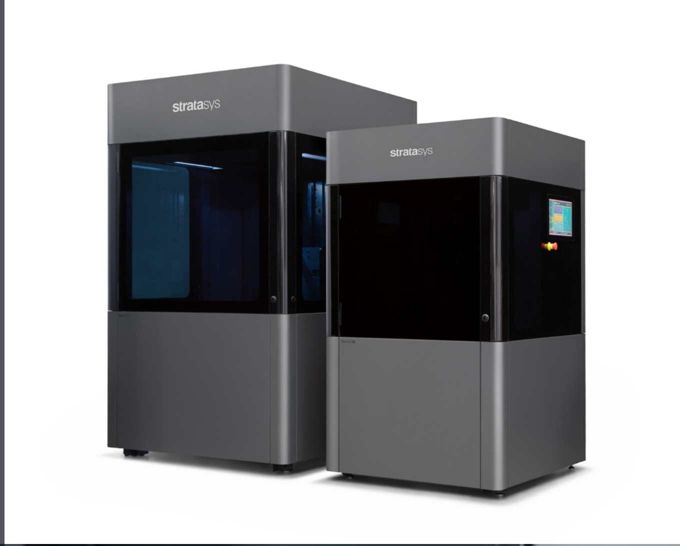
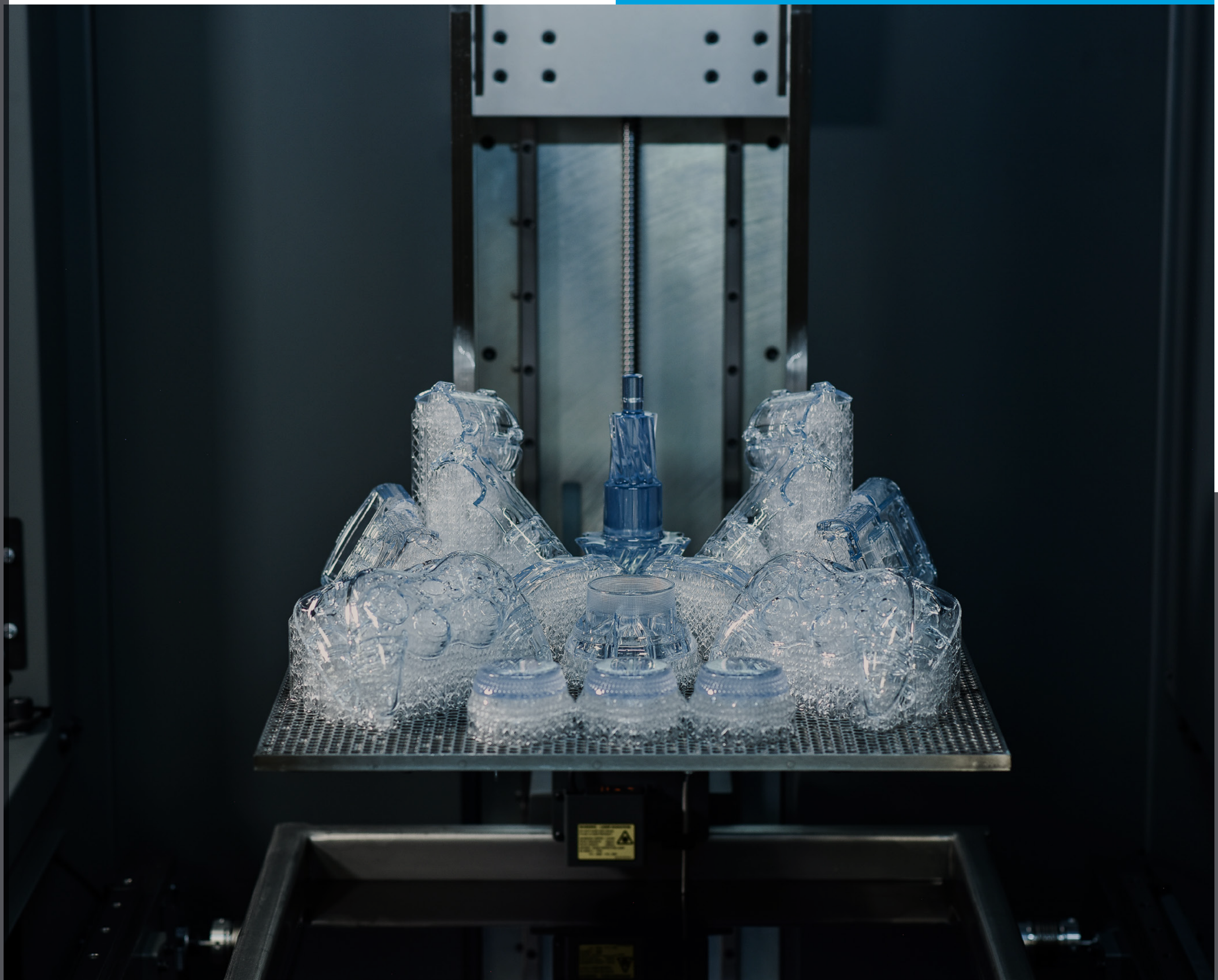




