FDM AND POLYJET 3D PRINTING

DETERMINING WHICH TECHNOLOGY IS RIGHT FOR YOUR APPLICATION

By Fred Fischer

Fused Deposition Modeling™ (FDM®) and PolyJet® are two of the most advanced and effective additive manufacturing (AM) or 3D printing technologies available. They span the range from budget-friendly, desktop modeling devices to large-format, factory-floor equipment that draw from the capital expenditure budget, and can produce a range of output from precise, finely detailed models to durable production goods. While there is crossover in applications and advantages, these two technology platforms remain distinct and bring different benefits. Understanding the differences is the baseline for selecting the right technology for your application, demands and constraints.

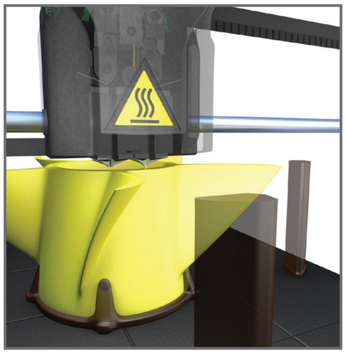
Stratasys
FOR A 3D WORLD™

White Paper

THE TECHNOLOGIES

Fused Deposition Modeling (FDM):

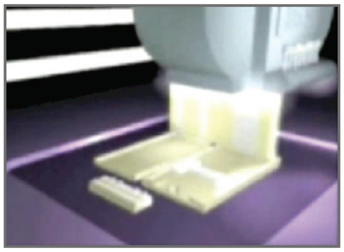
Thermoplastic filament feeds through a heated head and exits, under high pressure, as a fine thread of semi-molten plastic. In a heated chamber, this extrusion process lays down a continuous bead of plastic to form a layer. This layering process repeats to manufacture thermoplastic parts.



FDM process

PolyJet 3D Printing:

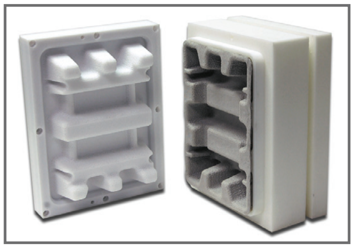
A carriage — with four or more inkjet heads and ultraviolet (UV) lamps — traverses the work space, depositing tiny droplets of photopolymers, materials that solidify when exposed to UV light. After printing a thin layer of material, the process repeats until a complete 3D object is formed.



PolyJet process

These well-established technologies create models or finished goods for industries that span jewelry and architecture to aerospace and consumer electronics manufacturing. Complete setup for the systems that use these technologies range from $9,900 to over $600,000.

PolyJet detail



Durable FDM part

There truly is something for everyone and every application; so much so that many companies operate both FDM and PolyJet machines to take advantage of each system's strength. However, for those with a budget that forces the selection of only one system, consider operations, part characteristics and material options.

COMPARE AND CONTRAST

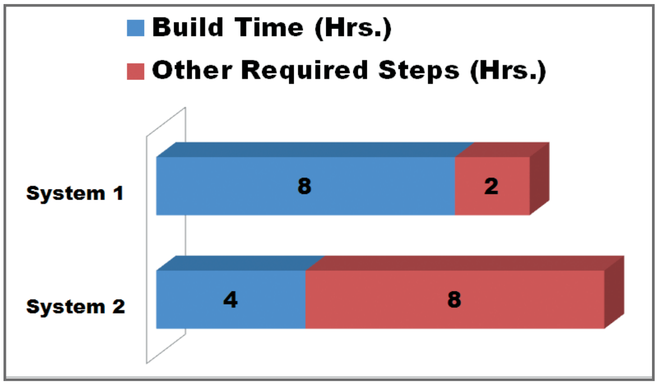
Comparing three categories between FDM and PolyJet will address the common decision-making criteria. Operations address the operating environment, work flow and time. Part characteristics cover items that address output quality. Material options consider the physical properties available from FDM and PolyJet processes.

