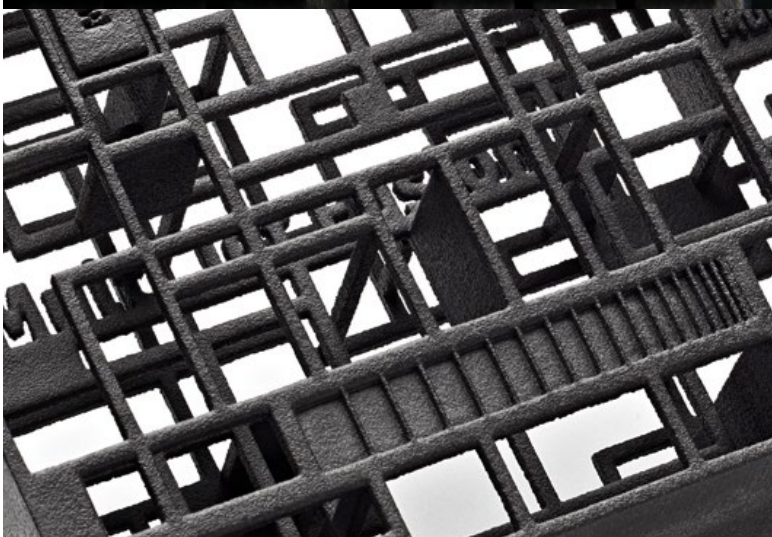
Multi Jet Fusion design guide



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DIRECT MANUFACTURING

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Multi Jet Fusion design guide

HP Multi Jet Fusion (MJF) is an additive manufacturing, or 3D printing, process that builds parts layer-by-layer with infrared heating alongside fusing and detailing agents to create 3D models in powdered material.

The HP Multi Jet Fusion process begins with a layer of material applied to the build platform area. In the opposite direction, in one continuous pass, the machine applies droplets of fusing and detailing agents across the full working area. This pass combines the printing with the fusing energy. The process continues until all of the layers have been built. After the print is finished, the build unit with the material and parts are rolled to a processing station for cooling and powder excavation. Leftover powder is recycled with new material for use in future builds.

This layer by layer manufacturing process allows for the direct fabrication of complex parts that would be cost-prohibitive, if not impossible, to produce through traditional manufacturing processes. For example, interior features, undercuts and negative draft are not an issue for Multi Jet Fusion.

Design Considerations	Specifications
Build Volume	16 x 12 x 16” (381 x 292.1 x 381 mm) – see Part Size below
Resolution Z (Layer Thickness)	70 microns (0.003” / 0.07 mm)
Resolution XY	1200 dpi (0.0008” / 0.02 mm)
Accuracy	±0.010” (0.25mm) or ±0.001 “/” (0.025 mm / 25.4 mm), whichever is greater
Minimum Wall Thickness	0.020” (0.5 mm)

MJF design considerations

As with any manufacturing process, a number of issues can impact the performance of a particular design. In many ways, designing parts for Multi Jet Fusion is very similar to designing parts for Laser Sintering (LS), with a few key differences:

Fine Feature Resolution

Multi Jet Fusion parts have a fine feature resolution of 0.02”. Smaller features will print, but they may not be fully dense and may not deliver specified material properties.

Materials

The number of materials available for Multi Jet Fusion are steadily increasing. Material datasheets should be consulted to determine if there are material-specific design considerations that should be incorporated.

Surface Finish/Texture

The average surface finish of Multi Jet Fusion parts is 125-250 micro-inches RA finish. Surfaces can be hand sanded or tumbled for a smoother finish.

Cosmetics

Because of the black fusing agent utilized in Multi Jet Fusion, all parts from the technology are built in a shade of black or grey. Like other 3D printing processes, cosmetic finishing is possible in parts built with Multi Jet Fusion (paint, primer, texture matching, etc.). However, doing so counters the low price per unit that may be needed for production applications.

Part Size

The build envelope for the Multi Jet Fusion machine is 16” x 12” x 16”. The recommended maximum part size is 14.96” x 11.25” x 14.96” because of the need to scale parts larger to compensate for in-process material shrinkage and to add a buffer around parts for printing agents.

Material Considerations

HP Multi Jet Fusion currently utilizes nylon materials. Material properties can be found on stratasysdirect.com. The current technology's fusing agent is black. Out of the machine, Multi Jet Fusion parts appear a shade of black to heathered grey. To deliver part consistency, Stratasys Direct Manufacturing employs a proprietary ColorTek process to finish parts to a uniform black.

Some fusing agents utilized in this process contains carbon and may impact specific application performance (e.g. RF transparency, electrical insulation resistance).

Dimensional Accuracy

Typical tolerances are ± 0.010 inches (0.25 mm) or ± 0.001 inch/inch (0.025 mm/25.4 mm), whichever is greater. Tighter tolerances may be offered on a case-by-case basis.

Minimum Feature Size

The minimum practical Multi Jet Fusion feature size is 0.020 inches (0.5 mm).

Draft

Draft, or lack thereof, is not an issue for Multi Jet Fusion parts.

Sharp Edges

The Multi Jet Fusion process adds a natural radius of 0.010 inches (0.4 mm) to all sharp edge features.

Wall Thickness

Nylons, like any other plastic material, shrinks as it solidifies. Very thick walls can accumulate heat and cause spot shrinkage in dense areas with an accumulation of material, resulting in geometric deformations.