Design Guide:
How to orientate parts for stereolithography.

Achieve industry leading part quality with Neo stereolithography 3D printers.

E-Book

Careful build preparation results in reliable part production

Design consideration and part orientation is an important step in the 3D printing build preparation process.

When printing parts using stereolithography (SL) 3D printing technology, how you orientate a part on the platform and generate supports prior to print can impact the accuracy and success of the final build.

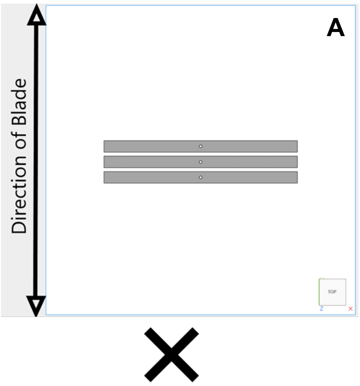
The reliable and proven Neo® stereolithography printer can build high-quality parts that are dimensionally accurate, with exceptional sidewalls and sharp feature resolution, reducing finishing time by up to 50%. The Neo 3D printer can produce many parts in one build or larger parts, perfect for highly demanding industries requiring more speed and reliability.

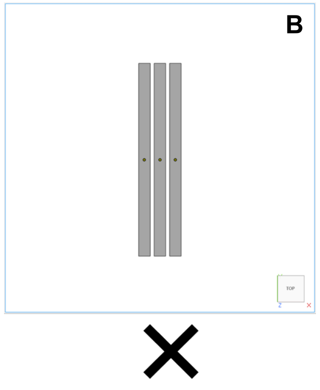
This guide will give you an overview of the types of design considerations to look out for, such as analyzing the geometry for optimal part placement. The capabilities of the Neo, combined with careful build preparation will result in reliable, industry leading SL part production, every time.

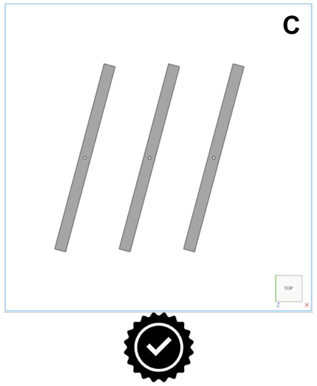
What Is Stereolithography Technology?

The Neo 3D printer series uses 3D printing process called stereolithography. The stereolithography technology process consists of a vat of liquid UV-curable photopolymer resin and a UV laser, that builds parts one layer at a time. Using the photopolymerization process, light causes chains of molecules to link together, forming polymers that make up the body of a three-dimensional solid. Understanding this layer-by-layer, UV curing process and how this technique makes the final part geometry is important when preparing builds. Read more to find out why.

Orientating
to the Blade







To ensure each layer is evenly coated with uncured resin at the correct height, a blade/recoater is used which travels along the Y axis.

