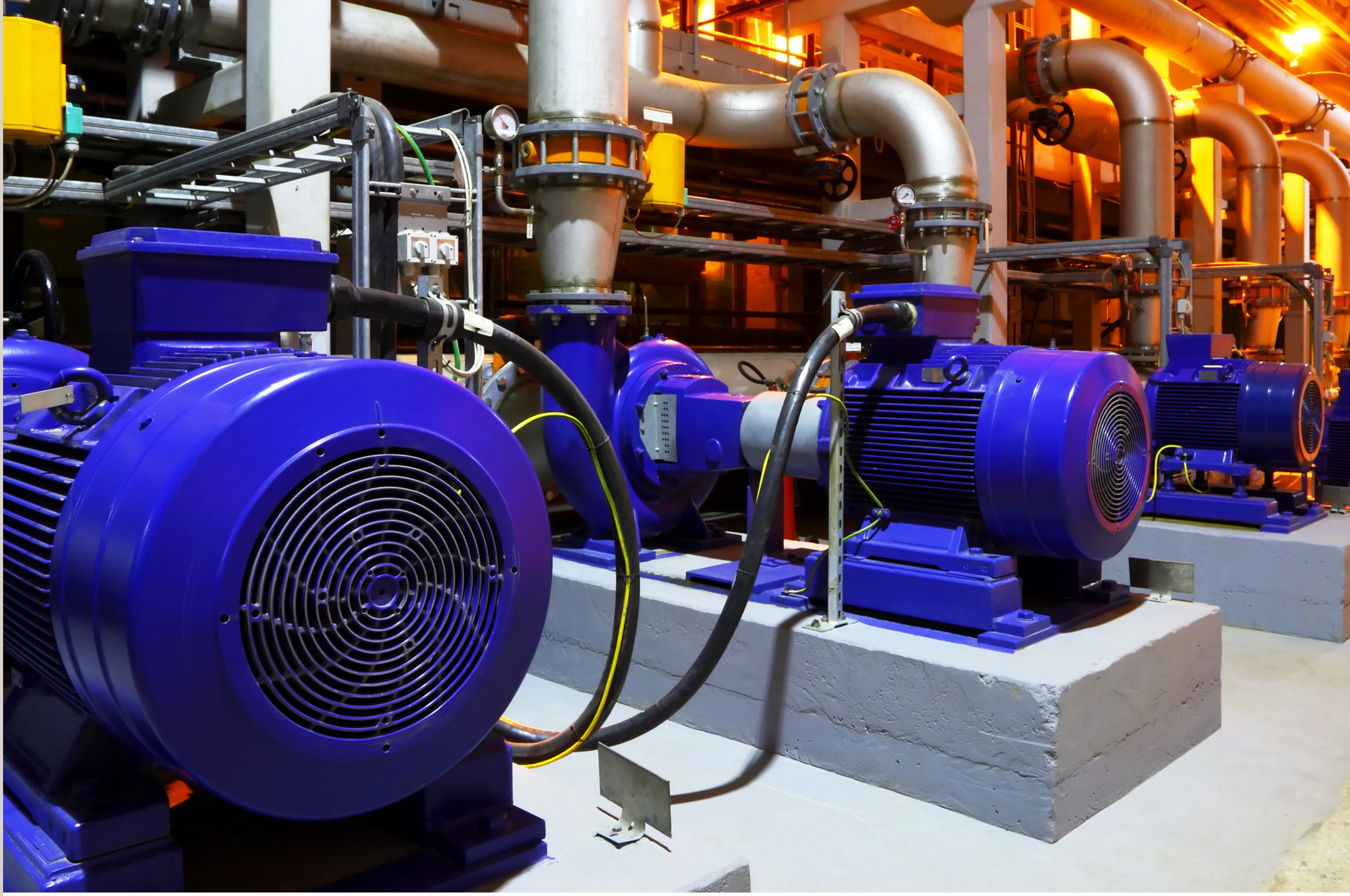


Minimizing costs and lead times for support machine components

Additive manufacturing solutions guide for manufacturers, industrial equipment suppliers and service bureaus producing or utilizing industrial equipment.

