the **Open STL File** button and open the file through Windows Explorer (Figure 4).

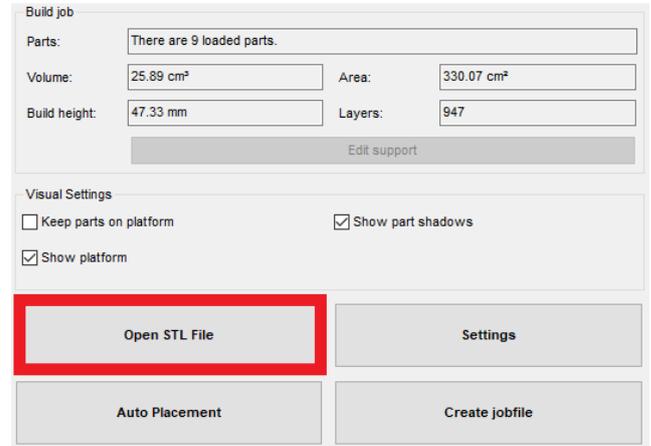


Figure 4: Open STL File

2. OBJECT ORIENTATION

Now that the object is imported into Netfabb, it needs to be positioned carefully to ensure correct printing.

2.1. NAVIGATE IN NETFABB

On the top-left of the screen, Netfabb's **view options** can be found (Figure 5). These consist of one isometric and six directional view options which control the **viewing angle**. Use these options when positioning the object.



Figure 5: View Options

 When using one of the six **directional view options**, you can only move the object in two dimensions. This can be extremely useful if an object needs to be reallocated while keeping the same distance from the building platform.

2.2. ROTATE PARTS

The **correct orientation** of the object is very important since the outcome of the print depends on it. It should be oriented in a way that minimizes the amount of 'overhangs' and 'steep angles' which can be difficult for the printer to print. The surgical guide should optimally be printed on an **angle of about 45°**.

This is done by left-clicking the part on one of its corners and then roughly rotating it to the desired rotation (Figure 6).

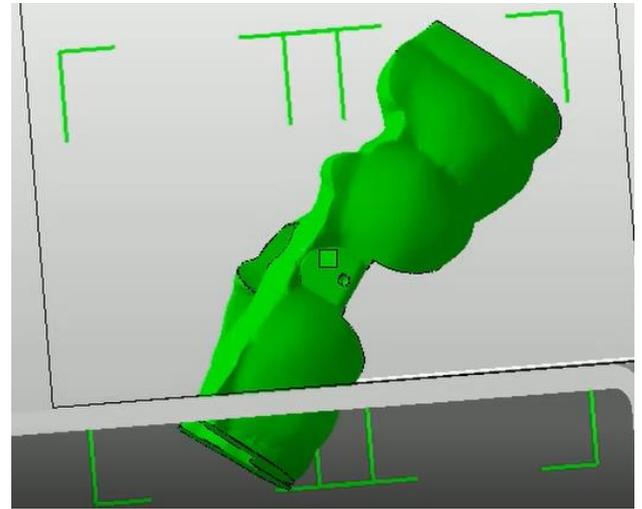


Figure 6: Correct Rotation

2.3. MOVE PARTS

For the following steps the box **Keep parts on platform**, which can be found under the **Visual Settings** tab on the left side of the screen, needs to be deactivated.

The part is now sticking through the building platform. To solve this issue, it has to be **moved upwards**, which can be done by clicking the **move parts** button in the top-centre of your screen (Figure 7). After clicking it, you will be greeted with a variety of options to move the part (Figure 8).

First of all, we want the part to be located on top of the building platform, which is done by selecting the **To Bottom** option and hitting the translate button.

Now that the part is located on the platform, it needs to be **moved up** even **further** to improve printing results by allowing the addition of support structures. To do this, apply a **positive 5 mm translation** along the z-axis (up) as shown in Figure 8. To finish, hit **translate**.



