the **differ*ence*** between

THE DIFFERENCE BETWEEN:

Production vs Rapid Prototyping 3D Printing Processes

A broader selection of materials, advanced technologies, and a variety of processes have provided a wide array of capabilities to manufacturers for prototyping through production part generation.

3D PRINTING HAS become a general term that applies to a wide variety of different technologies. Understanding that each of these technologies has its own benefits and drawbacks, we'll consider how they are used from concept to commercialization. Although, every one of these systems can be used for prototyping, material availability and costs might make them less advantageous to use. Similarly, every machine might be able to provide a production part, but only if tolerances, surfaces, and available materials perfectly match your needs. Ultimately, understanding your application needs will help to dictate which system to use as long as you understand that each application is different.

Stereolithography (SLA) uses a vat of liquid UV-curable photopolymer resin and a UV laser to grow parts one layer at a time. Fused Deposition Modeling (FDM) uses a plastic filament that is extruded through a nozzle which can be moved in vertical and horizontal directions. And, the PolyJet process jets photopolymer materials in ultra-thin layers that is then cured using UV light. The latest technology to hit the market is Multi Jet Fusion (MJF) (*see Figure 1*), which uses a powder-based process that performs layering in the X and Y axes simultaneously for high-speed output.

Production Parts Fast

The whole idea behind production parts from additive manufacturing processes is to eliminate the long wait times and high costs for tooling to be produced. In today's market where a short time to market is considered an asset, getting parts quickly is important. Where standard manufacturing methods often take anywhere from days to weeks, particularly if you have to send out for tooling, 3D printing processes are most often measured in hours. Of course, speed is relative to the size of the product and its complexity as well as the type of process you choose to use.

What's great about processes such as Multi Jet Fusion and Fused Deposition Modeling is that the machines were designed for production parts from the bottom up—and provide build times that are multiple times faster than other 3D printing technologies. FDM, which leaned into manufacturing with the ability to provide production parts, allowed companies to perform a number of valuable feats.

Geared toward low-volume production parts, FDM machines are able to meet production runs in a short

Figure 1: Multi Jet Fusion machines provide the highest speed for producing production parts.

Figure 2: These robot parts were built using an MJF machine, which provides the ability for greater design options for engineers.

turnaround time—as short as a few hours depending on the part being produced. Additional value is gained when, down the line, it is found that slight modifications need to be made. Because the parts are grown using a digital download from a standard CAD system ported to an STL file format, adjustments to the final product don't have to go through an additional tooling round—saving time and money. For applications where slight amounts of customization may be needed, these machines provide repeated benefits in production times. This benefit is also noted when companies use FDM to provide fixtures and jigs for in-house use, as well as other end-user products such as surgical guides and thermoform tools.

Once the industry found that production parts could be made using additive manufacturing processes, there was a greater need for a larger variety of materials. For example, the FDM process uses a number of ABS and Polycarbonate materials that offer thermal and chemical resistance as well as excellent strength-to-weight ratios, making the parts ideal for aerospace, automotive, medical, marine, and industrial applications of all types. It is always important to note what materials a company is able to provide for production parts to be sure they fit your application needs. The resolution for FDM machines is typically up to 200 microns, which is why these machines are ideal for production and end use projects.

Multi Jet Fusion machines are not only designed to create production parts, but due to their unique processing technique they are able to produce parts at higher volumes as well as faster speeds. MJF systems build in batches, which helps in reducing the cost of each unit. The machines are also designed in such a way as to increase functional design complexity, providing engineers with greater flexibility in design (*see Figure 2*).

In addition, the machines print each layer simultaneously in the X-Y axes. Since build height is the determining factor in print speed, complete part sets can be built at the same time with the tallest part determining the final speed. Engineers are able to position parts in any orientation for the build—unlike traditional machining processes—so that they can minimize the build height for even faster build speed. Further, multiple jobs can fit into one printer and therefore not limited to the highest parts' build time like other processes. This is because all components are suspended in the powder block or "nested" (see Figure 3). These features allow the MJF process to provide up to ten times the build speed of other systems. These machines provide customers with fine resolutions to 200 microns, for isotropic strength properties that make them capable of producing small holes, living hinges, and embossed text when required.

