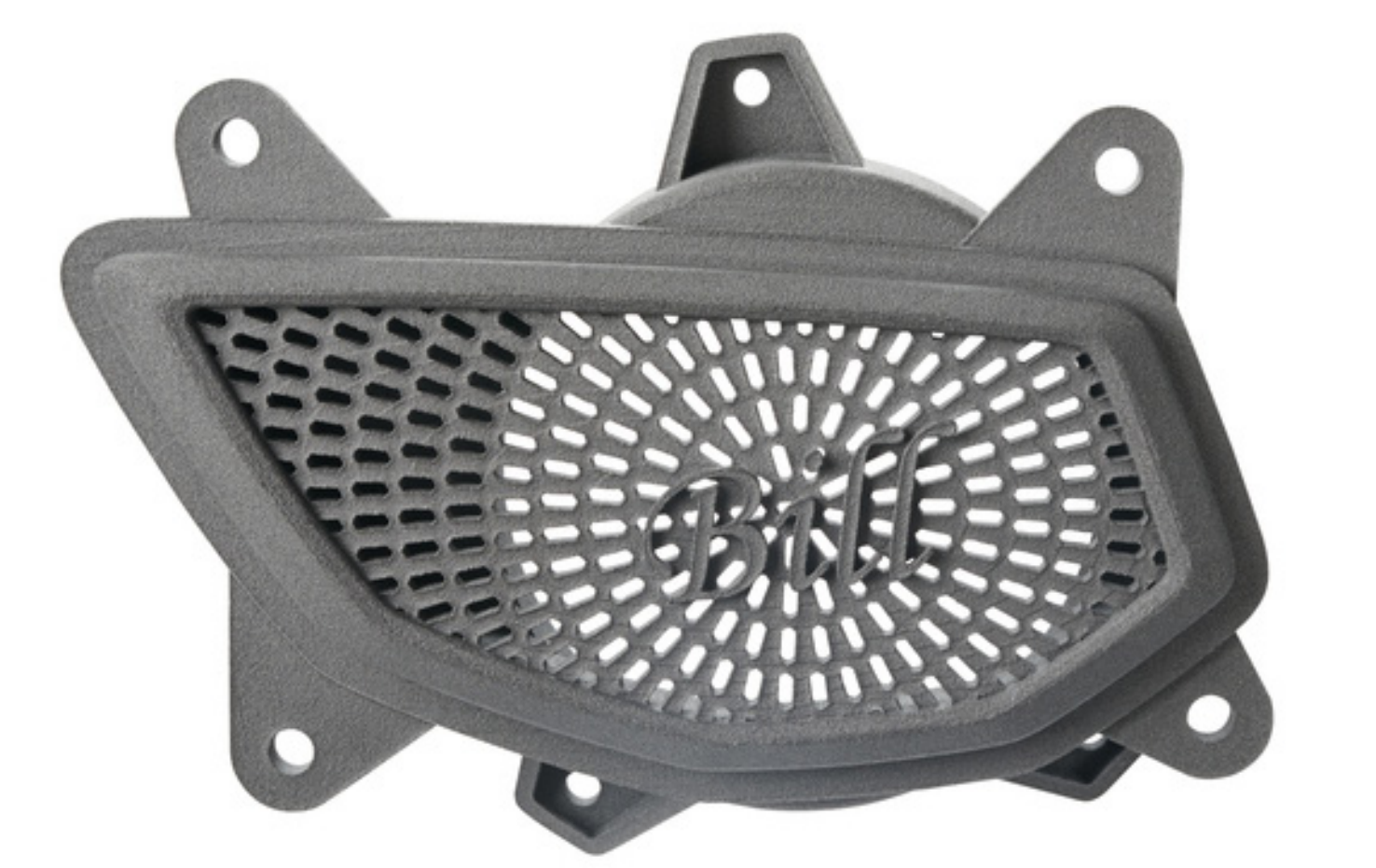
ABCorp™
Secure since 1795



Design and Information Guide:

Polypropylene

Pill containers. Plastic furniture. Containers for cleaning fluids, storage bins.

Since its origins in 1951, Polypropylene (PP) has become one of the most common thermoplastics for injection molding, accounting for over 22% of global plastic production (73.7 million tonnes of 330 million tonnes) in 2016. While a large proportion goes into fibers and storage containers, it has found increasing use in automotive applications. Its low density and high strength have made it very useful in the ongoing drive to reduce vehicle weight. It has also found growing use in medical applications and is used to augment asphalt for road construction. Polypropylene is everywhere.

It's now gaining traction in the 3D printing industry.

Printed with HP 3D High Reusability PP enabled by BASF

	Value	Method
Powder melting point (DSC)	138° C 280° F	ASTM D3418
Particle size	62 µm	ASTM D3451
Bulk density of powder	0.34 g/cm³ 0.012 lb/in³	ASTM D1895

3D@abcorp.com • abcorp.com • 617-325-9600

The Strengths of Polypropylene

Tensile strength

PP has high tensile strength (4,800 psi) and yet is the lightest of commodity plastics, boasting a density of between 0.895 and 0.92 g/cm^3 (compared to 1.04 g/cm^3 for polyethylene and 1.15 g/cm^3 for nylon).