Figure 7: Move Parts

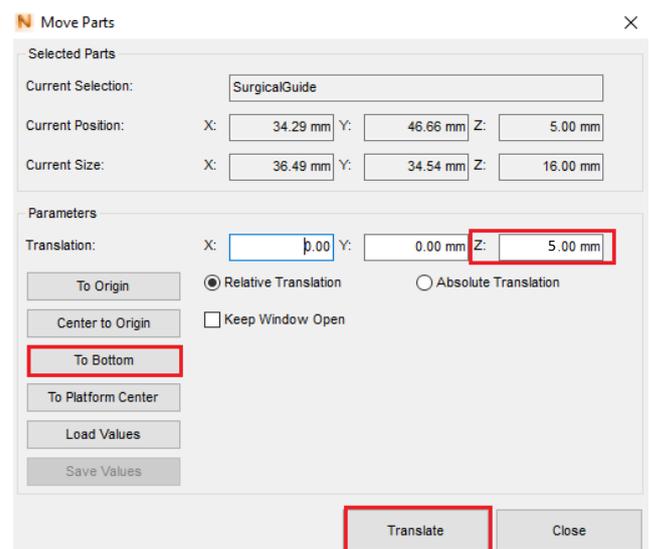


Figure 8: Move Options

2.4. Z-COMENSATION

Whenever working with printers that use light-curing materials, it can happen that the first few layers of the model are printed slightly thicker than the rest, which may result in a distorted print. To counteract this phenomenon, Netfabb offers the **Z-compensation option**.

It can be found by **right-clicking** the object and then navigating all the way down in the resulting drop-down menu to the **prepare** tab. By clicking the z-compensation button, a small window labelled Z-Compensation should open up (Figure 9). Set the **translation parameter** to **0.1 mm** and make sure the box **Use Up-/Down-Skin Analysis Preprocessing** is ticked. Hit the **OK** button to confirm.

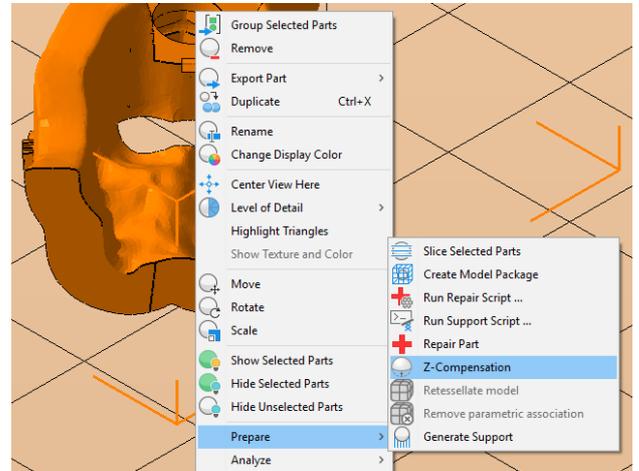


Figure 9: Z-Compensation

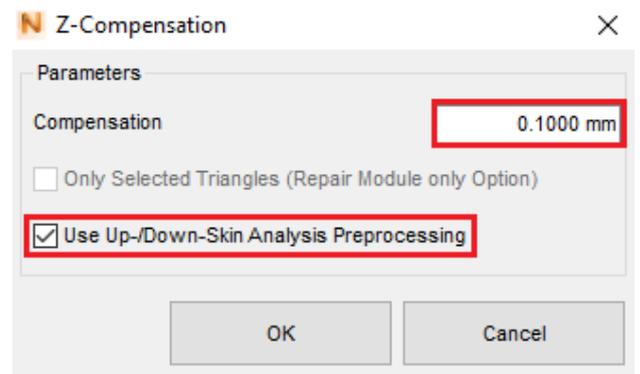


Figure 10: Z-Compensation

3. SUPPORT STRUCTURES

Even after correctly orienting and positioning the object, it can't be guaranteed to print properly. To further stabilize and improve the 'printability' of the bridge, **support structures** have to be added to it.