Operations

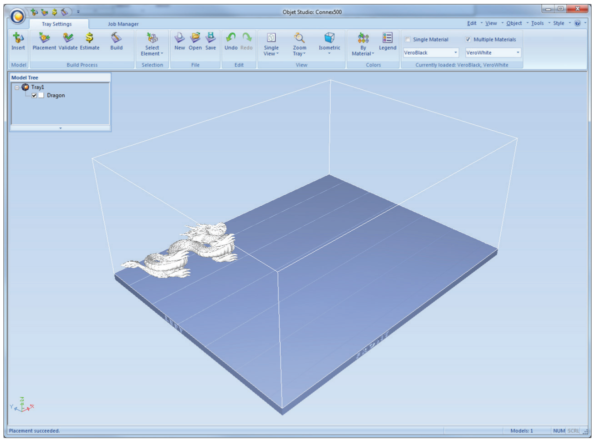
Speed

Build speed, while a flawed measure of performance, tends to be a priority for many. There are too many factors to make qualified speed generalizations of any AM technology, including FDM and PolyJet. At times, PolyJet is faster, but this is not always true.

When evaluating time from file preparation through finished part delivery over many jobs, you will discover that, on average, FDM and PolyJet have similar (and very competitive) total elapsed times. For more information on build time, read the Stratasys® white paper "The Truth About Speed: Is the Hare Really the Fastest?"



A system that builds slower may have an overall faster completion time.

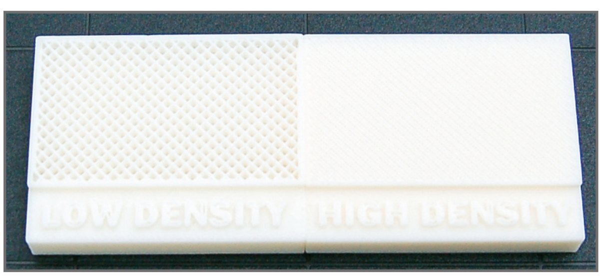


Objet Studio is simple to use

Pre-process

Both technologies offer very simple — just a few mouse clicks — front-end file processing that can make ready-to-print files in less than five minutes.

One difference: FDM's production 3D printers add sophisticated user controls that adjust the part-building process to match the demands for the application. All build parameters are open to the user.



Insight software for FDM 3D Printers allows control over all build parameters, such as fill density.

At the machine, both FDM and PolyJet can be printing parts within 10 minutes of a file upload.

Post-process

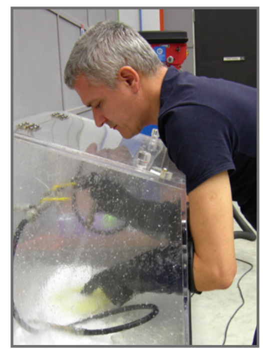
All similarities between FDM and PolyJet cease when it comes to support removal and part cleaning.

PolyJet gives you a quick, manual step to remove the gel-like support material: spraying with a waterjet. With FDM, you have either a fully automated, but longer, soak in a tank to remove soluble supports or a manual step that removes rigid, breakaway supports with simple hand tools.

FDM Automated support removal

When selecting a technology, evaluate the operational needs for your business. For example, is the staffing level low? If so, it's best to go fully automated with FDM. If quick turnaround is paramount, choose PolyJet.

Office environment



PolyJet support removal

Unlike some AM technologies, there is no need for sealed-off labs and OSHA respiratory protection for either of the Stratasys technologies. There is no powder, which can go airborne, or sensitivity to humidity and temperature, and all systems need only minimal plumbing or electrical work. Power and access to water and drain lines (for post-processing work) is all that is required.

Both FDM and PolyJet come in office-friendly sizes. There is one exception: The biggest systems, Fortus® 900mc™ and Objet®1000™, have large footprints, so they need to be placed in a large work area.

Ease of use

In addition to the simplicity of file setup, there are several other factors that contribute to the ease of use of both FDM and PolyJet.

- Material changeovers: Simply remove one material and slide a new material cartridge into the 3D printer.
- Setup for a build: Insert a build sheet (FDM only), bring the system up to operating temperature, push start and walk away.
- When complete: Open the door/hood and remove parts just seconds after a job completes.

Operating expense

Operating expenses are a bit higher for PolyJet, so if the budget is your primary consideration, FDM may be a better choice.

The key factor to determine operating expense is consumables, both in hardware and materials. For FDM, you will routinely replace build trays (or sheets) and extrusion nozzles. However, these are less expensive than the sophisticated printheads that are replaced after 2,000 hours (or more) of PolyJet 3D Printing.

Also, the total material cost per cubic inch of part is less with FDM. In the cartridge, the technologies have comparable material costs by weight. Yet, FDM has a lower cost per part because it needs only minimal support material. PolyJet systems need more support material to restrain the tiny liquid droplets.

