3D SYSTEMS

Investment Casting Solutions

Building productivity and new manufacturing efficiencies with 3D printed casting patterns and methodologies from 3D Systems

Image Credit: Vaupell

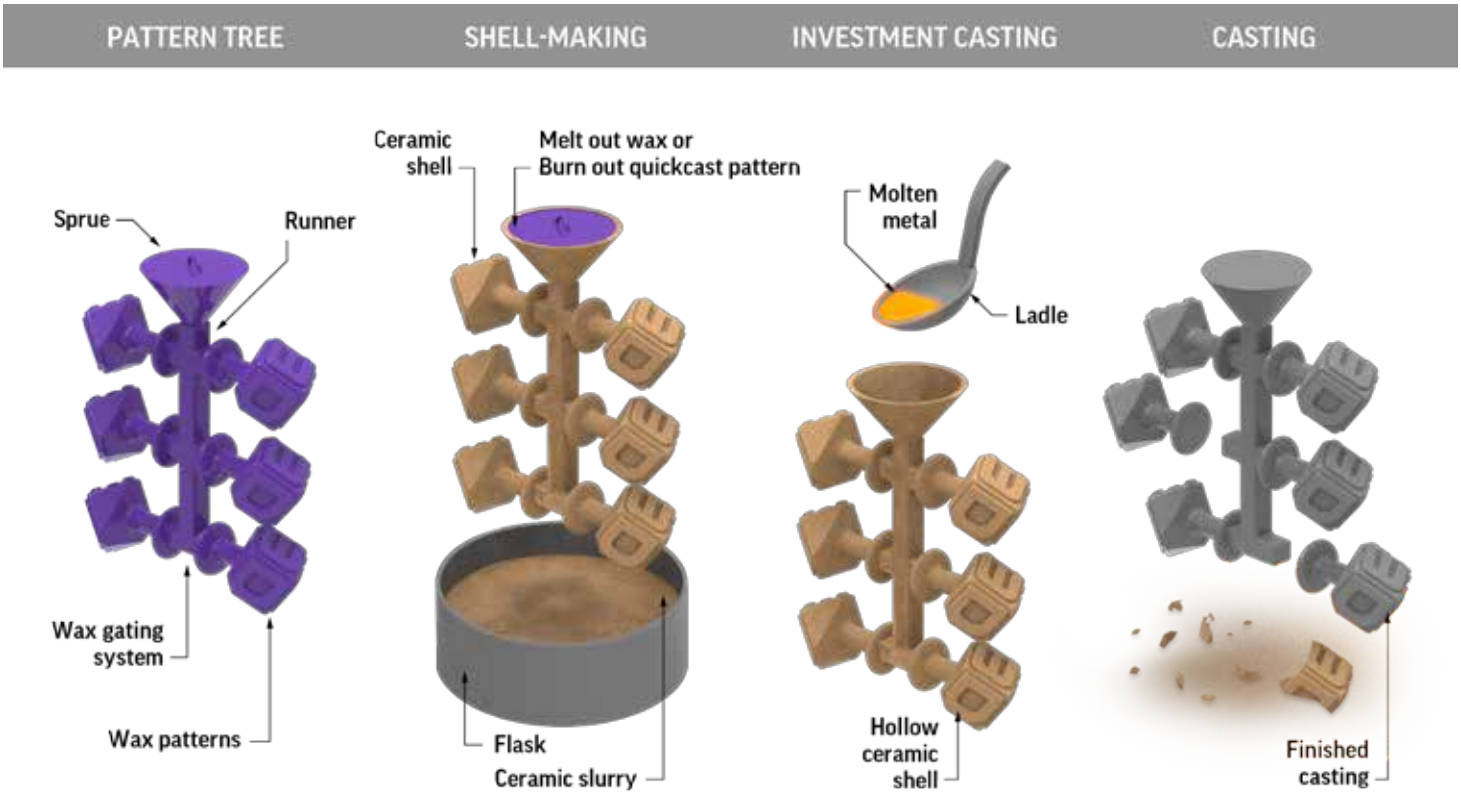
Investment casting in the 21st century

Investment casting is an important manufacturing process with a history that is thousands of years old. Also known as lost wax and shell investment casting, the process of shaping molten metal into objects using wax patterns and ceramic molds is still used today. The process is commonly used for all kinds of mechanical parts; engine parts; gears; dental work; jewelry; turbine blades; and other objects requiring complex and exact geometries.

Investment casting is often used when extreme smoothness and accuracy are required, production quantities are low, and design complexity is high.

