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3D Printing Makes Lean Manufacturing Leaner

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A lean manufacturing operation is one that aims at reducing waste – wasted time, material, personnel, space, and money – with a focus on ensuring that every activity related to the final product adds value, assures quality, and helps meet customer requirements.

A wide range of tools to support and sustain lean programs is available to manufacturing engineers, manufacturing plant managers, operations managers, and production engineers. These include software tools such as enterprise resource planning (ERP), manufacturing resource planning (MRP), supply chain management (SCM), and similar products. Robotics and automation are also important contributors to meeting lean program objectives.

3D printing is another tool that can enhance lean manufacturing efforts by saving time, reducing material wastage, cutting inventory requirements, and making the enterprise more agile, and better able to respond to a rapidly changing marketplace and customer demands.

Manufacturing operations can take maximum advantage of these enhancements by establishing an in-house 3D printing capability. An in-house capability can be used in the product design and prototyping process, or for creating low to moderate volumes of a final product or some its components. As the costs of purchasing and using a 3D printing system continue to decline, the return on the investment of setting up an in-house capability has become greater and is realized sooner. It is important to note that the size of a 3D printer does not necessarily limit its range of applications. Large printers can produce prototypes, and small printers can produce end-use products or parts.

Manufacturing operations can derive maximum benefits from 3D printing by establishing an in-house capability that can produce low to moderate volumes of a final product or some its components.

Saving Time and Money

Companies are always under pressure to reduce time-to-market. This pressure requires product designers and managers to operate in a highly compressed time frame, particularly during the conceptual stage of design, making decisions with little or no margin for error. These decisions can include material selection, manufacturing techniques and product life cycle, all of which ultimately affect total cost. 3D printing can help to accelerate and optimize design and prototyping processes by enabling as many iterations of a design as necessary, all the way through product testing.

Examples of significant time savings in prototyping can be found in a variety of manufacturing industries. Creating clay models is one approach often used in the conceptual stage of industrial design, but Cool Gear Inc., a manufacturer of consumer food containers and water bottles, experienced a time savings of 96% by using 3D printing instead. In the aerospace industry, 3D printing brought UAV maker Leptron a 43% time savings over injection molding with CNC-machined tooling of end-use parts.

For parts manufactured from plastic, 3D printing offers the added benefit of rapid production of a prototype in a material with mechanical and thermal characteristics nearly identical to those of the production material. RedDOT, a manufacturer of ABS plastic and nylon components for vehicle climate control systems had switched over to 3D printing, employing Fused Deposition Modeling (FDM®) technology and one of Stratasys's five ABS

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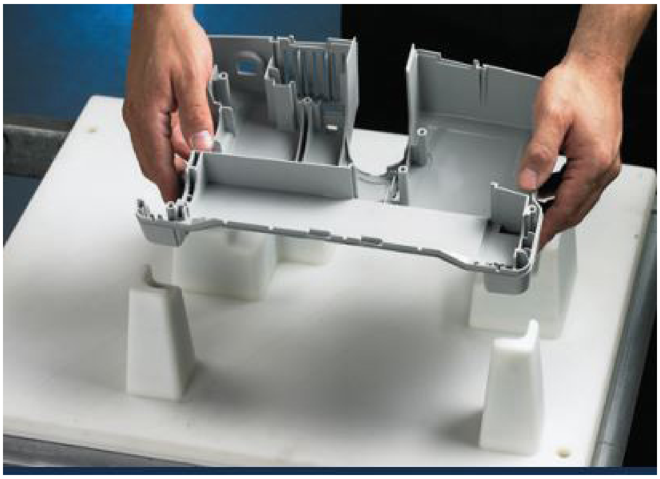
FDM materials, for creating functional prototypes of ABS plastic parts.
But for parts that were to be manufactured out of nylon, the company used machined metal prototypes. The metal versions were dimensionally accurate but did not have the physical properties of the nylon from which the actual parts would be made. Nylon was chosen for its flexibility for snap-fit assembly and its shock-resistance, so the actual performance of the parts could not be evaluated until some were molded in nylon for functional testing. When problems arose, the whole process had to be restarted, from metal prototyping, to mold-making, to molding parts. In some instances, this involved six-figure costs and months of waiting time. However, once Stratasys introduced its Nylon 12 FDM material, prototypes of nylon parts were produced at a fraction of the cost of the machined metal parts, eliminating unnecessary tooling costs and allowed the opportunity to test the part with the true end material - Nylon.

When the design process is a team effort, an in-house 3D printer can make the process more compatible with lean principles. Rapid prototyping can enable accelerated collaboration within the design team, as well as between the design team and other departments such as manufacturing, marketing, product testing, and quality assurance. All stakeholders have an opportunity to review the design and necessary adjustments can be made before committing to expensive production tooling.

An in-house 3D printer can also support the design process and production of the jigs and fixtures required for manufacturing, measurement, or quality control processes. 3D printing can be especially beneficial in saving time and costs when producing jigs or fixtures for which the designs are complex, subject to iterative changes, or when tolerances are on the order of ± 0.005 in.



The quality assurance department at Oreck, Inc., a manufacturer of household cleaning devices, performs first-article inspections of product components – up to 30 injection-molded parts per end product – using coordinate measuring machines (CMMs). Prior to establishing an in-house 3D printing capability the company used CNC machining to produce the required jigs and fixtures, resulting in a process that took 30 days and cost $250 per item. When the company started using 3D printing to create the jigs and fixtures, the time required per item dropped to just one day, and the per-item cost was reduced to $55.

