3D SYSTEMS

Investment Casting Solutions

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

Image Credit: Vaupell

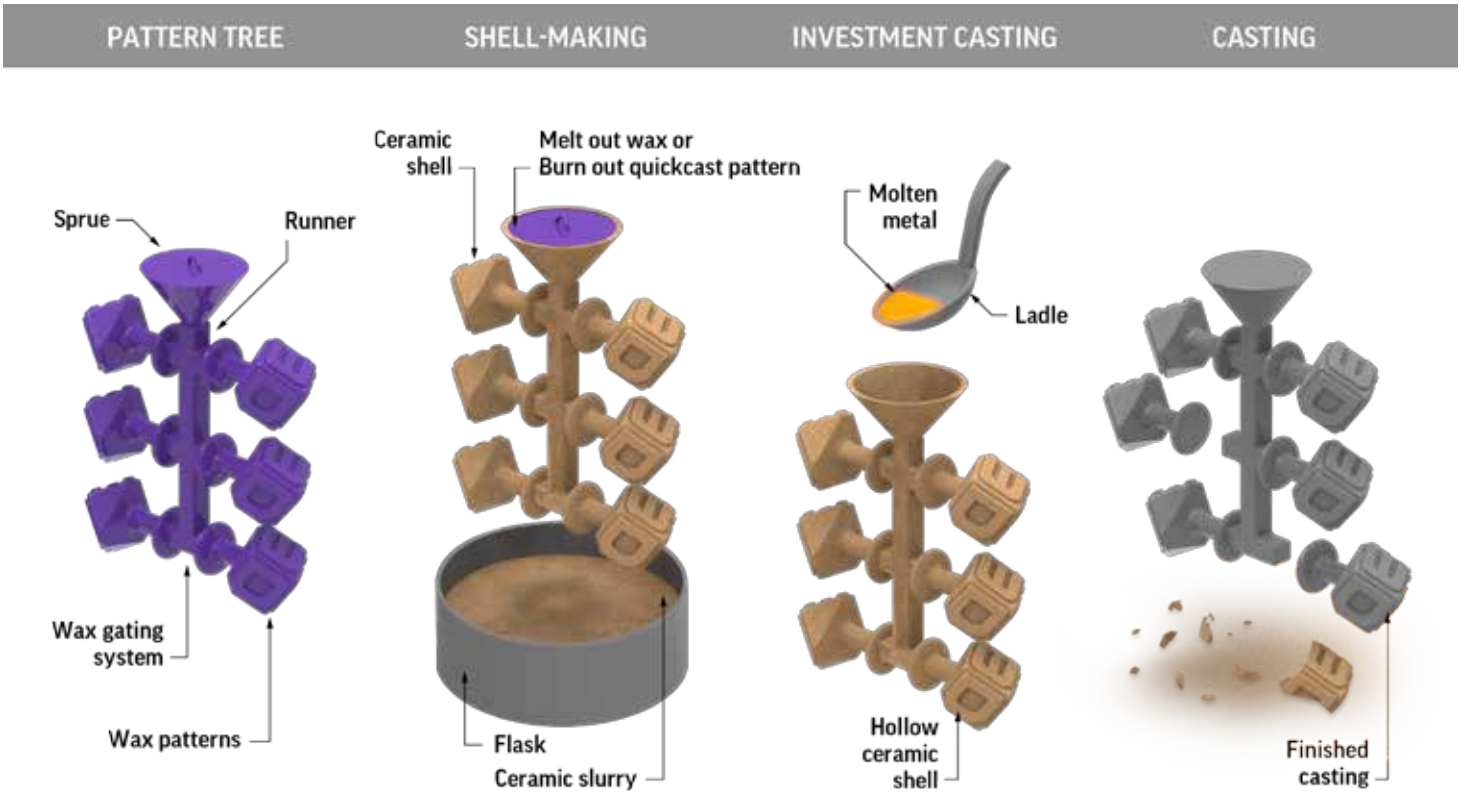
Investment casting in the 21st century

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

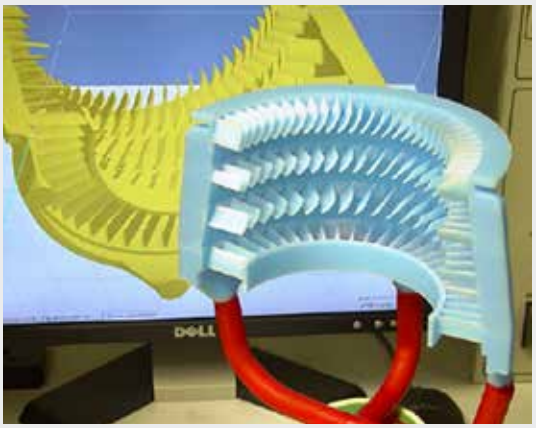
- Removed from the limitations and restrictions of traditional wax pattern production processes, 3D printed casting patterns can deliver higher design complexity.

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.



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.

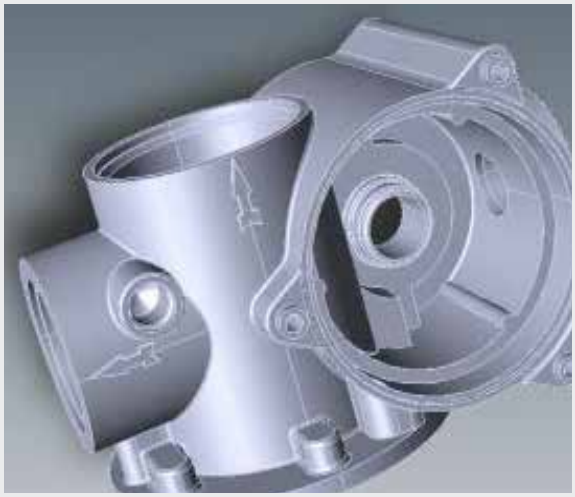
Wax multiJet printing for investment casting

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

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

Investment Casting Printer Comparison Charts

	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.