The process starts with a pattern — also known as a master, or master pattern. Traditionally this pattern is made of wax and produced with injection molding, but 3D printing revolutionizes this time-consuming step. Once the pattern has been created, whether traditionally or with 3D printing, the process is the same. The pattern is dipped in an ultra-fine ceramic slurry followed by a coating of one or several layers of a coarser sand/ceramic, depending on design specifics. If the original pattern was wax, it is then melted and drained; if the original pattern was printed, it is burned out. With the right 3D printing material, this burn out leaves very little ash which is an important prerequisite for certain applications. At this point the pattern is ready for metal casting.

Investment casting is precise, but it is also time consuming and expensive. For example, for one customer the traditional method of using a wax injection tool to create an axial turbine blisk mold requires at least five weeks and can cost upwards of $20,000 from start to finish. In comparison to traditional methods, the time and cost investments for 3D printed investment casting patterns are much lower, and 3D printing can also produce patterns of greater complexity. A typical 3D Systems customer can create a 3D printed investment pattern overnight; in the morning it is ready for the foundry at a cost of under $2,000.



The lost wax or shell investment casting process

Specific benefits of 3D printed casting patterns

3D printed casting patterns have enabled the evolution of significantly more timely and cost-efficient production of casted parts. In direct comparisons between 3D printed casting patterns and traditional methods, customers have saved anywhere from $20,000 to $200,000 per part, and removed weeks and months from the process. Additional benefits of 3D printed casting patterns include:

Produce patterns with greater design complexity

- Removed from the limitations and restrictions of traditional wax pattern production processes, 3D printed casting patterns can deliver higher design complexity.

Produce patterns significantly faster

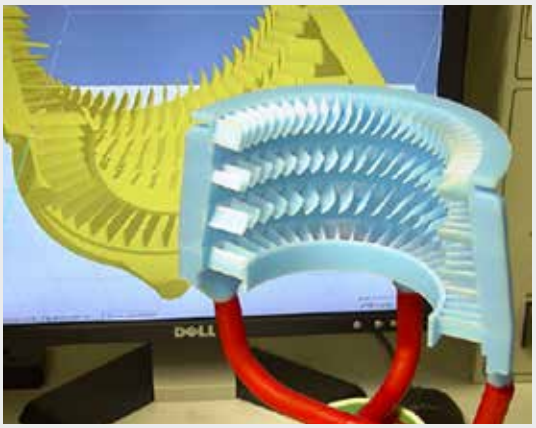
- Customers have cut weeks and months from the time taken to produce casting patterns and reduced time to casting by 90% or more.

Save significant costs of production

- Customers have saved hundreds of thousands of dollars with 3D printed casting patterns in direct comparisons.
- Rapid production of casting patterns also helps quickly identify design flaws to reduce the need for costly design changes and rework that can lead to massive time and cost overruns.

Increase product quality and finish

- The perfect surface resolution of stereolithography (SLA) casting patterns delivers an unprecedented level of quality to the final casted parts, reducing lengthy machining and post-processing requirements.



TURBINE TECHNOLOGIES IMPROVES TURBINE BLADE PRODUCT ITERATION WITH 3D PRINTED WAX PATTERNS

Challenge:
Expert R&D team needs to reduce costs yet increase quality of 3D printed blade casting patterns for critical product development.

Solution:
3D printed wax parts from the ProJet MJP 3D printers

Results:

- Created 3D printed wax casting patterns for one-tenth of the cost of traditional processes from $20,000 to $2,000
- Produced casting patterns overnight, compared to weeks waiting for traditionally-created patterns

	CONVENTIONAL PROCESS	TECH CAST PROCESS
Total time to finish casting	10-12 weeks	4 weeks
Labor cost (at $60/hr)	Base	Base - $81
Purchases	$40,000	$3,150

Customer benchmark shows that 3D printed investment casting can provide an impeller in roughly one third of the time and at one tenth of the cost compared to conventional processes.

AEROSPACE PARTS SUPPLIER, VAUPELL, DELIVERS CASTED PARTS FASTER AND MORE COST-EFFECTIVELY THAN EVER BEFORE WITH 3D PRINTED SLA CASTING PATTERNS

Challenge:
With the market becoming yet more competitive and cost-conscious, how can Vaupell work to compete successfully for its aerospace clients?

Solution:
3D Systems ProX® 800 SLA 3D printer and Accura® CastPro Free materials

Results:

- Cut delivery time for complex casting patterns from several months to a few days
- Cut costs of casting patterns from $200,000-$300,000 to $6,000-$15,000
- Enabled very iterative process without high costs

The 3D Systems end-to-end approach to investment casting

3D Systems offers two key 3D printing technologies for creating investment casting patterns: stereolithography (SLA) and MultiJet Printing (MJP). Yet while 3D printing technology is a major contributor to the drastic cost and time reductions possible with investment casting, there is more to the solution than a 3D printer alone. 3D Systems' end-to-end manufacturing solutions help to streamline this time-and labor-intensive task with the software, hardware, and printing materials required to transform the investment casting methodology into a 21st century process.