Part Characteristics

Surface finish

PolyJet gives you a near-paint-ready surface right out of the 3D printer. With a little wet-sanding and polishing, it can deliver a smooth, glossy surface that is ready for any process where even minor surface imperfections are glaring, such as electroplating for a mirror-like finish.

PolyJet offers smooth surfaces

That's not true for FDM. The extrusion process can produce visible layer lines on side walls and "tool paths" on top and bottom surfaces. These can be eliminated, but that requires additional post-processing, such as an automated finishing station or some manual finishing.

Resolution & feature detail

High resolution and fine feature detail are hallmarks of the PolyJet process. Using 600 x 600 dpi printing in 16- to 32-micron layers, PolyJet can reproduce very small features and fine-grained textures. So if feature resolution is a prime consideration, PolyJet is your best bet.

Accuracy

For dimensional accuracy, the published specifications show that comparable FDM and PolyJet platforms have similar results for parts when they are removed from the systems. However, over time and under a load, FDM materials are more dimensionally stable, which is critical when used for production parts.

Size

Note: The following specifications have been rounded for simplicity. For exact specifications, refer to the product spec sheets.

PolyJet and FDM machines offer build volumes ranging from 5 x 5 x 5 inches (127 x 127 x 127 mm) to 39 x 31 x 20 inches (1000 x 800 x 500 mm), and they have comparable mid- and large-size options. The difference is only in the small-volume category. With FDM there is an entry-level 5 x 5 x 5-inch option with a footprint small enough to sit on a desktop. PolyJet's smallest is 9 x 8 x 6 inch (240 x 200 x 150 mm), and that 3D printer is best placed on a stand near the work area.

For maximum part size, consider the orientation in the 3D printer. For example, the two largest machines, the FDM 900mc and the Objet1000, have similarly sized build envelopes, but the tallest part in the Fortus 900mc is 36 inches. The tallest for the Objet1000 is 20 inches. The opposite is true for width: The Fortus 900mc offers 24 inches and the Objet1000 offers 31 inches.

Materials

For many, the greatest distinction between FDM and PolyJet comes from materials. Combined there are nearly 600 options, ranging from real thermoplastic to thermoplastic-like resin, rigid to flexible, and opaque to transparent.

PolyJet offers product realism across a wide band of requirements. With its unique, unmatched Digital Materials (two materials blended at the printhead), there are over 450 options offering a range of hues, transparency, strength, rigidity and flexibility. For example, flexible, rubber-like parts can be printed with Shore A hardness ratings of 27 to 95. Another factor that contributes to product realism is multi-material printing. Any part can have up to 46 distinct material properties, so applications like flexible overmolding of rigid structures can be reproduced in one print job.

If a breadth of material properties is what you need, PolyJet is the best platform.