Elasticity and Fatigue Resistance

PPE is considered to be a 'tough' material in that it can plastically deform without breaking. It will retain its shape following a fair amount of torsion, bending, or flexing. This makes it an ideal material when making living hinges like those on shampoo or detergent lids.

Chemical Resistance

PP is resistant to diluted bases, acids, and organic solvents. This makes it a good choice for gas cans, cleaning agent containers, first-aid products, and more.

Water resistance

PP is hydrophobic. This means it does not absorb water, and when removed from an immersive state, dries quickly. This property is essential for full immersion applications in medical and industrial applications.

Insulation

PP has a very high resistance to electricity and consequently is very useful for electronic components.

Non-Toxic

It is BPA-free. Biological factors, such as bacteria and fungi, will not cause it to mold or deteriorate in quality.

3D@abcorp.com • abcorp.com • 617-325-9600

HP Polypropylene Enabled by BASF: It is Polypropylene

Like other thermoplastics, Polypropylene has some drawbacks. It is UV-sensitive, has a high coefficient of thermolinear expansion, not good in heat applications, and is susceptible to chlorinated solvents.

HP 3D High Reusability PP enabled by BASF:

- Get the same properties as many commonly used PPs with this genuine polypropylene material
- Accelerate your product development process using the same prototyping material as the final part
- Excellent chemical resistance and low moisture absorption ideal for piping or fluid systems and containers
- Outstanding welding capabilities with other PP parts produced with traditional methods like injection molding
- Versatile material ideal for a wide range of automotive, industrial, and consumer goods applications

3D@abcorp.com • abcorp.com • 617-325-9600

3D Printing Polypropylene: Parts

Heat is the enemy with any plastic really and Polypropylene using MJF technology is no different. For this reason, big parts tend to warp more, and shrinkage can be an issue with parts that have varying thicknesses. Iterations can be done, and orientation does play a big role in the success of larger parts.

Design for HP MJF Polypropylene

DESIGN CONSIDERATION SPECIFICATIONS – PP	
BUILD VOLUME	14.96 x 11.2 x 14.96 in (380 x 284 x 370 mm)
RESOLUTION Z (LAYER THICKNESS)	80 microns (0.003 in / 0.07 mm)
RESOLUTION XY	1200 dpi (0.0008 in / 0.02 mm)
ACCURACY	±0.016 inches (0.4mm) or ±0.001 inch/inch (0.025 mm / 25.4 mm) whichever is greater
MINIMUM WALL THICKNESS	0.020 in (0.5 mm)

3D@abcorp.com • abcorp.com • 617-325-9600

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.
- **COSMETICS:** Because of the black fusing agent utilized in Multi Jet Fusion, all parts off the technology are built in a shade of grey(5200series). Like other 3D printing processes, cosmetic finishing is possible in parts built with Multi Jet Fusion (paint, primer, texture matching, smoothing, etc.).
- **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 is automatically handled with the build parameters.

MATERIAL CONSIDERATIONS

The current technology's fusing agent is black. Some fusing agents utilized in this process contain carbon and may impact specific application performance (e.g. RF transparency, electrical insulation resistance, food safety).

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.

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

Polypropylene, 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. All Polypropylene parts are naturally cooled to allow for optimal part quality.

FEATHERED EDGES

Feathered or knife-edges should taper to no less than 0.010 inches (0.25 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 my use joints.

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

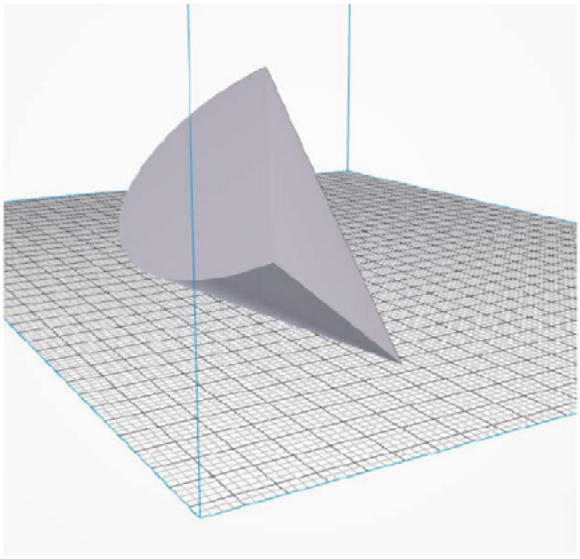
Suited for thin parts or parts that have complex load distributions. The re-design time investment is higher and requires more engineering hours. Optimized weight reductions are achieved given the computational nature of the process while maximizing mechanical properties of the part

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. 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)

ABCorp™
Secure since 1795

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

To learn more about how we can help you with your manufacturing and 3D printing needs, contact us at 3D@abcorp.com or 617-325-9600