3D Systems also offers On Demand Manufacturing services, bringing the benefits of investment casting to those who are new to the concept or who need to occasionally farm out extra work.

Stereolithography and the QuickCast® build methodology

Stereolithography (SLA), the original 3D printing technology invented in 1983 by 3D Systems' Co-founder and Chief Technology Officer, Chuck Hull, is widely considered the gold standard for accuracy in 3D printing.

The QuickCast build style is an SLA print methodology developed by 3D Systems to answer a pressing need for the investment casting industry. The speed advantages and the high accuracy and quality of 3D Systems' SLA technology have made QuickCast one of the most popular and effective methods for 3D printed casting patterns in North America, as well as the preferred method for medical, aerospace and defense casting applications.

The QuickCast build style consists of a hollow stereolithography pattern with internal hexagonal supports that add strength to the pattern. This structure also facilitates the collapse of the pattern during thermal expansion, which helps to prevent the shell from cracking.

The internal design of a QuickCast pattern minimizes the amount of material used, creating an almost ash-free burnout that reduces manual steps and can deliver a higher quality cast. The QuickCast method improves upon other 3D printing-based methods for creating investment casting patterns, offering advantages such as lower moisture absorption, smooth surfaces, high dimensional stability, and the ability to produce large pattern sizes to bypass or limit the need for assemblies.

With QuickCast patterns, castings can be created at a fraction of the time and cost of traditional tooling to produce wax patterns. This allows designs to be evaluated in days instead of weeks or months. The use of QuickCast patterns can also provide the user with invaluable gating and shrinking information prior to hard tooling.

3D Systems offers a selection of high quality SLA printers, engineered to deliver true-to-CAD parts to meet a wide range of applications. These printers create exact plastic and composite material parts without the restrictions of CNC or injection molding. With the accuracy, surface quality, size and detail achievable with 3D Systems' SLA technology, producing low- to medium-run parts is not only faster, but per-unit part costs are lower.

Developed specifically for its SLA print engines, 3D Systems' portfolio of Accura® materials deliver a variety of material features and properties for high quality performance, including polypropylene-like, tough/durable, clear, castable, and high-temperature resistance as well as composite and specialty materials to meet application and product requirements.

Accura® CastPro™ material

3D Systems Accura CastPro is an accurate, expendable pattern material ideal for QuickCast investment casting. It is good for both metal parts prototyping and low-to-medium production runs without tooling. It can be used to create titanium, aluminum, magnesium, and zinc castings as well as ferrous castings.

> "Customers often create 2 or 3 casting patterns with different gating options in order to fully test which works best. This enables higher quality of the final castings without the costs and time normally involved with running prototypes using traditional investment casting patterns."
>
> - Jeff Smith, On Demand Manufacturing, 3D Systems

Accura® CastPro™ Free for aerospace castings

Accura CastPro Free delivers antimony-free casting patterns for the clean burnout necessary for aerospace applications. It is a durable, transparent general purpose SLA resin well-suited for metal casting. It is highly accurate, allowing for stable, superior quality investment casting patterns free of heavy metals for excellent casting results.

Key Benefits:

- Higher quality master patterns for investment casting parts
- Less part finishing time with ease of post-curing
- Users can build accurate and tough parts that retain their dimensions and impact resistance over time without switching the material vat for different applications

Other casting materials

3D Systems offers a selection of materials for the investment casting process, varying in durability, resolution, moisture resistance and purity, among other properties. Specialized materials for casting include clear plastic, wax-plastic hybrids, styrene-based for expendability, and more.

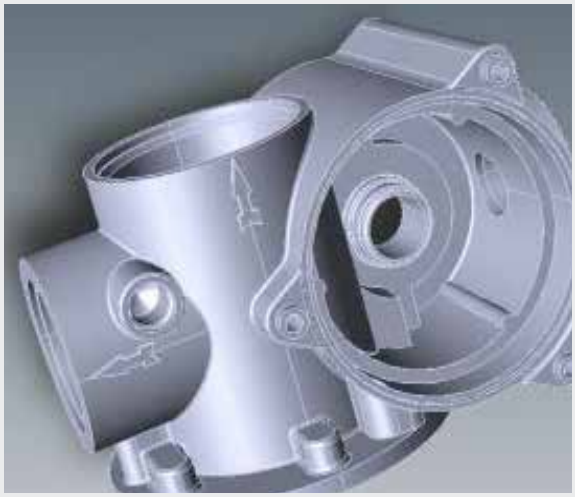
Wax multiJet printing for investment casting

Wax MultiJet Printing (MJP) from 3D Systems uses an inkjet process to deposit RealWax™ materials. The material is deposited layer-by-layer, and offers very high resolution builds. Depending on the model and the material in use, layer thickness can be as thin as 16 microns (0.000591 inches). Advancements in materials science have improved the durability of wax parts printed in MJP, making the patterns more robust and reliable throughout the casting process.