Wall thickness should be between 0.02 to 0.12 in (0.5 to 3.0 mm). In general, the minimum recommended wall thickness is 0.02 in (0.5 mm). Thicker walls are possible to build but may have inaccuracies and deformation due to non-uniform in-process shrinkage. For parts with a high aspect ratio, it's recommended to increase the wall thickness, or add ribs or fillets to reinforce the part.

Design consideration	Specifications
Minimum hold diameter at 1 mm thickness	0.02 in (0.5 mm)
Minimum shaft diameter at 10 mm height	0.02 in (0.5 mm)
Minimum printable font size for embossed or debossed letters or numbers	6 pt
Minimum clearance at 1 mm thickness	0.02 in (0.5 mm)

Interior Corners

The Multi Jet Fusion process is capable of constructing 90° interior corners (within the limits as described for Sharp Edges). It is recommended that a minimum of 0.015 in (0.4 mm) fillet and corner radii be designed on all inte¬rior corners for stress relief.

Feathered edges

Feathered or knife-edges should taper to no less than 0.020 inches (0.5 mm).

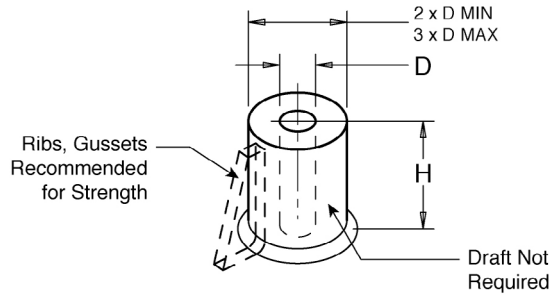

Figure 1: Boss design

Bosses

Bosses are used for attaching fasteners or accepting threaded inserts. The boss diameter should be 2-3 times the diameter of the insert to provide sufficient strength and to minimize hoop shrink. The height of the insert should not exceed the height of the hole in the boss. As with injection-molded parts, ribs and gussets can be added to the boss for increased strength. It is not necessary to add draft to the boss.

Holes

Holes in large blocks of material can be larger (due to overspray of detailing agent) or smaller (due to shrinkage effects). Keeping wall thickness at 0.12 in (3.0 mm) or less will minimize this effect.

Inserts

With the Multi Jet Fusion process, it is not possible to build parts around metal inserts. The insert installation takes place as a secondary operation. Heat staking is the preferred method of installation. Threaded and bonded inserts can also be used. Design recommendations from the insert manufacturers should be followed for incorporation into the design of bosses and holes where inserts are needed.

Joints

Multi Jet Fusion parts can be bonded with a variety of adhesives. Lap joints, with a 0.010 inch (0.3 mm) bond line clearance, are the preferred joint method. The recommended joint overlap is 3-5 times the wall thickness.

Joint performance can be adversely affected by temperature, bonding and mixing techniques, joint geometry and other factors. It is recommended that a vigorous prototyping program be used to validate any Multi Jet Fusion designs that include joints.

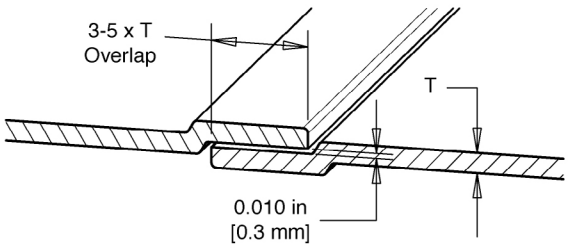

Figure 2: Joint design

Ribs, Gussets, Fillets & Bulkheads

One of the significant benefits of the Multi Jet Fusion process is that interior features, such as stiffeners, baffles, ribs and struts can be designed and constructed as one integral part.

There are no special design requirements for ribs, gussets, fillets or bulkheads, other than to stay within the guidelines for wall thickness.

Snap Latches

Limited use integral snap latches are possible with Multi Jet Fusion.

Living Hinges

A living hinge with Multi Jet Fusion is possible with a secondary annealing process. Without secondary processes, living hinges for a few cycles are possible. Minimum thickness for a living hinge is 0.020 inches (0.5 mm)

Orientation

Due to the unique build style of Multi Jet Fusion, parts have higher isotropic characteristics, meaning they are nearly as strong in the Z orientation as the XY orientation. However, there are still key considerations for designers when building 3D models in a certain orientation, including surfaces that need a higher level of detail, accuracy, part strength and part curl.

The accuracy of the parts is better in the XY plane than in the Z direction. Features that require the highest resolution should be placed in the XY plane. In order to avoid stair-stepping with curved or sloped surfaces, do not position those surfaces with angles less than certain values with the horizontal (XY plane), depending on the thickness of the layers. A smoother surface is achieved with surfaces that are facing down, and a sharp surface is achieved with that surface facing up.

The best mechanical properties of a part are achieved in the XY plane (horizontal). Any feature such as a pin and clip that needs to hold a load should be positioned horizontally whenever feasible.

Design Services

Need additional help designing for HP Multi Jet Fusion? Our design services team can optimize CAD models for functionality and value with MJF. Companies can collaborate with our experts to enhance your designs or quickly implement changes before manufacturing your parts.

Get more information >

The game controller on the right was orientated facing down, resulting in a smoother outer surface.

Stratasys Direct Manufacturing Locations

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