Solution Guide

stratasys

Is your business affected by **supply chain delays?**

Due to extended traditional manufacturing timelines, you've most likely experienced longer lead times for specific support machine components like cable grommets, cable clips or ducts. And whether you manufacture refrigerators, air conditioners, turbomachinery, construction machinery or even 3D printers, the lack of necessary parts and flexibility can hinder production — costing your company time and money as well as impacting your output and reputation.

However, producing necessary industrial equipment parts that meet performance requirements — on demand and at the desired volume — is achievable. This guide will discuss how three polymer 3D printing technologies – SAF™, P3™ and FDM® – are solid solutions for overcoming supply chain challenges.

The advantages of additive manufacturing

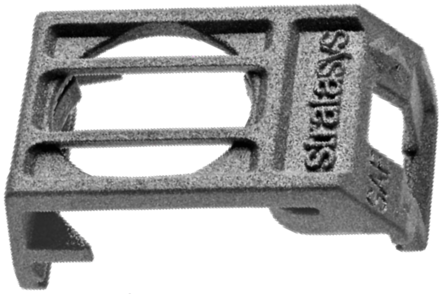
Shorten part production lead times

Traditional manufacturing for industrial machine components — such as CNC milling, injection molding and sheet metal forming — can result in delayed part delivery. For instance, it may take polymer milling subcontractors anywhere between five days to five weeks to fill requests depending on current workloads. While companies wait to receive these crucial replacements from the subcontractor, the industrial machine cannot be completed.

With additive manufacturing, industrial machine components can be printed immediately at low and high volumes — enabling a seamless transition from product development to production. In as little as a few hours, these critical parts can be designed, printed and ready for implementation.

During production of the H350 3D printer, a crucial part required for completion (circuit board bracket) could not be sourced due to supply chain delays. The Stratasys production team realized that they could utilize their own SAF technology to print the bracket immediately. This allowed the printer to be completed and advance to the next stage of development. This end-use part is now used in serial production and can be found in all H350 3D printers.

Time to part is also a challenge that the Origin One 3D printer is designed to successfully overcome. Lead times for polymer molding can take weeks or months. But by implementing leading-edge P3 technology, users can achieve a mold-like surface finish in a fraction of the time. This means businesses looking to launch production as quickly as possible can rely on the Origin One printer for short runs for testing as well as product launches. Additionally, when a part shortage hits or lead times increase, flexible production with Origin One can provide short-term fixes or long-term solutions for manufacturing businesses.



Circuit Board Bracket

Lower inventory and production costs

Storing large amounts of surplus inventory, such as spare parts, can be extremely costly and financially negligent if cashflow declines. With additive manufacturing, companies can print the exact number of parts needed on demand. This capability helps eliminate tooling costs associated with other manufacturing methods and labor-intensive manual fabrication (welding). Cost per part is also minimized and can lead to greater efficiency. This is especially important when it comes to small orders from suppliers.

Between labor and shipping, outsourced parts become increasingly more expensive compared to in-house 3D printed parts. Additive manufacturing also reduces warehousing costs and working capital while enabling consistent part supply over long life cycles.

Achieve design freedom

Once the part is sent to be produced by traditional manufacturing, it is time consuming and costly to change the design or iterate its function. As a result, the manufacturer must wait to receive the parts before implementing updates — leading to longer turnaround times.

With additive manufacturing, the full production process is unlocked. Design freedom is enabled to create complex parts that fit exact specifications within the machine. Additionally, the ability to print on demand allows potential designs to be iterated and tested quickly.

Industrial machine components created with additive manufacturing can also be stylized based on the designer's preference. This results in customer-facing parts that are created according to the desired aesthetic.

Another common challenge for traditional manufacturing is assemblies. Additive manufacturing allows these parts to be built as a single piece. This reduces the BOM (bill of materials) and leads to less assembly and inventory typically required for multiple parts.

Replace heavy metal with lighter materials

CNC milled support machine components are typically composed from material blocks or formed in sheet metal. Materials can include steel or aluminum polymers — including composites — if a more lightweight option is required. In either case, the metal materials create heavy parts.

Comparatively, additive manufacturing offers lighter polymers like High Yield PA11, which is utilized on the H350. This type of material allows for faster and more effective moving systems. The end-use parts not only physically weigh less but are more durable and ductile within the machine.