It is important to consider the blade when setting up parts on the platform and where possible, avoid placing parts flat to the blade.

In the three images to the right, we can see the same parts rotated at different angles to the direction of how the blade travels.

Image A is completely flat to the blade, presenting the largest surface area to the blade. Imagine a wave hitting the side of a boat. There is a chance the part could move slightly between layers and affect accuracy and side wall quality. Worst case scenario, the part could move so much that it crashes the build.

Image B, though rotated 90°, is still not ideal. The blade is hollowed out on the inside and uses a vacuum to hold a certain amount of resin to aid the recoating of the parts. If long parts or multiple short parts are orientated straight along the travel of the blade, it is possible to run out of resin during recoat. In such a case, when the laser draws the next layer there is no resin present to cure. Worst case scenario, subsequent layers do not connect with the part and float away, leading to a build crash.

Image C would be an example of optimal orientation to the blade. The parts still have a small surface area facing the travel of the blade but are rotated slightly at 15°+, to avoid resin starvation during recoat.

Trapped **Volumes**

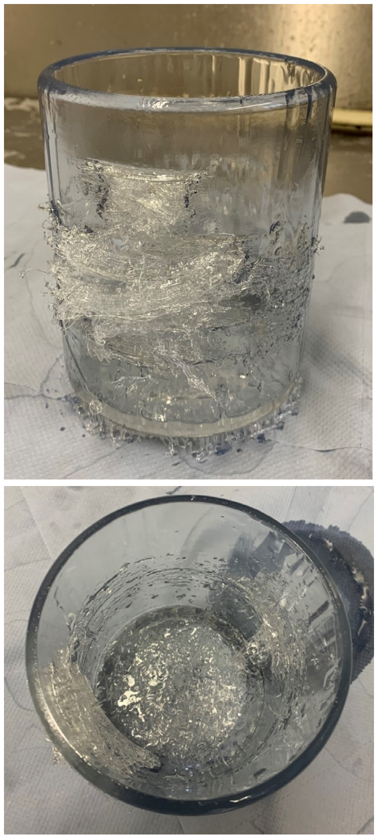
Stereolithography is a technology where parts are printed top down in a vat of resin. Fluid flow and leveling are important to take into consideration when orientating parts and will impact the success of your builds.

The part in **image A** is an example of a trapped volume and the consequences of trying to build one. As the resin cannot drain after the dipping/recoating phase of the layer, excess resin accumulates on the edges due to surface tension, this can result in additional height printing causing the blade to strike the part. It may also create delamination of layers as the extra height in resin prevents new layers from bonding with the layers below.

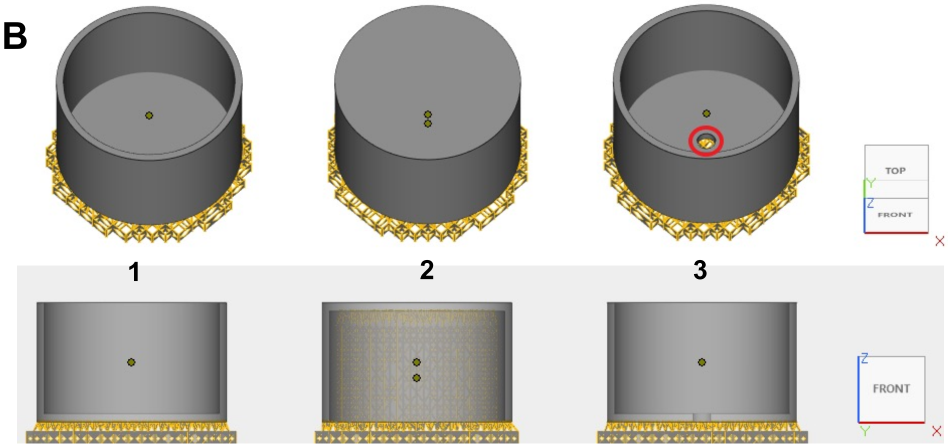
Image B illustrates a closed cup geometry and how to solve a trapped volume