Hit the **Edit Support** button under the build job tab to access the **support application mode**.

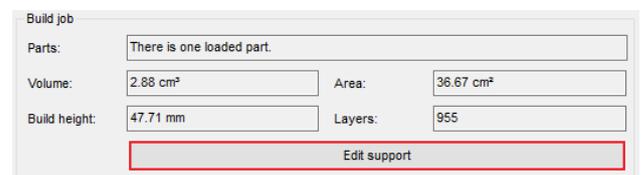


Figure 11: Edit Support

3.1. EXAMINE THE PART

Your surgical guide will be **analyzed automatically** and **critical areas** that need support will be marked **in red**.

Additionally, you can examine the part **manually** by activating the z-view slider (Figure 12). This allows you to inspect **individual layers** of the part. Supports have to added to areas where the green indicating line gets **significantly thicker** than usual or **splits in two**, which means that at this exact spot there is an overhang.

 Again, it helps a lot here to work with **directional viewing** options integrated in Netfabb.

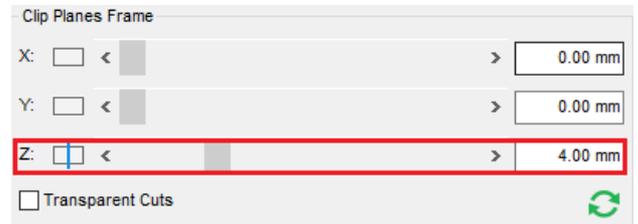


Figure 12: Z-View Slider

3.2. ADD SUPPORT STRUCTURES

After examining the part, you are ready to add the support structures. There are three types of structures available in Netfabb, which all can be found at **the top** of your screen (Figure 13).

We start by adding a so-called **polyline structure** to the very bottom of the part to support its base. To do this left-click on the polyline button, then place the polyline as shown by left-clicking the correct spots on the part itself (Figure 14). For this specific surgical guide, a second polyline has to be added in the same way at the next big overhang.

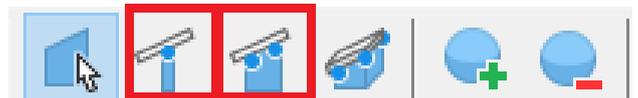


Figure 13: Support Structures (Bar / Polyline)

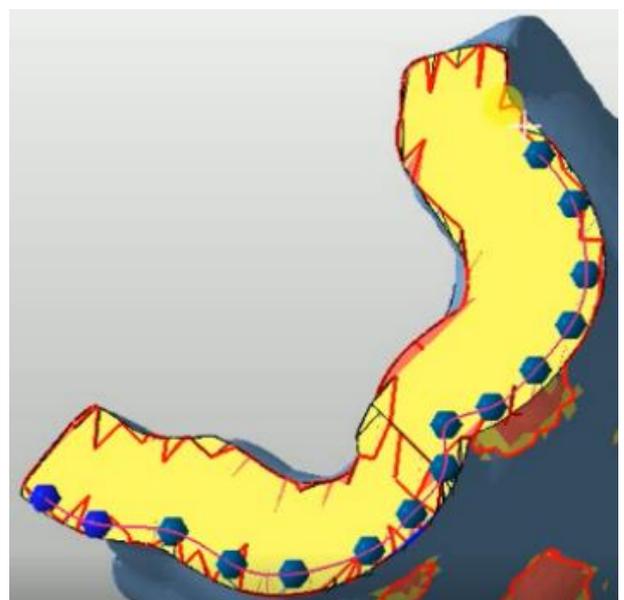


Figure 14: Polyline Supports

The second kind of support which has to be added are so-called **support bars**. This is done by first clicking the support bar button and then double-clicking the part anywhere where support is needed. It is important to **cover all red areas** thoroughly and to **reinforce** the supports at the base of the part (Figure 15). It is often better to add too many supports than not enough!