In the case of investment casting, MJP Wax materials deliver very fine detail for patterns quickly, with excellent outcomes for very small parts in jewelry and dental applications as well as smaller industrial parts.

MJP Wax is ideal for a wide range of parts and patterns requiring fine feature detail. These systems are economical to own and operate, and use a separate meltable or dissolvable support material for quick post-processing. The process of removing support material is virtually hands-free; even the most delicate features and complex internal structures can be thoroughly cleaned without damage.

MJP Wax printers are suitable for many direct investment casting applications where digital workflows already exist. Their ease of use and office compatibility make them a time-saving and cost-effective alternative to traditional lost wax casting processes. MJP Wax printers can create virtually any geometry for one-off or scalable volume throughput.



ELSTER AEROTEH DELIVERS CASTED GAS REGULATION ASSEMBLIES IN A MATTER OF DAYS

Challenge:
Romanian team needed to cut months from its gas regulation assembly casting process by producing casted parts locally.

Solution:
3D printed wax parts from the ProJet MJP 3D printers

Results:

- Fulfilled production of casted parts in 12 days rather than months

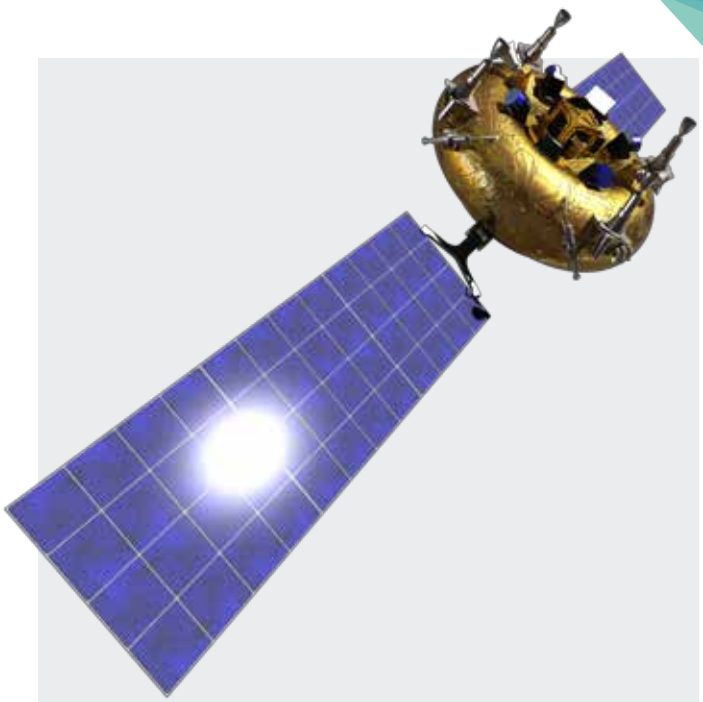
On Demand Manufacturing services for investment casting

3D Systems' On Demand Manufacturing offers a broad range of processes and technologies globally without requiring customers to invest in their own systems and materials. It is an ideal way to start using 3D printing for investment casting, or to extend existing capabilities in both additive and traditional manufacturing.

The online quoting process is instant, and requires only that users upload a 3D CAD file and indicate their project specifications. Using this information, 3D printing and manufacturing experts in strategically located facilities around the world are ready to respond with lead times and custom quotes.

3D Systems' On Demand Manufacturing is certified to meet ISO quality management system standards as well as ITAR and AS9100C specifications.

A wide range of 3D printers suitable for investment casting is available through this service, allowing customers to order parts from the smallest to the largest possible. 3D Systems' team of dedicated project managers review each individual order for manufacturability and can assist in producing the pattern only or assist with the entire casting process, identifying opportunities to reduce development costs along the way as applicable.



PLANETARY RESOURCES DELIVERS LIGHTER, BETTER SATELLITE COMPONENTS WITH 3D PRINTED SLA CASTING PATTERNS OF CONSOLIDATED ASSEMBLIES

Challenge:
Deliver a very compact, lighter satellite system with a total weight of 24-33 pounds, far smaller and lighter than any satellite before.

Solution:
Consolidated assemblies into a single, combined design and 3D printed SLA casting patterns delivers the weight reductions needed. Embedded parts and features enable the small sizes required.

Results:

- Significantly reduced part count and meeting the required weight restrictions enabled by SLA printed casting patterns.