MJF machines use "build-units" that can be configured and then rolled into the printer. This approach reduces time spent during multiple preparatory steps that must be taken prior to starting the build cycle. The build units are preloaded with material and ready

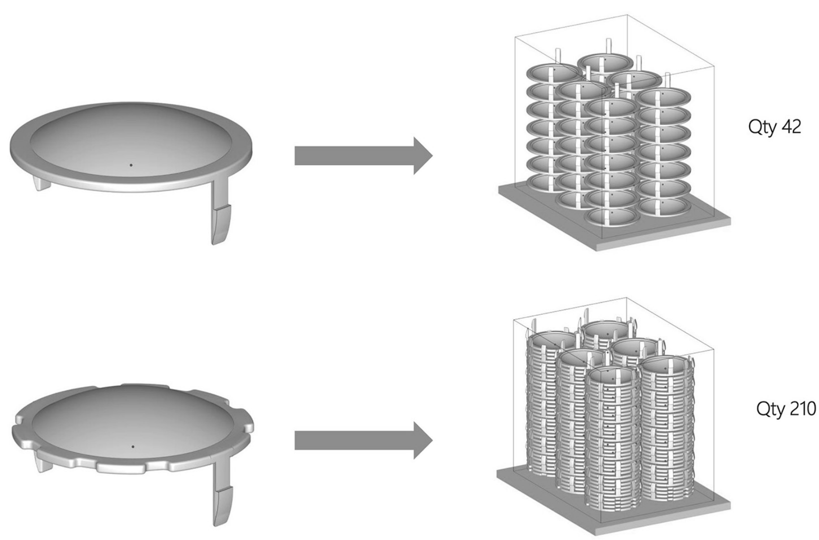

Figure 3: By "nesting" parts into one powder block, the MJF process is able to produce higher quantities in shorter timespans.

Figure 4: PolyJet is a widely used rapid prototyping process, and was the first to provide over-molding capabilities to engineers.

for processing once installed into the build platform. Once a batch has been printed, the build unit is rolled from the machine to the processing station for cooling powder excavation during which time another build unit is quickly rolled into the machine to begin the next batch printing process.

Rapid Prototyping

Although speed is subjective, rapid prototyping processes were initially created to allow companies to produce a component in hours rather than the days it took when using a machine shop or modeling shop. Rather than using wood or foam, a rapid prototyping machine such as PolyJet and Stereolithography could provide a part that allowed the engineer to examine its form, fit, and function without entailing the cost of a production-level component. This is especially important for commercial items such as hand tools that have an aesthetic value as well as a functional value—they have to look good and fit the hand properly. In this way, 3D printed parts can easily mimic the look and feel of an actual product.

Originally, the key to rapid prototyping was that the designer could digitally develop multiple iterations of a particular product as they went through the process of fine tuning a design. Rapid prototyping allowed engineers to physically test the form, fit, and function the product quickly, easily, and repeatedly without taking up days of time. This type of approach allowed for greater creativity and allowed designers to "play" with even minor details for their ideas to eventually reach the best solution for their application. This ability is one of the most important reasons to use a rapid prototyping process in the first place.

When it comes to producing a rapid prototyped part, either process mentioned above is capable of doing so. Some of the earlier 3D systems were designed specifically for rapid prototyping and therefore are less expensive and, although slower than production-oriented machines, much faster than traditional methods. Depending on the material used, advanced testing such as drop tests can also be performed to be sure the final product is of a high quality.

Stereolithography was the original rapid prototyping process and has continued to be used as it has gone through upgrades and innovation to increase build speed and accuracy. The PolyJet (*see Figure 4*) process was the first to provide the ability for over-molding, allowing engineers the ability to produce complex designs with internal cavities. PolyJet processes are still the most often used for prototyping, specifically for producing concept models of all types. These machines are also ideal for producing master patterns and tradeshow models as well. Again, you'll want to review and select the material that best suits your particular needs. But because these machines are now a staple in the industry, there are more materials available.

Conclusion

The bottom line might be that if you wish to increase your product development lifecycle so that you are able to get to the market faster, rapid prototyping systems such as PolyJet, Stereolithography, and even MJF, considering its high throughput, are key methods to consider. If your aim is to manufacture robust parts in low to mid-volume production quantities, consider that SLS, FDM, or MJF processes might be right for you. Be sure you consider working with a qualified supplier a high priority endeavor. You'll want to partner with a company that offers multiple processes and with the technical expertise to help you select the right process for your specific needs.