- B1 would be a high-risk build. It is a classic trapped volume that would prevent resin from flowing out until the final layer has printed.
- B2 is the easiest solution, by simply inverting the part, the resin can now flow out the bottom and level during printing. The downside to this option is the extra supports required and the additional post processing.
- B3 is an example of adding a drain hole to the part, circled in red. This sometimes is the only option when there are multiple trapped volumes, or the part orientation cannot be changed. A useful trick is to create a threaded insert that you print with the parts and then bond this in after part cleanup.

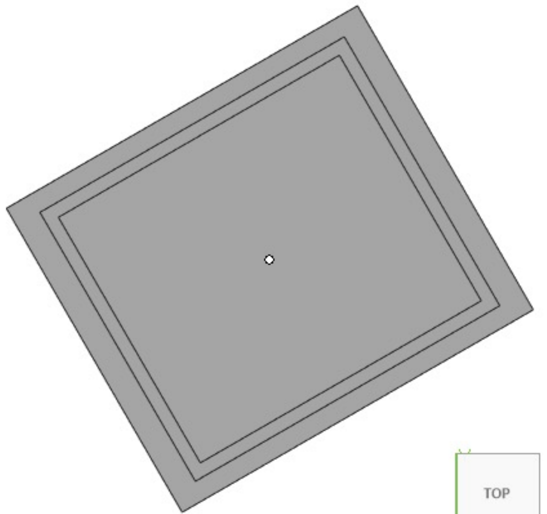
A



B



Large Flats



Large Flats

Large flats in stereolithography can be problematic for several reasons:

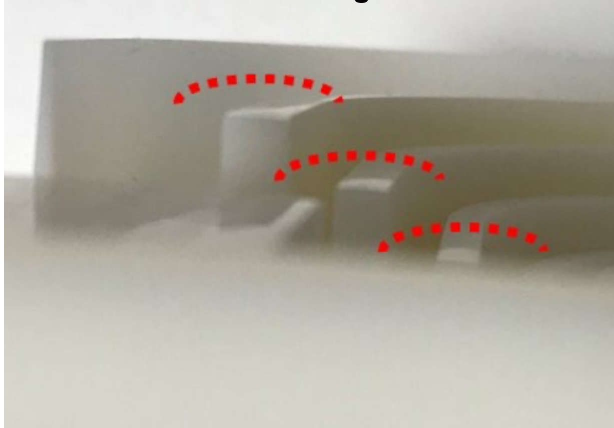
Resin Starvation
A large surface area may not be fully recoated during the dipping and recoating phase and one pass of the blade may not be enough to fully recoat the part.

Doming (or Mounding)
Certain SL resins have high viscosities making recoating, draining and leveling between layers more challenging. These types of resins suffer more with doming and the issue is exacerbated on large flat areas. Visualize poring honey on to a flat surface and the time it would take to flatten out compared to water. Doming will affect the accuracy of the final part.

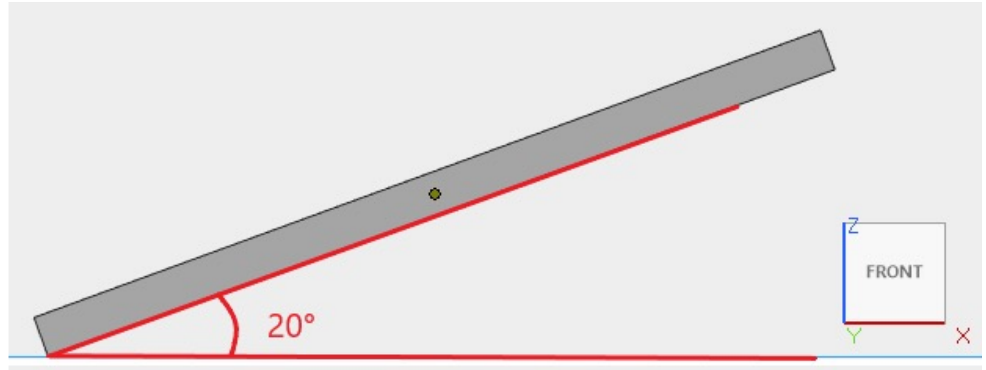
Differential Shrinkage
All materials suffer a degree of shrinkage; therefore, we use scale factors to compensate for this. Differential shrinkage is non-uniform and can cause parts to warp. Most differential shrinkage is seen on the early layers of long or large flat sections. The early layer of a print are only held in place by the supports and will shrink more than subsequent layers that have the previous layers of the part to hold them in place.