Stereolithography 3D printers from 3D Systems

3D Systems offers a selection of SLA printers, each offering the highest precision and accuracy and varying in capacity and footprint.

Known applications for 3D Systems' SLA printers:

- Master patterns for vacuum casting
- Sacrificial patterns for metal casting
- Complex assemblies
- Wind tunnel models
- Enhanced fluid flow visualization models
- Mass customization (i.e. orthodontic, dental applications)
- Assembly jigs and fixtures

Features across 3D Systems SLA printers:

- Highest precision and accuracy that can rival injection molding and CNC
- Exchangeable Material Delivery Modules (MDMs) for high flexibility and fast changeover
- Intuitive software for part set-up and production
- High material efficiency uses less than 1/3 the material of competitive printers

Benefits across 3D Systems SLA printers:

- Quick and easy material changeover to serve multiple applications
- Local field service and application support
- Single source solution (for printers, materials and software)
- Ease of use—intuitive workflow
- Fast part availability
- Low material waste
- Security of intellectual property by keeping CAD data in-house
- Finest feature detail on parts of any size

ProX® 800: High throughput with highest accuracy and detail

3D Systems' ProX 800 is a strategic choice for large parts (up to 650 x 750 x 550 mm or 25.6 x 29.5 x 21.65 in) requiring the highest accuracy and detail. Parts are accurate (+/- 45 µm) and precise throughout the entire build platform and features are reproducible down to 0.1 mm (0.004 in), depending on geometry, orientation and build mode.

Features of 3D Systems ProX 800:

- Max build envelope capacity (W x D x H): 650 x 750 x 550 mm (25.6 x 29.5 x 21.65 in)
- Specific software module available for medical applications
- Also available with rigid, stable nanocomposite material
- Accura performance engineered materials

ProX® 950: Large parts in a single piece

The build envelope of the ProX 950 can produce parts up to 1,500 mm (59 in) long in plastic or composite materials. In applications like investment casting, large single piece builds increase final part strength by eliminating the attachment points that introduce weaknesses and also free up additional resources that would otherwise be occupied with assembly of the various segments.

The high capacity of the ProX 950 also allows batch production of smaller parts at a lower per-unit cost.

Features of 3D Systems ProX 950:

- Max build envelope capacity (W x D x H): 1500 x 750 x 550 mm (59 x 30 x 22 in)
- Up to 4+ times faster than competitive 3D printers
- Up to 2.5 times higher resolution than competitive 3D printers
- Accura performance engineered materials

ProJet® 6000 HD: Highest quality in a smaller footprint

ProJet 6000 HD printers deliver the unmatched capabilities of SLA technology in a smaller footprint using a wide range of VisiJet® performance engineered materials.

The ProJet 6000 HD enables daily use of 3D Systems' gold standard technology and has high uptime numbers. Parts are accurate (+/-45 µm) throughout the entire build platform, print after print, and features are reproducible down to 0.05mm (0.002 in) depending on geometry, orientation and build mode.

Features of 3D Systems ProJet 6000 HD:

- Max build envelope capacity (W x D x H): 250 x 250 x 250 mm (10 x 10 x 10 in)
- Up to 4+ times faster than competitive 3D printers
- 2.5 times higher resolution than competitive 3D printers
- True line drawing in X and Y to accurately define curves
- VisiJet performance engineered materials

ProJet® 7000 HD: Unrivaled accuracy for larger builds

ProJet 7000 HD printers offer 3D Systems' SLA in single large-sized prints or smaller prototypes and end-use parts in a wide choice of VisiJet performance engineered materials that can rival traditional plastic properties.

The ProJet 7000 HD has high uptime numbers and parts are accurate (+/-45 µm) throughout the entire build platform, print after print. Features are reproducible down to 0.05mm (0.002 in), depending on geometry, orientation and build mode.

Specific to ProJet 7000 HD:

- Max build envelope capacity (W x D x H): 380 x 380 x 250 mm (15 x 15 x 10 in)
- Up to 4+ times faster than competitive 3D printers
- 2.5 times higher resolution than competitive 3D printers
- True line drawing in X and Y to accurately define curves
- VisiJet performance engineered materials