To finish the process, go to the Analysis tab on the bottom left of the screen and confirm with **apply support**.

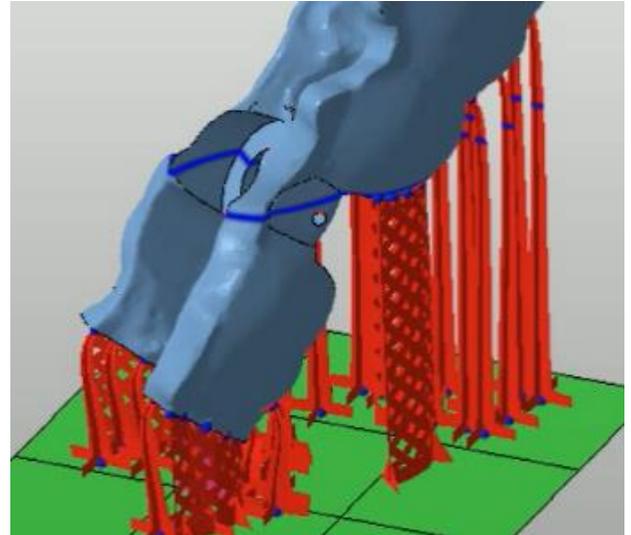


Figure 15: Bar Supports

3.3. DUPLICATE PARTS

This step is optional. If needed, parts can be duplicated easily to allow for higher print volumes.

To do this, first **right-click** the part and then navigate down to **Duplicate** (Figure 16). This will open up a window labelled **Duplicate Parts**. There, the **Total Count** of duplicates can be set. The maximum number may vary depending on **the size of the model** and the printer in use. In this case, the SolFlex 350 printer supports 9 of our guides (see the appendix for more printers).

Following that, navigate down to the **Placement** tab and make sure to only check the **X** and **Y** options. This will ensure that the duplicated parts will not be stacked on top of each other. Now also set the **count** of duplicates for each dimension and the **gap size** between the duplicates (Figure 17).

After you are done, simply hit **Duplicate** which - if the settings were chosen correctly - will result in an array

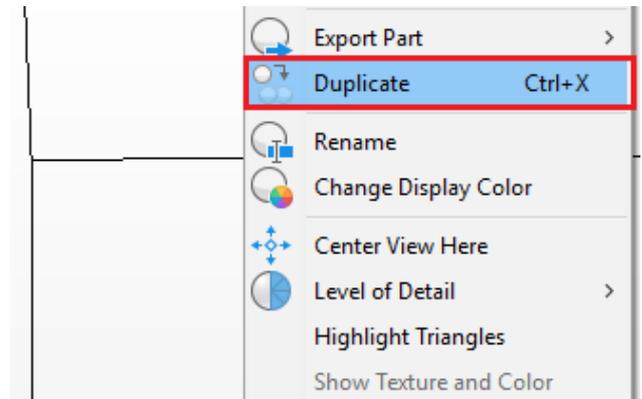


Figure 16: Duplicate

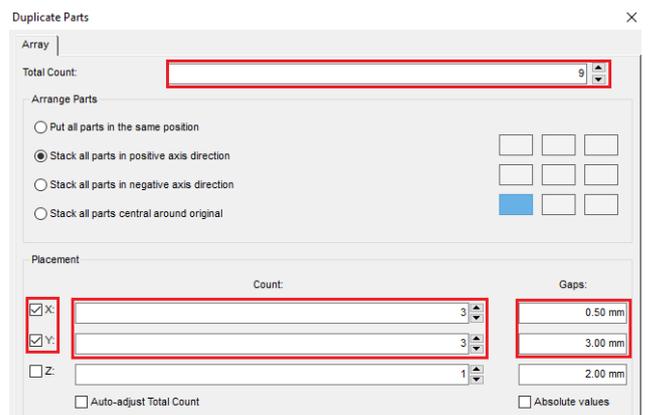


Figure 17: Duplicate Parts

of properly positioned parts. However, if some them are coloured **yellow** or **red**, their exact positions need to be adjusted.