Rubber-like and transparent materials are available for PolyJet

Durable FDM thermoplastic parts

PolyJet offers multi-color options

PolyJet bio-compatible material

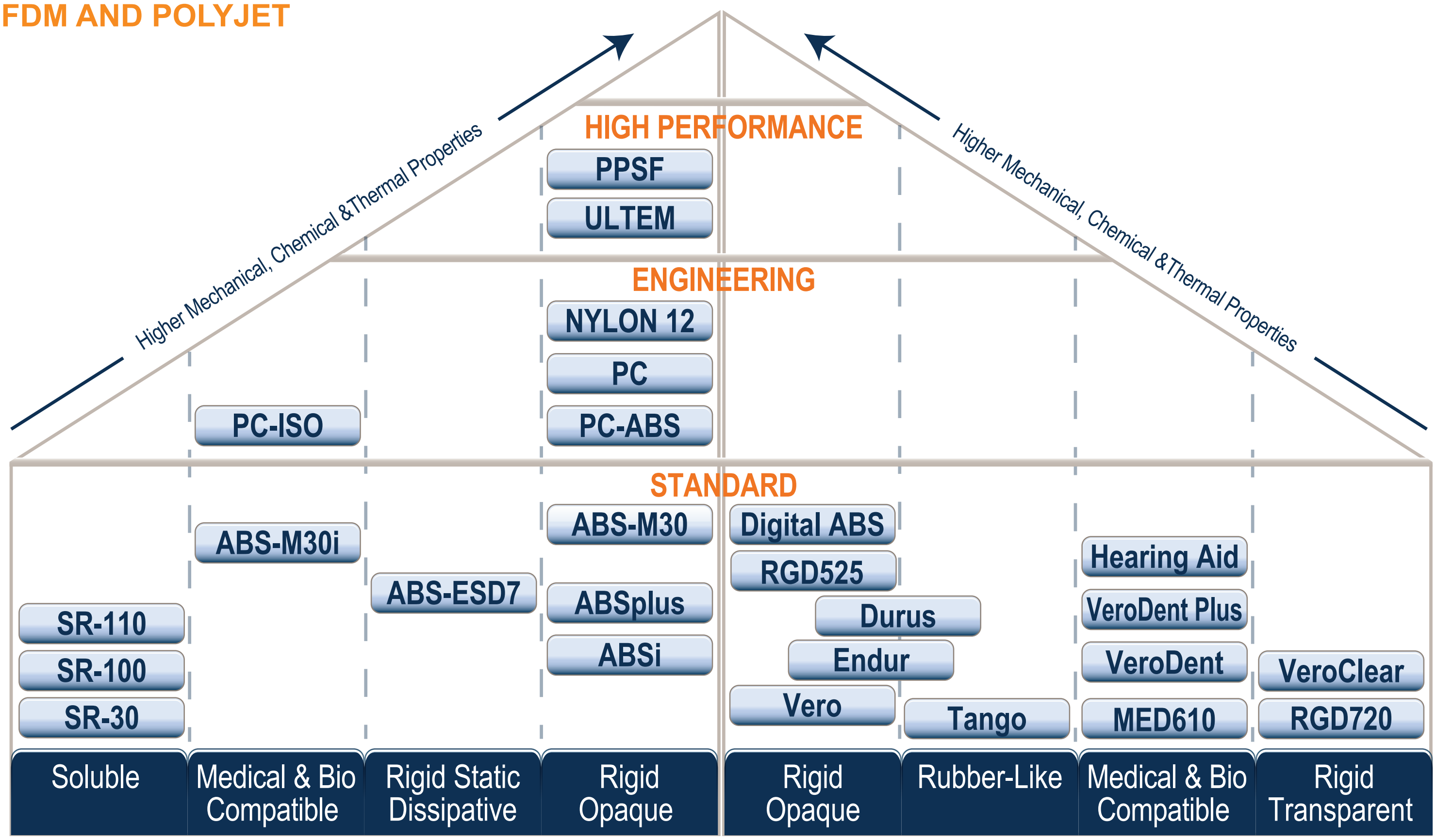
On the other hand, if your applications demand real thermoplastics with functionality and durability, FDM is the correct platform for you. Ten material options range from the commonly used plastic, like ABS, to the highly advanced, like ULTEM™ 9085 resin. Material options include: anti-static, FST rating (flame, smoke and toxicity), chemical resistance and very high temperature resistance. FDM can also make soluble patterns for challenging manufacturing jobs.

Both FDM and PolyJet offer bio-compatible materials with USP Plastic Class VI to ISO 10993 ratings. They can be used for hearing aids, dental procedures, and surgical guides and fixtures as well as food and pharmaceutical processing.

AM spans the concept, design and production components of product development in industries that range from medical appliances to industrial goods. Each application shares requirement as well as distinct demands. It is these application-specific demands that ultimately decide which is the best tool for the job, FDM or PolyJet 3D Printing.

The pairing of FDM and PolyJet enables Stratasys to handle much of the spectrum of industry applications. For those with demands that align with FDM benefits and others that align with PolyJet benefits, the best alternative may be to follow the lead of other companies that employ both technologies.

FDM AND POLYJET



PERFORMANCE
FDM TECHNOLOGY

- Real thermoplastics
- Strong, stable & durable parts
- Final product mechanical properties

PRECISION
POLYJET TECHNOLOGY

- Smooth surface finish and fine details
- Final product look & feel
- Multi-Material printing

Stratasys FDM and Polyjet technology offer hundreds of material options.

	PolyJet 3D Printing	Fused Deposition Modeling (FDM)
Operations		
Process Time	●●●	●●◖
Pre-process	●●	●●●
Post-process	●●●	●●●
Office Environment	●●●	●●●
Ease of Use	●●●	●●●
Characteristics		
Surface Finish	●●●	●
Feature Detail	●●●	●
Accuracy	●●	●●●
Size	●●●	●●●
Materials		
Rigid	●●●	●●●
Flexible	●●●	◖
Durable	●◖	●●●
Transparent	●●●	●
High-performance	●	●●●
Bio-compatible	●●●	●●●

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