Featuring a broad material catalog, the Origin One machine has the capability to produce many parts with varying requirements — from flexible parts with high rebound to lightweight, high-strength parts — that can replace traditionally metal-made parts. Components produced on the Origin One provide manufacturers with the flexibility to produce parts for both test fit and final function.

Similarly, FDM thermoplastics offer manufacturers high-strength, lightweight material options. Carbon-fiber composite materials and high-performance PEKK, PEI and PAEK thermoplastics are particularly well suited for replacing heavier metal materials in certain applications.

Leverage a more sustainable, eco-friendly solution

With additive manufacturing, support machine components are printed on site. This eliminates the need for shipping and transport, which helps decrease emissions and minimize your carbon footprint. Additionally, High Yield PA11 polymer powder is completely derived from bio-based castor oil and end-use parts produced with this material can be recycled.

Manufacturers using powder and photopolymer-based 3D printing technologies experience reduced waste production compared to other production methods like CNC machining or routing. The H350 and Origin One can reuse materials, extending the life of these production materials while minimizing waste streams.

H350 3D printer: repeatable accuracy, consistency and high scalability


Ink Hose Flow Bend Clip


3D Lamp Wire Router

Within a matter of hours, the H350 leveraging SAF technology efficiently produces original and spare machine components. These end-use parts can include holders, brackets, mounts, fasteners, housings, covers, panels, gaskets, seals, latches or handles. Depending on what is required at the time, these production-grade parts may be printed in small batches or on an industrial scale. To certify production, the H350 offers machine connectivity and relevant manufacturing data. This provides traceability for every build and easily allows builds to be reproduceable.

Industrial machine components printed with High Yield PA11 polymer powder on the H350 exhibit consistency, impressive part strength, impact resistance and durability. This material is highly recyclable and results in less wasted powder at higher nesting densities. The unused powder can then be utilized in future builds. Plus, with the H350's long-lasting printheads and 12% nesting density*, manufacturers save on machine recertification and part costs.

From low-high production volumes, SAF technology provides consistent and repeatable parts build-to-build and machine-to-machine. This is based on SAF's in-line, unidirectional architecture — which maintains exact thermal control between fusing and recoating across the bed. This provides all positions on the bed with a uniform thermal experience and enables SAF to produce both complex and bulky parts without affecting part quality.

Support machine components may also require fine feature details, flat areas, thin or thick walls and smooth surface finishes. This is all possible with SAF technology since parts are created accurately and precisely as intended.

* 12% nesting density is an average standard and depends on the part's geometry. Certain geometries may achieve 12% nesting density, some can't reach 12%, while others surpass 12%.

H350 3D printer: support machine components

Alignment clip

This industrial machinery clip is utilized within the H350 3D printer. There are pins located on the printer's lid that are connected by a corresponding "female" part. This part ensures that the gas spring is always positioned in the center of the pin, essential for the machine's operation. Due to the accuracy of the clip's geometry and durability, the part effectively secures the gas spring in place. In just over nine hours, 2,142 alignment clips are produced in a single build. This demonstrates the type of machine component that the H350 can quickly produce at volume.

Duct

This duct is an end-use part implemented within the H350 to direct air flow through the printer. It is situated inside of the H350 so it must remain intact within the hot environment. The holes in the duct must be geometrically accurate since they are used to position the duct correctly into place. This level of accuracy is achievable with the aid of SAF technology, which accomplishes exact specifications.

Since the duct is created with PA11, it exhibits high ultimate tensile strength and impact resistance. In close to nine hours, 51 repeatable ducts can be produced.

Cable clip

This is an example of a clip that positions and holds cables in place within an industrial machine, such as mechanical testing equipment, industrial robotics, pumps or compressors. The clip tightly secures cables while remaining structurally sound. This is due to High Yield PA11, which is ductile and maintains high elongation at break. In less than 10 hours, 1,440 cable clips can be produced.

Since this is a high yield of end-use parts, it is necessary that the results be repeatable. This allows the parts to be placed in a bin and randomly selected when required on the production line. Every build that the H350 prints is precisely reproduceable based on SAF technology's consistent thermal control across the bed.