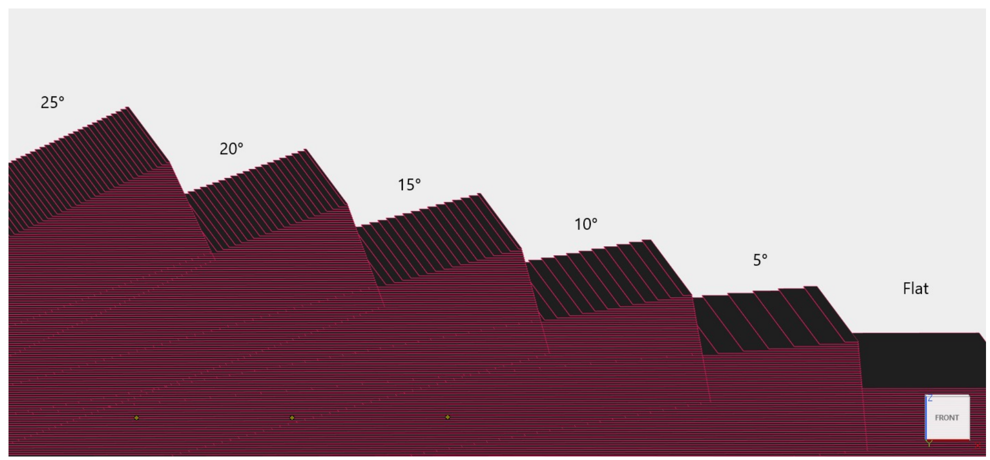
All these issues can be avoided or reduced by angling flat parts, so they are not parallel to the platform. The Titanium software on the Neo series does allow the user to modify certain build parameters to combat some of these issues mentioned above, if orientation cannot be changed.

Doming



Stairstepping





Due to the surface of parts being built layer by layer, any angle that is not square to the build direction will be solved in a stepwise manner. Though layer thickness will have an impact on how preservable this stepping is, careful part orientation can minimize the effect.

Taking this into account, it would be appealing to place vertical surfaces in the Z direction and horizontal surfaces parallel to the platform but doing so may mean that you fall foul of issues mentioned earlier in this guide.

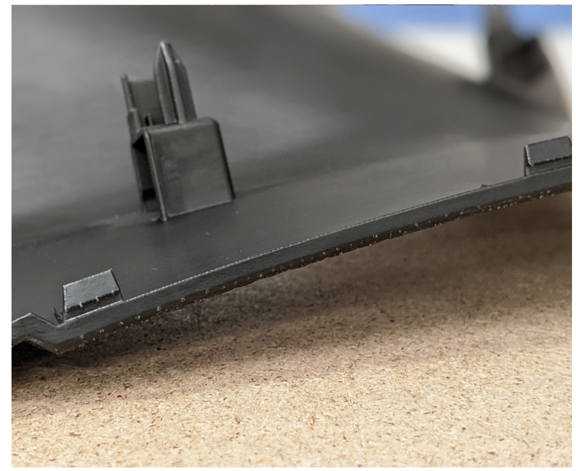
The reality is you are not always working with geometries that have perfectly straight lines. The aim is to minimize shallow angles, as these will produce the most noticeable stairstepping. Try to avoid angles less than 20° at 100µ layer thickness on the Neo series.

