APPLICATION BRIEF

Fastening into 3D Printed Parts

3D Systems MultiJet Printing Technology

Due to the material properties, accuracy, surface finish and aesthetics of 3D Systems MultiJet Printing (MJP), this technology is commonly used to prototype for the injection molding process. For continuity between the prototype and final production part, screw bosses, metal fasteners or snap fits are frequently used on MJP parts.

These guidelines will help you make the right selection in terms of screw types and processes when working with 3D printed parts made with MJP technology.

MJP is an ideal technology for your prototyping application if:

1. You need high fidelity, true-to-CAD parts
2. You require robust material properties and functional versatility
3. Good surface quality is important for your use case
4. You need repeatable accuracy with fine details and complex geometries

MJP materials

All the VisiJet® Rigid and Engineering materials for MJP printers can be machined, drilled and tapped, and can be treated like traditional thermoplastics, such as acrylic, polypropylene, polycarbonate and ABS. VisiJet MJP materials are a rigid or semi-rigid thermoset that will not melt or easily gum-up with heat. Slow to medium drill speeds are recommended for best results.

Key considerations for fastening into MJP printed parts

It is always recommended to avoid inducing excess stress on parts when possible. In cases where design modifications are needed to ensure sufficient robustness, it may be advantageous to increase the printed hole size for thin walled injection molded bosses by ~1% to reduce the possibility of failure due to hoop stress as the threads are cut into the plastic. When rapid prototyping complex injection molded screw bosses that may be prone to failure, adding an additional wall extrusion in CAD to strengthen the boss may help mitigate that risk. These can easily be suppressed when the final tooling geometry is needed.

Things to keep in mind regarding screws and screw hole sizes:

It is advised to follow manufacturer's guidelines for boss and screw hole dimensions whenever possible, as threading into plastic with metal screws can result in a few different failures. General recommendations for standard size screws can typically be found in a machinist handbook.

- Anytime the hole is oversized for the screw, the joint will fail due to a lack of thread engagement or the thread engagement will be stripped out.
- When the hole is undersized, the smallest screw sizes may sheer off of the screw driver engagement or the thread engagement may be stripped out.
- For medium or large screws, undersized holes will likely strip out the threads as they are formed into the hole, or the 3D printed part will fracture.

Material selection can also play a role in determining hole size. See the below chart for more information.

MATERIAL TYPE	MATERIAL PROPERTIES	CONSIDERATIONS	GOOD FOR
VisiJet M2R-WT	Stiff	Tends to fracture if hole size is too small	All types of metal screw applications
VisiJet M2R-CL	Stiff	Tends to fracture if hole size is too small	All types of metal screw applications
VisiJet M2R-GRY	Stiff	Tends to fracture if hole size is too small	All types of metal screw applications
VisiJet Armor (M2G-CL)	High elongation and toughness	Less sensitive to smaller sized holes	Complex engineering applications
VisiJet Proflex (M2G-DUR)	Most elongation and toughness	May strip out threads more easily	Most engineering applications

Distinguishing among screw types

1. *Thread cutting screws* have features that facilitate cutting threads into plastic when inserted. They create less hoop stress, but also require less torque to loosen and less tensile force to be pulled out.
2. *Thread forming screws* do not have a cutting tip and are instead designed to displace material in the plastic boss to create a mating thread. This process generates high radial and hoop stress and may cause damage to a 3D printed part. Thread forming screws should be avoided for less-compliant materials, or the hole size should be increased along with a strengthened boss wall thickness to help mediate damage to the 3D printed part.
3. *Self-tapping screws* are fasteners designed to drill their own hole as they are screwed into wood, plastic, or metal. They typically have a short drill bit on the end with special threads on the shaft of the screw. Self-tapping screws are available in both thread-forming and thread-cutting options.

    - *Self-tapping thread-forming screws* are designed to stay in place and are typically used for plastics
    - *Self-tapping thread-cutting screws* can be more reliably removed and are typically used for metal and wood

Things to keep in mind with self-tapping screws

Self-tapping screws are **not** generally recommended, but they can be used successfully with 3D printed plastic parts.

- Drilling a pilot hole is always recommended, regardless of screw type (this includes screws with built-in drill bits)
    - For the pilot hole, use a smaller bit than the screw to allow the threads to engage and serve their purpose
- Allow adequate spacing between screw installations to avoid overlapping their induced stress regions
- VisiJet Armor (M2G-CL) and VisiJet ProFlex (M2G-DUR) materials will have the greatest success
- VisiJet white, clear and gray materials are likely to be more susceptible to damage or fracture if proper care is not taken

Pre-threaded holes

One of the advantages of MJP technology's true-to-CAD geometry and melt away supports is the ability to print accurate, pre-threaded holes. Many CAD packages allow for the addition of specific threads to a given hole and now those geometries can be printed and cleaned of all support material, even down to very fine threads.

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