3.4.ADD A SUPPORT GRID

To ensure that all the parts are stable and fixed to the platform adding a **support grid** is recommended.

If you already have a STL file of a support grid you can simply import it into your Netfabb project as described in **step 2** and ignore the following steps.

Otherwise you can create one yourself. To do so, first navigate to the **Part Library** button located on the top-left of your screen (Figure 18). Then enter the **Technical** tab and select the **Hexagonal Grid** (Figure 19).

Now you will be greeted with a **Pre-view** of the grid and a **Settings** tab. Simply adopt the settings from **Figure 20**. Note that the **Count of Holes** necessary in x- and y-direction may vary depending on the printer you are using (settings for other printers can also be found in the appendix).

To then bring the grid to your project simply hit the **Create Part** button.

After successfully adding a hexagonal grid, your building platform should look similar to the one shown in **Figure 21**.

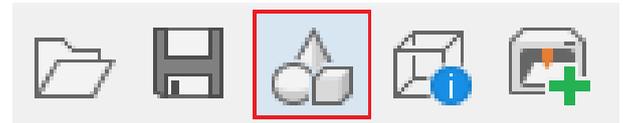


Figure 18: Part Library



Figure 19: Hexagonal Grid

Attributes	Settings
Hexagonal Grid	
Name	Hexagonal Grid
Color	
Radius	7.000 mm
Wall Thickness	1.500 mm
Count Holes in X-Direction	4 #
Count Holes in Y-Direction	10 #
Height	2.000 mm
Triangle Edge Length	1.000 mm
Triangles	17568 #

Figure 20: Grid Settings

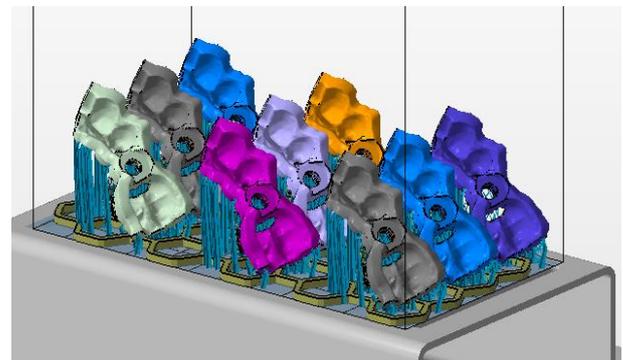


Figure 21: Supported Surgical Guides

4. CREATE A JOBFILE

The last step before you can finally print the parts is to create a **Jobfile**. To do so, navigate to the bottom-left of your screen and hit the **Create Jobfile** button (Figure 22).



Figure 22: Create Jobfile

This will result in an **explorer-window** opening up. Here you can choose a location where you want to save the file and name it.

To make handling a lot of jobfiles easier, it is recommended to use a naming scheme like this:

'PrinterModel_LayerThickness_SupportThickness_Material_Description'

Now your jobfile is being created. Note that this process may take up to several minutes depending on the **amount** and **size** of the parts and your computer's **CPU** (Figure 23).

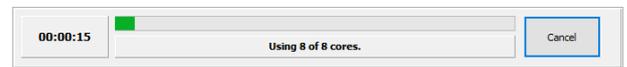


Figure 23: Process of Creating the Jobfile

After the jobfile has rendered, you are done and can simply select it on your **SolFlex 3D printer** either from a **USB flash drive** or a **network connection**.

REFERENCE FILES

Netfabb project: Surgical_Guide.fabbproject

Jobfile: 350_100_200_NDSGo_SurgicalGuide.zip

5. APPENDIX

SolFlex 650

In total, the SolFlex 650 printer can print 36 bridges using settings shown in Figure 24.