ProJet® 1200 for desktop SLA accuracy

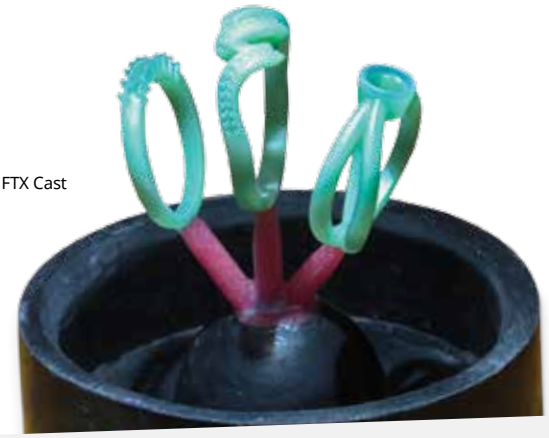
The ProJet 1200 is ideal for workshops and labs in need of a compact and affordable solution for small, finely detailed metal casting patterns, dental wax-ups and plastic parts in short cycle times. The ProJet 1200 delivers SLA accuracy to the desktop with 30-micron layers (0.0011811 inch) and 56-micron resolution (0.00220472 inch) for consistently crisp features and details that rival the output of printers that cost over six times as much. The printer's factory calibrated and self-contained curing station are an added bonus for streamlined, hassle-free operation.

The ProJet 1200 uses easy-install VisiJet® FTX cartridges in a range of materials to meet the needs of casting workflows, visualization models and prototyping. It is also equipped with 3D Systems' powerful and simple 3D Sprint™ software for print preparation and management.

Most jewelry applications can be printed in less than two hours, and as many as 10 dental wax-ups can be printed in less than one hour, enabling dental technicians, jewelers and other users to maintain a steady and productive workflow. Combined with the affordability of the printer, the low material cost-per-part invites businesses to scale operations with ease.

Known applications for 3D Systems ProJet 1200:

- Extremely finely detailed small metal casting patterns
- Castable and pressable dental wax-ups, ideal for copings, pressed ceramics, bridges and veneers
- Micro-parts for concept modeling and validation prototyping



VisiJet FTX Cast

VisiJet FTX Green

Features of 3D Systems ProJet 1200:

- Max build envelope capacity (W x D x H): 43 x 27 x 150 mm (1.69 x 1.06 x 5.90 in)
- VisiJet® FTX Green and FTX Cast materials cleanly burn out for ash-free castings
- VisiJet® FTX Clear is a transparent material perfect for prototypes
- VisiJet® FTX Gray shows off every detail and is ready for painting
- VisiJet® FTX Gold and FTX Silver provide metallic appearance
- Streamlined design-to-print workflow with the new 3D Sprint™ software capabilities

Benefits of 3D Systems ProJet 1200:

- Ease-of-use and reliability
- Exceptional part resolution and surface finish
- High fidelity parts for perfect fit every time
- High print speeds deliver parts faster
- Integrated material cartridges ensure consistent high quality

Wax MultiJet (MJP) Printers from 3D Systems

ProJet® MJP 2500W and ProJet MJP 3600W: High quality, real wax 3D printing

Accessing precise, durable, high-resolution real wax casting patterns has never been faster, easier or more reliable, with 3D Systems' ProJet MJP Wax printers and VisiJet® RealWax™ material.

3D Systems' industry-leading MJP Wax printers give small businesses, job shops and labs access to precision parts in 100% real wax materials for reliable performance and results throughout existing lost-wax casting processes. The best-in-class part quality of 3D Systems' MJP technology ensures true-to-CAD accuracy and designs that are delivered exactly as prescribed. The ProJet MJP 2500W and ProJet MJP 3600W produce complex parts with sharp edges, extremely crisp details and smooth, defect-free surfaces, which means less expensive hand finishing and a faster pattern to part workflow.

Throughout cleaning, spruing and casting, 3D Systems' RealWax materials deliver the durability casters need. VisiJet M2 CAST and VisiJet M3 CAST materials offer exceptional mechanical performance to provide users with a higher yield of viable casting patterns. Furthermore, the speed and throughput of 3D Systems' MJP Wax printers deliver casting patterns up to ten times faster than alternative solutions, allowing companies to scale and grow their operations.

3D Systems' ProJet MJP Wax printers also integrate with the company's 3D Sprint™ print preparation and management software, eliminating the need to invest time or money into a third-party solution. 3D Sprint offers a full range of powerful file editing and file repair tools to ensure consistently great prints and comes with printer purchase.

VOWSMITH PUTS 3D PRINTING AT THE HEART OF ITS CUSTOM JEWELRY PRODUCTION

Challenge:
When Canada-based Vowsmith founded a company delivering wedding rings personalized to each customer, they needed a proven way to deliver rapid casting patterns for a mass-custom market.

Solution:
They turned to 3D Systems' ProJet MJP wax 3D printers to deliver fast turn-around of custom wax patterns for casting.

Results:

- 35-40 personalized ring patterns produced per build
- Aiming to cut production and delivery times by 50%

ARMENIAN JEWELRY MAKER BUILDS BUSINESS OPPORTUNITIES WITH 3D PRINTED WAX PATTERNS

Challenge:
Enable VS Chakhoyan Jewelry, that was using traditional processes, seize growth opportunities while maintaining very high product quality.

