HP Multi Jet Fusion – PA12

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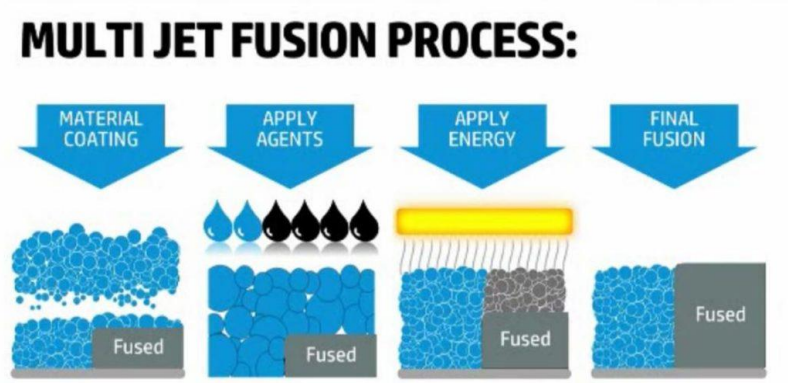
HP Multi Jet Fusion – PA12

HP Multi Jet Fusion (MJF) is an additive manufacturing process that builds parts layer-by-layer with the heating of powdered material and leveraging HP's industry-leading print heads to apply fusing and detailing agents creating a 3D model.

THE PROCESS



The HP Multi Jet Fusion process begins with a layer of powdered material applied to the build platform area. In an additional pass, the machine applies voxels of fusing and detailing agents along the XY work area only where parts are positioned to be built. This pass combines the powder and agents using heat and energy to fuse the material to build apart. The process continues until all of the layers have been built. After the print is finished, the build area with the material and parts is cooled and powder excavation. The 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 CONSIDERATION SPECIFICATIONS – PA12	
BUILD VOLUME	14.96 x 11.2 x 14.96 in (380 x 284 x 380 mm)
RESOLUTION Z (LAYER THICKNESS)	80 microns (0.003 in / 0.07 mm)
RESOLUTION XY	1200 dpi (0.0008 in / 0.02 mm)
ACCURACY	±0.011 inches (0.25mm) or ±0.001 inch/inch (0.025 mm / 25.4 mm) whichever is greater
MINIMUM WALL THICKNESS	0.020 in (0.5 mm)

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MULTI JET FUSION 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 (SLS), 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 is steadily increasing. Material datasheets should be consulted to determine if there are material-specific design considerations that should be incorporated.
- COSMETICS: Because of the black fusing agent utilized in Multi Jet Fusion, all parts of the technology are built in a shade of grey(5200series), off white (500 Series). Like other 3D printing processes, cosmetic finishing is possible in parts built with Multi Jet Fusion (paint, primer, texture matching, smoothing, etc.). I will go into post processing in a different paper.
- 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.
- PART SIZE: The part needs to scale parts larger to compensate for in-process material shrinkage and to add a buffer around parts for printing agents. This automatically handled with the build parameters.

MATERIAL CONSIDERATIONS

HP Multi Jet Fusion currently utilizes nylon, polypropylene and TPU materials from BASF(5200 Series only). The current technology's fusing agent is 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 for PA12 are ± 0.011 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. If you intend to go from 3D printing to injection molding, we recommend putting drafting in so you can streamline your design.

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SHARP EDGES

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

INTERIOR CORNERS

The Multi Jet Fusion process can construct 90° interior corners (within the limits as described for Sharp Edges). It is recommended that a minimum of 0.015”(0.4 mm) fillet and corner radius should be designed on all interior corners for stress relief.

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.

THIN AND LONG PARTS

Long and thin parts are susceptible to having non-uniform cooling, which will cause an uneven shrinkage all along the printed part, which creates a distortion along the part in a certain direction that varies from the nominal shape. Cooling the part uniformly is a key factor in reducing the warpage. As a rule, any part that has an aspect ratio higher than 10:1 is susceptible to showing warpage.

FEATHERED EDGES

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

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 enough 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 a 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

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.

HOLLOW

Solid parts that do not have high mechanical requirements. This can be automatically re-designed and applied in minutes with additive software. The cost and weight of part are highly reduced.

LATTICE STRUCTURES

Ideal for solid parts that require mechanical properties. Automatic re-design that can be applied in minutes once the type of lattice needed for the specific part is chosen.

TOPOLOGY OPTIMIZATION

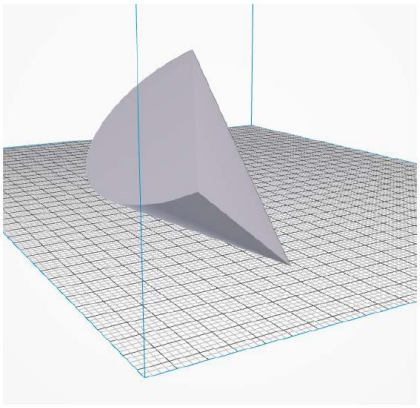
Suited for thin parts or parts that have complex load distributions. The re-design time investment is higher an requires more engineering hours. Optimized weight reductions are achieved given the computational nature of the process while maximizing mechanical properties of the part

LIVING HINGES

A living hinge with Multi Jet Fusion is possible with a secondary annealing process. Polypropylene particularly is very good for living hinges and has an excellent life cycle of 100’s

and 1,000's easily, once post processed properly. Without secondary processes, living hinges for a few cycles are possible. Particularly, PA11 material has more life cycles than PA12. Minimum thickness for a living hinge is 0.020 inches (0.5 mm)

ORIENTATION



Due to the unique build style of MJF, 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, 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. Any feature such as a pin and clip that needs to hold a load should be positioned horizontally whenever feasible.

DESIGN CONSIDERATION	
MIN HOLE DIAMETER AT 1 MM THICKNESS	0.02 in (0.5 mm)
MIN SHAFT DIAMETER AT 10 MM HEIGHT	0.02 in (0.5 mm)
MIN PRINTABLE FONT SIZE FOR EMBOSSED OR DEBOSSED LETTERS OR NUMBERS	6 pt
MIN CLEARANCE AT 1 MM THICKNESS	0.02 in (0.5 mm)

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Throughout the past 225+ years, ABCorp provided Essential goods and services to world-class companies and federal, state, and local government agencies in more than 120 countires. Now, ABCorp is pleased to expand our partnership with HP and launch the first global, enterprise-grade additive manufacturing platform.

We hope that you found this guide insightful. We'll reach out to see how you can leverage this technology to benefit your business. In the meantime, please feel free to contact us directly with any questions you may have.

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