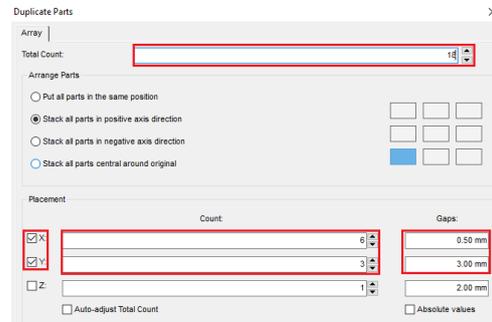


Figure 24: Duplicate 650

The correct grid settings shown are shown in Figure 25.

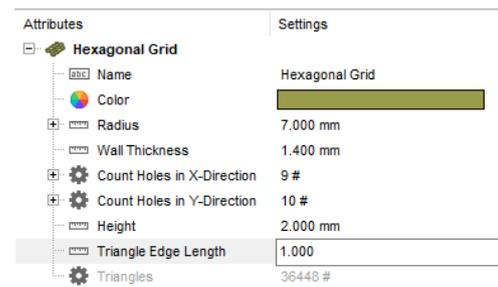


Figure 25: Grid Settings 650

SolFlex 150

In total the SolFlex 150 printer can fit 6 parts as shown in Figure 26.

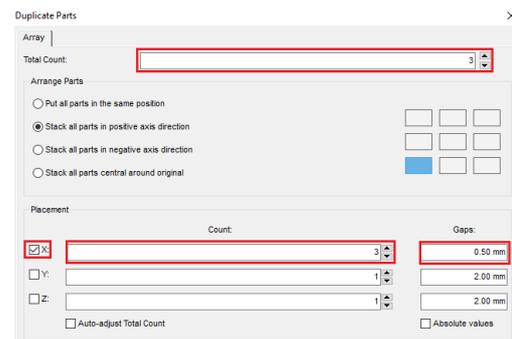


Figure 26: Duplicate 150

Correct grid settings are shown in Figure 27.

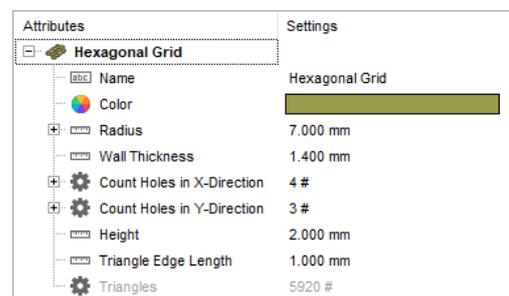


Figure 27: Grid Settings 150

SolFlex 170

In total the SolFlex 170 printer can fit 8 parts as shown in Figure 28.

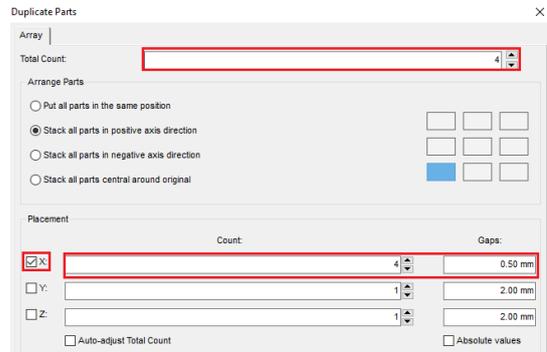


Figure 28: Duplicate 170

Correct grid settings are shown in Figure 29.

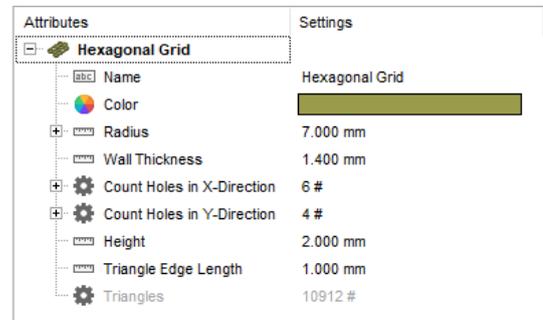


Figure 29: Grid Settings 170