Similar contributions to lean manufacturing programs can be applied directly to manufacturing processes. Advanced Composite Structures (ACS), a manufacturer of advanced composite components for the aerospace and defense industries, had been producing layup tools, drill fixtures and consumable core patterns on CNC machines. Alternatively, a model was produced using a CNC machine or power tools and used to mold a composite layup mandrel.

It typically costs around $2,000 to hire a machine shop to produce a metal composite mold. The cost for producing a model and molding a composite layup tool is about the same. In both cases, lead times were eight to ten weeks. Initial tooling design sometimes presented problems. In these cases, the company incurred additional expenses and the project was delayed while the tooling was repaired or rebuilt from scratch.

The company has switched to producing nearly all of its tools using FDM technology. A typical FDM layup tool costs about $400 and takes 24 hours to produce. This lower cost and shorter lead time enables the company to affordably remake tools that are found to have problems on the manufacturing floor.

Leaning Towards Growth

Few markets require greater agility and responsiveness to consumer whims than the intensely competitive small appliances segment. New models of existing products must be introduced yearly, and when this pressure is multiplied by an imperative to grow, the stress on the product design and development function assumes critical proportions.

The R&D team at Australia-based Breville found its capabilities nearly outstripped by time-to-market and new product demands, potentially hindering future growth. The bottleneck was the creation of prototypes with CNC milling. The process was simply not efficient or flexible enough to cope with the growing variety of designs and the shortened time frames required for developing them, testing them for manufacturability, and putting the products into production.

The solution was an in-house 3D printing capability that enabled the designers to produce prototype parts that previously were especially challenging to create. The parts can now be printed easily with a high degree of accuracy and smooth surfaces. These qualities are critically important for functional tests like snap-fit and fixture tests on buttons and levers for coffee machines and mixers.

Cutting design, prototyping and functional test times to fractions of their previous lengths through the use of 3D printing has enabled the company to meet time-to-market, new product introduction and growth goals in a globally competitive market.

Better Ergonomics, More Productivity

Workers at the assembly plants of luxury car manufacturer BMW use a variety of custom-manufactured tools and jigs to maneuver and align parts for chassis assembly. An FDM process on a production-scale 3D printer has replaced metal machining as the means of creating many of the handheld tools and jigs, but the engineers designing the items have taken further advantage of the flexibility of 3D printing. First, they designed a flow chart that helps determine which specific tools are best suited to manufacture by 3D printing in ABS material. The factors considered are temperature, chemical exposure, precision, and mechanical load. With Stratasys ABS material, which the engineers find comparable to polyamide (PA 6), many tools for vehicle assembly satisfy the criteria. The selected tools are then designed for minimum weight and optimized ergonomic characteristics.

The freedom of design afforded by 3D printing, which cannot be matched by machined or molded parts, allows the engineers to create tools with improved handling, reduced weight, and improved balance. In one example, the weight of one device was reduced by 72 percent with a sparse-fill build technique. Replacing the solid core with internal ribs cut 1.3 kg (2.9 lbs.) from the device. This improvement makes a big difference when a worker uses a tool hundreds of times in a shift. Additional benefits include improved productivity, added worker comfort, ease-of-use, and process repeatability.

Reducing Inventory, Boosting Agility

Acist (Advanced Contrast Imaging System Technology), a manufacturer of systems used to infuse patients with contrast material for medical imaging studies, uses FDM technology for fixtures, functional testing, industrial design, and end-use parts. One reason for the heavy reliance on FDM parts in fielded systems is that the company uses feedback from users of its products to make improvements. In one example, users in the field expressed the need for multiple types of transducers to be connected to the same machine, along with the ability to switch rapidly from one transducer to another. The company was quickly able to design a part in

CAD software to meet this need, and printed it as a functional part to be shipped and used on machines worldwide. The complex part would have been very challenging to mold using traditional methods.

With FDM, much of the company's inventory is a collection of digital files on a server. The company doesn't have to manage shelf space or relationships with vendors. If an FDM part breaks in the field — even five years after the product was sold — the company simply prints a replacement on one of its two 3D printing systems and ships it the next day. Used in this way, FDM 3D printing is the ultimate lean manufacturing technology.

Across many industries and applications, in-house 3D printing offers manufacturers leverage to make their lean operations even leaner. Whether for rapid prototyping, creating jigs, fixtures, tooling, or end-use parts, in-house 3D printing offers considerable savings in time, money, materials, and inventory space. As more items are added to the already extensive list of 3D-printable materials, the benefits of this inherently lean technology will be available to an even wider spectrum of manufacturing companies.

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ABOUT STRATASYS

Stratasys Ltd. (Nasdaq:SSYS), headquartered in Minneapolis, Minnesota and Rehovot, Israel, is a leading global provider of 3D printing and additive manufacturing solutions. The company's patented FDM®, PolyJet™, and WDM™ 3D Printing technologies produce prototypes and manufactured goods directly from 3D CAD files or other 3D content. Systems include 3D printers for idea development, prototyping and direct digital manufacturing. Stratasys subsidiaries include MakerBot and Solidscape, and the company operates a digital-manufacturing service comprising RedEye, Harvest Technologies and Solid Concepts. Stratasys has more than 2,500 employees, holds over 600 granted or pending additive manufacturing patents globally, and has received more than 25 awards for its technology and leadership.

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