Solution:
A ProJet MJP Wax 3D printer for perfect jewelry casting patterns

Results:

- Producing many different and varied wax jewelry casting patterns at once
- Increasing the customer base and developing new growth opportunities

Known applications for 3D Systems MJP Wax printers:

- Investment casting for jewelry and industrial applications

Benefits of 3D Systems MJP Wax printers:

- High-fidelity parts with smooth, defect-free surfaces
- Robust patterns that survive from print to part
- Repeatable, true-to-CAD accuracy on complex parts
- High pattern throughput helps businesses scale
- High quality patterns with competitive total cost of operations
- Office-friendly footprint with no special housekeeping requirements
- Streamlined design-to-print workflow with 3D Sprint™ software

Features of 3D Systems ProJet MJP 2500W:

- Max build envelope capacity (WxDxH): 295 x 211 x 142 mm (11.6 x 8.3 x 5.6 in)
- VisiJet M2 CAST material
- Fast and easy post-processing with the MJP EasyClean System (optional)

Features of 3D Systems ProJet MJP 3600W:

- Max build envelope capacity (W x D x H): 298 x 185 x 203 mm (11.75 x 7.3 x 8 in)
- VisiJet M3 CAST and VisiJet M3 Hi-Cast material

Software Solutions from 3D Systems for Investment Casting

Creating perfect 3D printed investment casting patterns demands good 3D data, and this starts with the right software. 3D Systems' design and manufacturing software streamline the design and development process and improve quality.

Dx Geomagic® Design X™

When a casted part needs to be produced but no CAD data exists, the only viable solution is reverse engineering with 3D scanning and 3D Systems Geomagic software.

3D Systems' Geomagic software tools offer task-specific automation of key processes. Geomagic Design X is the acknowledged leader in reverse engineering, using both history-based CAD processes and 3D scan data to create feature-based, editable solid models for use in other CAD software or as the final design. Geomagic Design X supports all major 3D scanner brands to enable accurate and accessible reverse engineering.

Geomagic Design X offers automatic and guided solid model extraction for scan data, allowing designers to create exact surfaces fitting to organic 3D scans, with mesh editing and point cloud processing included. When starting with the scan data or an import of existing CAD geometry, Design X can automate the mesh creation process. Feature extraction with accuracy analysis further accelerates design goals.

Ff Geomagic® Freeform®

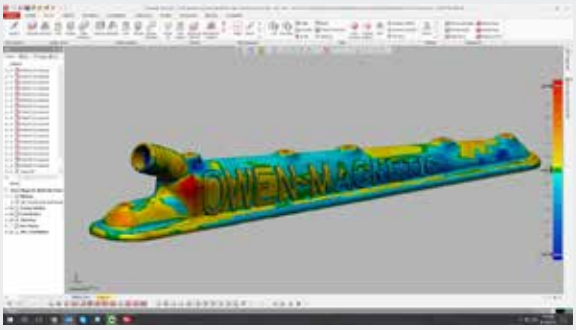
Some design challenges and faulty 3D data in digital casting workflows require special attention not available in the typical 3D CAD product. Geomagic Freeform Plus provides the tools to solve complex design problems involving organic shapes. The software/hardware combination provides touch-based (haptic) 3D sculpting, CAD interoperability, scan data processing, and mold making for intricate designs. Freeform is a hybrid modeling environment that offers the best of all CAD design paradigms: solids, surfaces, mesh, and subdivision surfacing ("SubD"). Checking tools allow testing for 3D printing suitability. The patented voxel technology assures designs are topologically error-free, sparing users from the time and expense of other geometric analysis and repair methods.

Sp 3D Sprint™

3D Sprint software ships with all 3D Systems' printers outlined in this paper for investment casting workflows. The software streamlines the optimization and preparation of CAD data for printing in both resin and wax. 3D Sprint delivers 3D Systems' expertise to edit and repair CAD data as well as manage printer operation. Intelligent routines within the software optimize part placement for the 3D printing process, providing one intuitive interface for design, model prep, and printing.

Cx Geomagic® Control X™

Geomagic Control X is a comprehensive software platform for metrology, with powerful tools and a straightforward workflow. Perfect for checking the size and measurements of your 3D printed casting patterns and casted parts, Quality Managers like using Control X in combination with 3D and industrial CT scanners for its intuitive controls, repeatable workflows, and high reliability in the quality measurement process. The unique Synchronous Inspection system captures data hierarchy and coordinates automation of processes in the background. Control X makes creating First Article Inspections faster than ever using the CAD-based dimensioning tools. CAD data import includes accurate gathering of model-based GD&T data at no extra cost, and reporting features make it easy to communicate data to all relevant parties. Intelligent 3D dimensioning and annotation processes allow users to control in fine detail how dimensions will be presented. Control X offers NIST-PTB certified results.