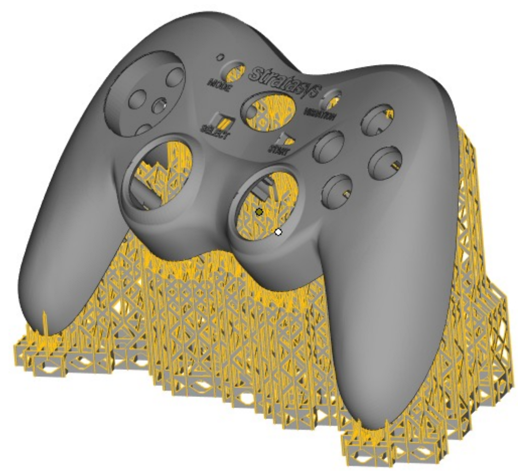
Orientating for Best Surface Finish

Stereolithography requires support generation, therefore orientation will affect the magnitude of supports required. Post build, these supports are removed but do leave witness marks known as pips on the surface of the part.

These pips can be easily removed with sandpaper but where possible you want to avoid the cosmetic face of the part, especially where textures or text is present. The images to the right show both an example of a textured finish and the supports pips left behind on the part after support removal. Here the part was orientated in such a way as to minimize placing supports on the A-Surfaces.

The application itself can direct how you choose to orientate your parts, so understanding the design intent of the models you are printing is key. For example, production of parts for wind tunnel models. Though the aerodynamic surfaces will likely be fully sanded, you can minimize the time taken to do this by reducing stairstepping and supports pips in these areas with careful orientation.





Understanding Minimum Y

The importance of part orientation has been looked at but part placement on the platform is also essential to optimize builds for fastest print times.

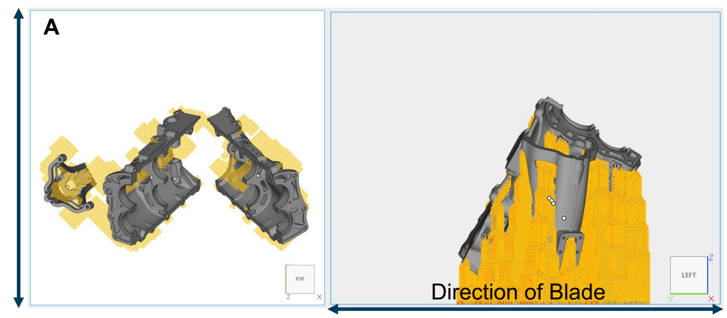
Like many points in this guide, it relates to the blade that recoats the parts. Due to the fact the Neo series uses intelligent recoating, there is a direct relationship between part placement and the distance the blade has to travel to recoat the parts.

As mentioned previously, the blade travels along the Y-axis, so minimizing part placement in the Y area will reduce the distance the blade travels, this in turn will reduce the layer time and bring the overall build time down. This can be seen in the images on the right.

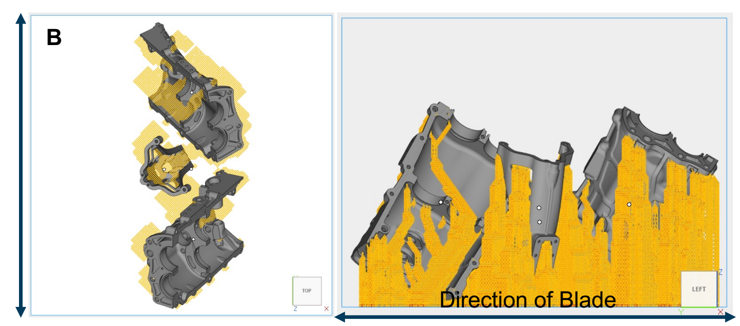
Both builds have the same parts:

- Build A the parts have been positioned to occupy the minimal area in Y-axis while still being mindful of how the blade will interact with the parts when recoating. During this build the blade will travel 1.51 km.
- Build B the orientation of the parts are the same as build A but the parts have been positioned on the platform paying no respect to 'Minimum Y' and this shows in the build time estimates. During this build the blade will travel 3.03 km.