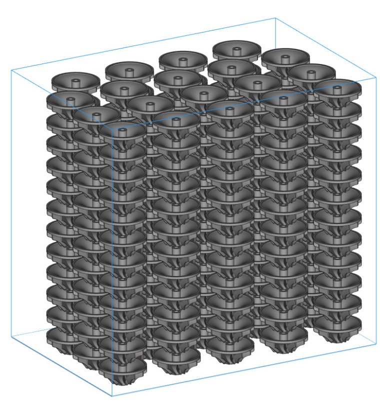
Door hinge cover

This door hinge cover is commonly found inside the cab of a construction machine, where it covers the hinges to help prevent injury. It is essential for the locating shafts to be concentric, so they fit properly. This is easily achieved with the H350 since end-use parts produced are consistent and repeatable. Additionally, High Yield PA11 polymer powder provides high impact resistance and elongation at break required for this application. In eight hours, 12 door hinge covers can be printed in a single build.

Impeller

This impeller is utilized in turbomachinery and as the vanes rotate, energy is transferred from the pump's motor to the fluid. It is important for the vanes to be smooth so that they can spin properly. Additionally, the thin walls must be robust, and the part needs to maintain its circularity after printing.

The H350 produces the impeller with smooth vane and body surfaces. By placing the mounting shaft in the Z orientation, optimal concentricity of this feature is achieved. Plus, the impeller can be nested tightly to allow for printing large batches. Within nine hours, 228 impellers can be produced.

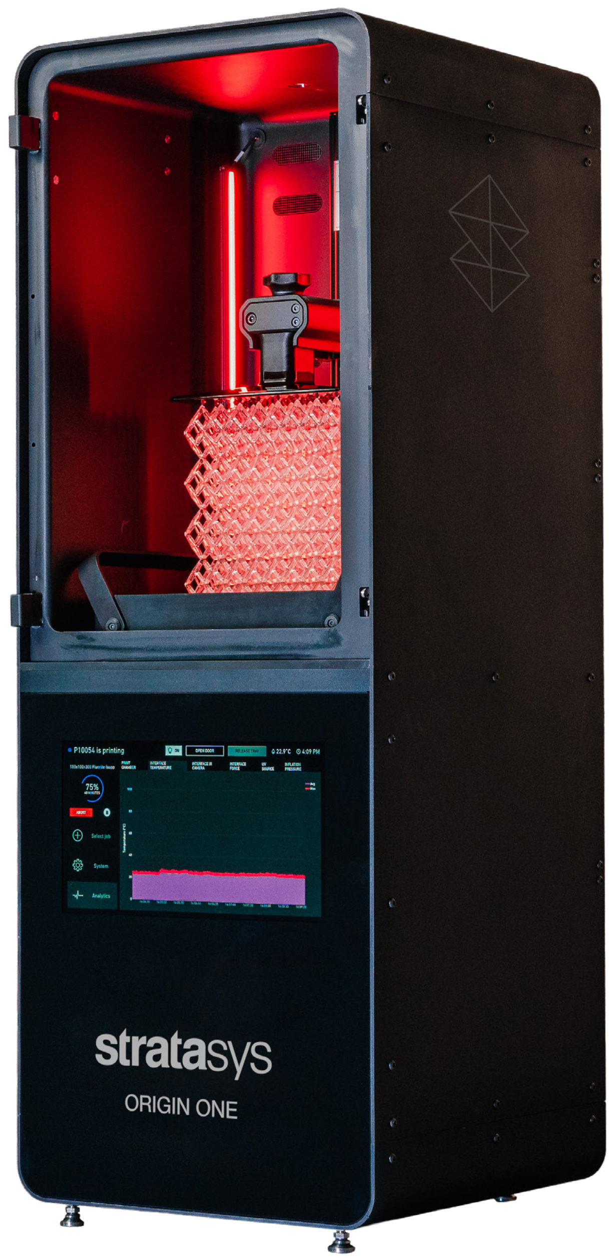


Origin One 3D printer: flexible, accurate and repeatable production

Accuracy and repeatability are essential for manufacturers, allowing them to save both time and money during the production process. These elements are key features of the Origin One 3D printer. P3 technology precisely controls print forces and provides optimized control of light and temperature during prints. This results in highly accurate parts that meet both tolerance standards and surface finish requirements.