RAPID CREATION OF CASTED ENGINE PARTS WITH OWEN MAGNETIC

Challenge:
Quickly recreate old parts to deliver foundry castings.

Solution:
Scan the old parts and recreate the data in Geomagic Design X software to print the SLA pattern for foundry casting. 3D printed casting patterns delivered by On Demand Manufacturing services.

Results:

- Accurate recreation of part
- Quick SLA pattern turnaround
- Completed part in 4 weeks

The Final Result

Using 3D Systems' end-to-end manufacturing solutions for investment casting can revolutionize manufacturing processes. 3D printing enables casting patterns to be created much faster than with traditional methods, at significantly reduced costs. The ability to print, test and adapt casting patterns quickly also makes 3D printing the only repeatable and cost-effective option for casting patterns that may need to undergo change. The materials available are precise, and the printing process is true-to-CAD. Furthermore, 3D printing allows companies to create digital inventories of casting pattern models to print or modify on demand. 3D printing technology delivers logistical benefits with high-strength, lightweight molds that are easier to handle and transport than their conventional tooling counterparts.

Investment Casting Printer Comparison Charts

	ProX® 800	ProX® 950	ProJet® 6000	ProJet® 7000	ProJet® 1200
Max Build Envelope Capacity (WxDxL)	650 x 750 x 550 mm (25.6 x 29.5 x 21.65 in)	1500 x 750 x 550 mm (59 x 30 x 22 in)	250 x 250 x 250 mm (10 x 10 x 10 in)	380 x 380 x 250 mm (15 x 15 x 10 in)	43 x 27 x 150 mm (1.69 x 1.06 x 5.90 in)
Casting Materials	Accura® CastPro™ Accura® CastPro™ Free Accura® 60 Accura® ClearVue Free	Accura® CastPro™ Accura® CastPro™ Free Accura® 60 Accura® ClearVue Free	VisiJet® SL Clear	VisiJet® SL Clear	VisiJet® FTX Green VisiJet® FTX Cast
3D Printing Process	Stereolithography (SLA)	Stereolithography (SLA)	Stereolithography (SLA)	Stereolithography (SLA)	Micro-Stereolithography
Accuracy	0.001-0.002 in per in (0.025-0.05 mm per 25.4 mm) of part dimension				Reference voxel size (XYZ)
Max resolution	4000 DPI*	4000 DPI*	4000 DPI*	4000 DPI*	56 micron (effective 585 DPI **)
Features	• Ideal for companies requiring high throughput or large parts in a single piece with highest accuracy and detail • Supports QuickCast build style patterns with lower moisture absorption, smooth surfaces, high dimensional stability and virtually an ash-free burnout • Offers antimony-free casting materials for clean burnouts necessary for aerospace applications		• Ideal for organizations who want all the benefits of SLA in a smaller footprint • Supports QuickCast build style patterns with lower moisture absorption, smooth surfaces, high dimensional stability and virtually an ash-free burnout • Versatile, high clarity material and also USP Class VI capable		• Ideal for workshops and labs requiring an affordable solution for small, finely detailed metal casting patterns, dental wax-ups and plastic parts in short cycle times

	ProJet® MJP 2500W	ProJet® MJP 3600W
Max Build Envelope Capacity (WxDxL)	295 x 211 x 142 mm (11.6 x 8.3 x 5.6 in)	298 x 185 x 203 mm (11.75 x 7.3 x 8 in)
Casting Materials	VisiJet® M2 CAST (100% wax)	VisiJet® M3 CAST (100% wax) VisiJet® M3 Hi-Cast (100% wax)
3D Printing Process	MultiJet Printing (MJP)	MultiJet Printing (MJP)
Accuracy	±0.004 in per in (±0.1016 mm per 25.4 mm) of part dimension	±0.001-0.002 in per in (0.025-0.05 mm per 25.4 mm) of part dimension
Max resolution	1200 x 1200 x 1600 DPI	750 x 750 x 1600 DPI
Features	• Ideal for small businesses, job shops and labs requiring precision parts in 100% real wax materials • Delivers very fine detailed patterns quickly, with excellent outcomes for very small parts in jewelry and dental applications as well as smaller industrial parts	

* Equivalent DPI based on laser spot location resolution of 0.00635 mm in 3D Systems testing
** Enhanced LED DLP technology provides an effective resolution of 585 DPI.

Next Steps to Adding 3D Printed Casting Patterns to Your Workflow

- Read more Investment casting stories
- Contact a 3D Systems specialist
- Learn more about On Demand Manufacturing

www.3dsystems.com

3D SYSTEMS