These builds have been sliced at 100μ layer thickness and there are 4261 layers. The blade will sweep at least once for 4167 of these layers, so you can appreciate why reducing the distance the blade travels can help to reduce build time.



Build Time: 1d 21h 17m

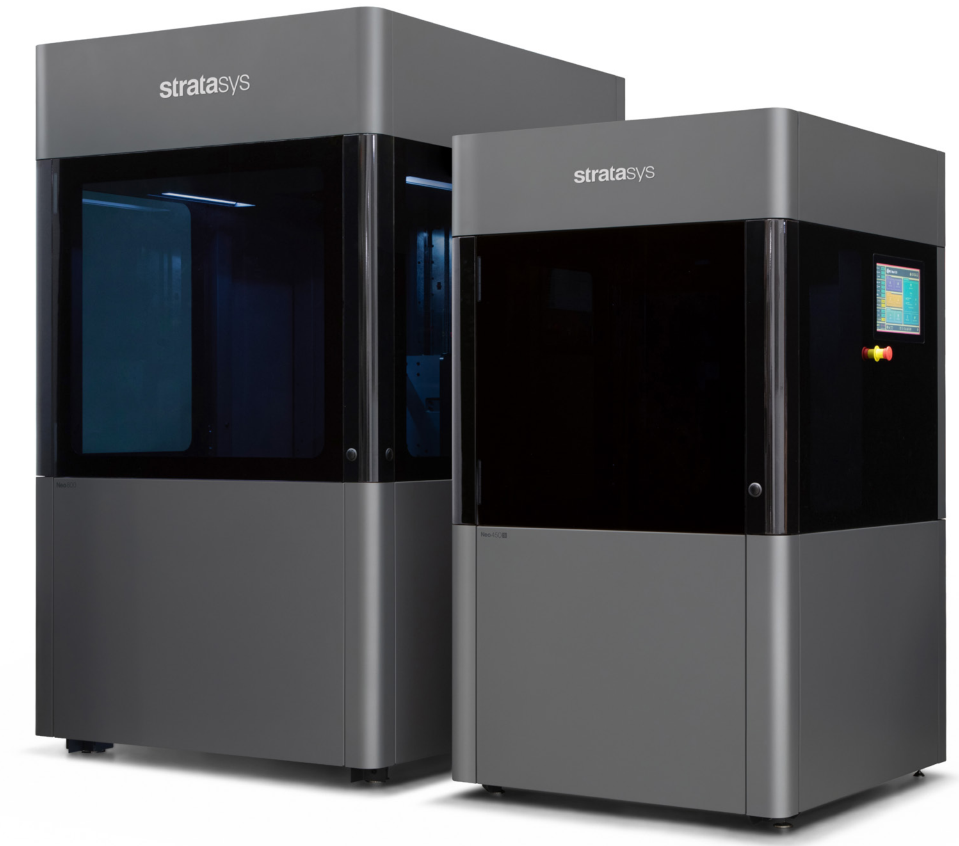


Build Time: 2d 6h 5m

Conclusion

Design consideration and part orientation prior to print is an important step when preparing builds for stereolithography and to ensure a successful build.

Following the key tips to part orientation mentioned in this guide when printing from a Neo stereolithography 3D printer will ensure you produce quality, industry leading parts with outstanding sidewall quality and detail. The capabilities of the Neo, combined with careful consideration of the design when preparing builds, will result in consistently successful part production.



Stratasys Headquarters

7665 Commerce Way,
Eden Prairie, MN 55344
+1 800 801 6491 (US Toll Free)
+1 952 937-3000 (Intl)
+1 952 937-0070 (Fax)

1 Holtzman St., Science Park,
PO Box 2496
Rehovot 76124, Israel
+972 74 745 4000
+972 74 745 5000 (Fax)

stratasys.com
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