The Origin One 3D printer provides manufacturers with a tool that can create robust parts for many purposes. The P3 process produces high polymerization conversion, which results in tough parts that can face the most challenging of environments or use cases.

Featuring a wide variety of materials, the Origin One printer has the flexibility to produce accurate parts with varying performance properties for a diverse range of applications. Flexible, elastomeric materials can be used to create support machine components like gaskets or seals while more general-purpose materials can be used to produce enclosures, clips or gears. The Origin One can also produce parts suitable for applications that require using materials that can pass FST and outgassing standards.



Wiring Harness

Origin One 3D printer: support machine components

Cable grommets

Grommets and cable-mounting devices may look simple, but their job is critically important for machine functionality. If a cord or cable moves or becomes disconnected, machine failure is a probability. Securely holding cables in place with durable materials that can absorb shock provide factories with more machine uptime across the board.

This cable grommet produced with Origin One and Henkel's IND 402 rubber-like material enabled a team of final assembly engineers to replace a faulty injection molded part with a durable elastomer material. This provided a better final fit than the molded grommet, which was inaccurately produced. In just two hours, 60 grommets can be produced — helping keep production timelines on track and moving forward.

Repair grommets

Product development is rarely a straightforward process. There can be shortages of parts or last-minute changes to designs. Many times, an investment has been made in cut or molded parts and changes are needed — requiring substantial redesign, or worse, more money spent securing new parts.

The Origin One engineering team recently experienced this situation firsthand when a late design change left literal "holes" in the process. Some quick thinking led the engineers to design and print grommets that seamlessly covered the holes in the costly, pre-fabricated machine parts — giving the printer a refined look and feel for customers. The engineering team used IND 403 from Henkel because it has great durability and a fantastic surface finish for end-use parts.

Hours were all that was needed to help the engineers avoid costly design changes and product delays. This is what flexible production with Origin One can bring to the shop floor.

Nozzle

Key components — such as covers, sheaths and deflectors — are susceptible to challenging environments within a factory. An elastomeric material such as Henkel's IND 402 material, can dampen vibration and allows for precise functionality of industrial machine components. Plus, a nozzle sheath printed on the Origin One can be a quick fix for the shop floor, or a permanent solution to protect valuable machinery components.

In under eight hours, users can produce up to 15 nozzles ready for immediate installation on the shop floor. This ability to print and quickly protect sensitive equipment empowers manufacturers to solve multiple problems with one tooling machine.

Handle

Parts such as machine handles and flywheels are constantly touched and utilized. Many of these parts have only been manufactured a certain way because there was no reason to change the process or break the mold. The Origin One enables a change in thinking for handle components or similar high-use parts. A focus can be made on tool fit or optimized function. Changes can be made regarding colors, textures and as-printed labeling or part instructions. These capabilities can even improve human factors, ergonomics and performance.

Origin One increases the options and elements to improve feel and function for operators on the shop floor. Using Dura 56 material, in just two hours, two custom, lighter weight and more ergonomic handles can be made.

Lenses and gauge covers

Gauges and sensors are vital for the safety and functionality of industrial manufacturing equipment. Gauges measure pressure inside enclosures and monitor the safe operation of high-risk equipment. Sensors give operators advance notice of issues with temperature or unsafe conditions. These parts are critical for the safe operation of valuable tools all across the standard factory floor.

When a sensor window cracks or a gauge lens is broken, operators are left with few options other than the dreaded "order and wait" scenario. Part replacements can take weeks or even longer in many cases. With Origin One, engineers can easily create functional, tough, and most notably, clear replacement parts for these applications. Using Henkel's 3843 material, engineers can print six lenses in just 30 minutes. With a multi-step sanding and polish process, lenses and covers can be processed to a final clarity in just hours. Using the speed of Origin One, a factory floor now has a quick fix for critical safety equipment to keep machines working around the clock.

FDM technology: large capacity printers and high-performance materials for demanding applications

The Stratasys FDM process is one of the original 3D printing technologies, having established a reputation for consistent, reliable, and accurate performance. It comes with a versatile array of thermoplastics to meet multiple applications in virtually any industry. Select Stratasys FDM printers are also open systems, allowing manufacturers to use third-party validated materials and adjust print parameters to meet specific application needs.

Stratasys FDM printers offer a selection of build volumes to meet application and facility requirements. Large-format printers accommodate big parts that can't be printed on smaller platforms.

An essential feature of FDM technology is its ease of use relative to other 3D printing processes. FDM printers are designed for plug-and-play simplicity with minimal training. Moreover, FDM's non-hazardous nature means there are no restrictions on where printers can be located. FDM technology also features minimal post-processing compared to some other 3D printing methods.

Example FDM Applications

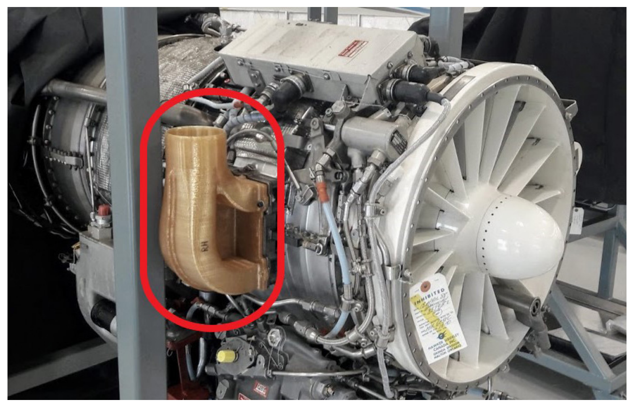
Functional prototypes

Functional prototyping takes the concept of rapid prototyping to the next level, giving manufacturers the ability to quickly test new designs in a real-world environment. FDM technology is a great fit for this application thanks to durable materials that withstand rigorous test conditions.

This working fluid sprayer uses an FDM housing, allowing Graco, the manufacturer, to obtain valuable contractor feedback before finalizing the design. An injection molded alternative would require supplier support, incurring more time and expense and a greater risk of delay from supply chain disruption. Instead, printing the housing on an FDM printer allows Graco to design, test, and iterate as needed, using in-house resources.

Similarly, Boom Supersonic used ULTEM™ 1010 resin to make functional bleed valve ducts to test engines slated for the next generation of commercial supersonic transport. 3D printing with ULTEM™ 1010 resin provided the high-temperature capabilities needed for this application, allowing engineers to quickly design and manufacture the ducts to meet the test schedule.

Functional prototype fluid sprayer made with an FDM housing.



Functional bleed valve duct (circled) made with high-performance FDM thermoplastic.

3D printed FDM decal application fixture shown on a marine engine cover.

Tooling and manufacturing aids

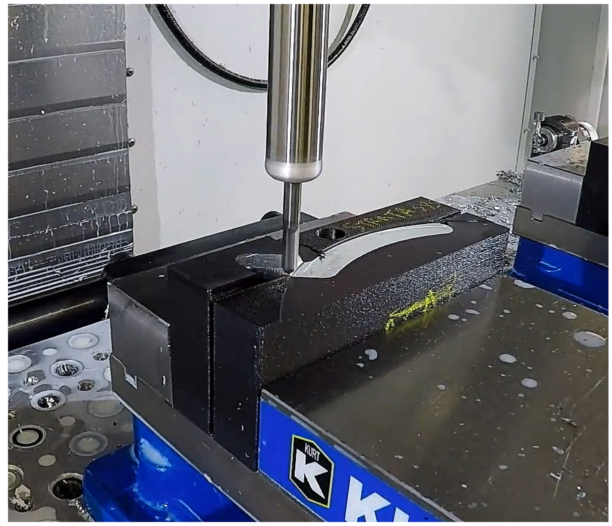
Tooling is a wheelhouse FDM application. Strong engineering-grade plastics and carbon-fiber composite materials provide the backbone for operator-customized, lightweight, yet strong manufacturing aids.

This example from marine engine manufacturer Mercury Marine highlights a tooling application that reflects the versatility of FDM technology. Fixtures used to apply decals to the engine cowls are typically damaged at some point during the production process, requiring new replacement fixtures. However, on average, new fixtures take six months to procure – even without supply chain challenges. In addition, these fixtures need provisions to avoid marring the painted cowls.

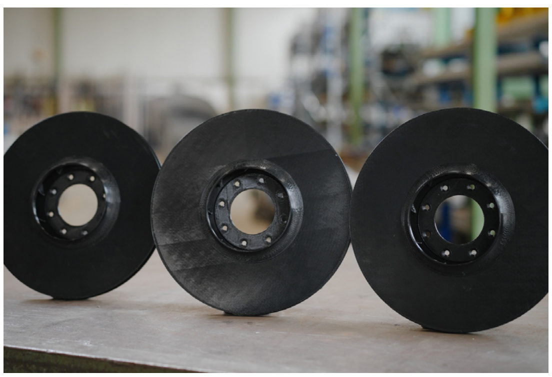
To alleviate these problems, tooling engineers used FDM® Nylon-CF10 carbon fiber and FDM® TPU 92A thermoplastic polyurethane to 3D print the fixture in-house. The carbon fiber forms the "spine" for the softer, non-marring TPU material. The result was an easily-produced, durable fixture that avoids reliance on external suppliers. And new fixtures can quickly be designed and 3D printed for new engine designs or to replace broken equipment.

Machining fixtures like soft jaws are ubiquitous in industrial fabrication shops. Usually machined from metal, they're either outsourced, which drives up lead times, or machined in-house, consuming resources that could otherwise be used for revenue-adding production. The better alternative is to 3D print them using high-strength FDM carbon-fiber composite polymers.

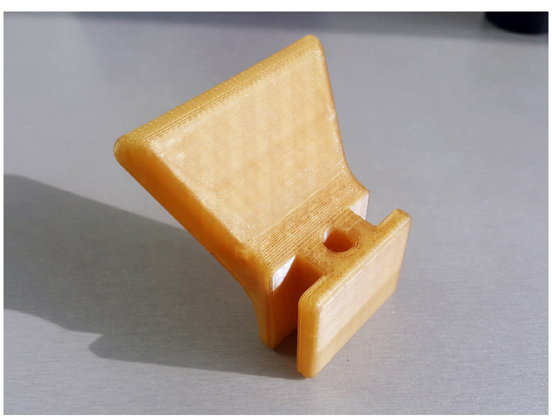
This is the approach taken by East/West Industries, a leading aerospace and defense contractor. When available CNC machines and the skilled labor to operate them became a constraint to their in-house soft jaw production, East/West 3D printed them instead. The result was a faster turn time, lower cost, and insurance against their internal supply chain obstacles.



Machining a complex shape using FDM composite-material soft jaws.



This 3D printed impeller reduced lead times by 50% compared to traditional metal machining.



FDM technology provides a faster, lower-cost solution for replacement and obsolete parts.

End-use parts

Another convenient application of FDM technology is the low-volume production of end-use parts. This is particularly helpful for highly customized applications and scenarios involving obsolete and out-of-production parts.

Reitz Ventilatoren, a manufacturer of radial fans for various industrial applications, turned to FDM technology to streamline its internal supply process. For example, the production process for a particular radial fan impeller involved numerous steps such as cutting, forming, joining, and coating. To condense the process, Reitz Ventilatoren 3D printed the impeller using a large-capacity Stratasys F770™ printer, eliminating those steps. This saved 50% on lead time relative to the previous manufacturing process.

Pack Line makes industrial packaging machines to manufacture food, dairy and cosmetic products. Supporting a worldwide base of these machines requires timely attention to keep customers' production moving when problems occur. Pack Line traditionally relied on outsourced metal forming or CNC machining for replacement parts. However, this was costly and resulted in long lead times.

As an alternative, Pack Line turned to FDM 3D printing to make replacement parts, such as this ULTEM™ 1010 resin machine part. Not only does this reduce the cost for these low-volume, custom parts by up to 55%, 3D printing also cuts the lead time from a minimum of one week to only a few hours. It's another example of how 3D printing can dramatically shorten the supply chain.

Advance your support machine component production to the **next level**

With the H350, Origin One, and FDM printers, supply chain setbacks and decreased inventory will no longer impact manufacturers, industrial equipment suppliers or service bureaus. And if a machine urgently requires a replacement or redesigned impeller, handle or gear, the part can be ready for implementation within hours. This will limit the reliance on external shipments that may take weeks to arrive, keeping production on track.

These solutions enable manufacturers to take control over their production process by printing the necessary end-use parts, exactly when needed — saving your business time, money and peace of mind.

Explore the H350 and Origin One at Stratasys.com.

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