Beyond the hype:
What companies are *really* doing with 3D printing

By Kevin Lach

3D printing is attracting a lot of buzz these days, much of it based on what just might be possible in the future. Many engineering organizations, however, would be surprised to learn what's real today and how 3D printing can improve business performance now.

What is real today is that 3D printing is no longer a novelty and is undergoing rapid adoption in product companies across a wide range of industries. Real companies are seizing tangible, quantifiable benefits from the strategic use of 3D printing, most often for prototypes they leverage from concept through production and sales.

Three-dimensional printers, which create real physical objects from 3D data, are paralleling the evolution of document printers. They're getting faster. The price is falling. They're becoming easier to use and more office friendly. The quality of the output is soaring. Color is changing everything. While increasing its presence in manufacturing, 3D printing is also making inroads in fields like architecture, disaster response, the arts, and entertainment.

Thermal analysis, stress/strain analysis, and more can now be applied to a 3D model in multiple colors like in this truck cab B pillar with FEA results from Hydroforming Design Light AB. A bright red splotch on the part design indicates high stress or potential weakness. A blue patch indicates low stress or part strength.

Real-world applications

The Timberland Company (boots, apparel, gear) uses 3D printing to more quickly and affordably produce prototypes for new arch supports, tread patterns, heel stabilizers, and materials. By switching from hand-crafting prototypes to 3D printing, the company has experienced a more than 30-fold reduction in prototype cost, a reduction in prototype creation time from one week to 90 minutes, and a 33% reduction in design time.

"We can now quickly do innumerable iterations and variations, and the designers and marketing mangers can really be sure the product is what Timberland is expecting and what people on the street are demanding," says Toby Ringdahl, Timberland CAD manager.

Powermate Corp. is a 700-employee Aurora, IL, maker of portable and standby electric generators, air compressors, air tools, pressure power washers, and emergency backup systems. With 3D printing, the company has reduced time-to-prototype from three weeks to half a day, and has reduced annual prototyping spending from $75,000 to $25,000.

The Denby Pottery Company, a 200-year-old UK manufacturer of fine tableware, has reduced prototyping time from four weeks to two hours and is launching product lines in half the time.

And so on.

Faster prototyping means companies make crucial decisions and detect hidden form/fit/function flaws earlier in the design cycle. Colleagues and prospective customers understand ideas better and have a wider range of choices. Suppliers and vendors participate earlier in development. Focus groups see their ideas adopted overnight. Sales are closed earlier in the development process.

Recent advances in 3D printing are tipping points for product companies that have traditionally outsourced their prototyping. Speed, affordability, and office friendliness make developing prototypes in-house a viable investment with a positive return.

Spirax Sarco Inc. closed a $600,000 job with this 3D printed scale model of the EasiHeat heat exchanger.

Inkjet-based 3D printers, for example, can now print a typical part in less than two hours. Material costs are as low as $2 per cubic inch, and some systems automatically recycle the benign composite powder left over from a build, making them entirely compatible for office use. 3D printed parts are increasingly versatile. You can build them to be flexible, strong, or ultra economical. Models can be drilled, tapped, sanded and painted, or electroplated to replicate the look and feel of the final product.

One of the biggest advances in 3D printing is the ability of some devices to print a single object in any combination or pattern of hundreds of thousands of colors. This is as momentous as the emergence of multicolor document printing. It permits not only multicolored objects, but the application of complex texture designs — even photographs — on parts. Such flexibility enhances communication, improves designs, and provides a better understanding of what a final product will look like before expensive production steps begin.

(Investing in a multicolor 3D printer is tricky, however. Some devices billed as color 3D printers are essentially monochrome printers that enable printing in any of seven colored materials that are impossible to blend. To get a multicolor assembly, users need to print parts separately, gather the colored parts, and assemble them. The finished assembly will have no more than seven colors. Textures, photographs, and labels are out of the question. This is an extremely laborious prospect with sometimes disappointing results.)

Concept models

Since many products, especially consumer products, have sophisticated color patterns, labels, and eye-catching packaging, it's vital to accurately communicate these design elements at the outset of the design cycle. Historically, companies have resorted to the time-consuming and tedious process of painting their models. To evaluate packaging and labels, which challenge most engineers' painting talents, companies have typically relied on computer renderings. True multicolor 3D printers can now handle all of this.

Designers at Fisher Price, one of the world's leading toy manufacturers, were able to release three product concepts directly to manufacturing in the first month of owning their new multicolor 3D printer. The decision was based on collaboration with 3D models that were printed, rather than painted, in color — a first for the company.

Communication

True multicolor 3D printers let you print labels on parts. It's important to remember that a monochrome 3D printer gives you only one color, usually white, whereas a monochrome document printer actually gives you both black and white (the white being the paper). To obtain the same contrast and reveal, printed text thus requires a multicolor 3D printer.

Labels matter. No one would consider producing a CAD drawing without some form of engineering label to provide information about the drawing. The same goes for a 3D part — without any label on the part, a lot of information is lost. With an engineering label, one can quickly see what the part name is, what scale it has, when it was printed, who designed it, etc.

Multicolor 3D printing capability also makes it quick and simple to mark up parts. Arrows and other highlighting techniques can spotlight what has changed in the latest iteration of the part. Different colors or patterns can convey instructions when a complete design is ready be transferred to manufacturing (or a supplier). By using multiple colors, it is easy to highlight part surfaces that need to be machined, holes that need to be drilled, or assembly order, (e.g., blue first, red second, and yellow last). Designers can get creative and start adding visual effects like shadows onto a part to enhance communication. The possibilities are limited only by the designer's imagination.

The Continental ContiProContact was recently introduced by Continental Tire North America in 22 sizes with advancements in wet traction and handling. The ZPrinter 310 provided the engineers with a hands-on evaluation of the tread design before investing in the expense of molds and tire building.

Data analysis is another area where multiple colors can offer tremendous value. Sometimes it's impossible to properly visualize the output of a finite element analysis (FEA) if you're only looking at the colorful data on the flat computer screen. It can be difficult to share analysis information in a meeting if there are no parts to pass around. Thermal analysis, stress/strain analysis, geological analysis, and more can now be applied to a 3D model in multiple colors, vividly representing data for better understanding.

Improved printing resolution means better application of colors than ever. A company selling soft drinks can now design and print various versions of can labels directly onto a can model with enough detail to read the ingredient list and scan the bar code.

A 3D printer capable of printing high-resolution parts in hundreds of thousands of colors can now be had for less than $40,000.

3D scan + 3D CAD + 3D print = powerful product development

A few visionary companies are beginning to combine 3D CAD and 3D printing with high-resolution 3D data capture. A global Tier 1 automotive supplier uses a 3D mobile scanner to capture the precise contours of a standard auto interior with components removed, thus creating a digital foundation on which to design a new, more technically advanced cockpit. Engineers import the data into their 3D CAD tools and create sleek new cockpit designs, then 3D print the parts and install them in a real automobile to create a powerful, persuasive prototype.

Moldmaking

Moldmaking is another area where 3D printing is making a major impact, saving valuable time and labor for moldmakers facing tight deadlines. 3D printers are playing a key role in investment casting, and they are directly producing molds for thermoformed, urethane, plastic, and metal parts. 3D printers can even be used for sand casting short-run metal production parts. Organizations like Ford Motor Company, NASA, and Neptuno Foundry

These Hi-Flo exhaust pipe and manifold prototypes ensured an exact fit for Trinity Products Inc. of Edison, NJ, a $10-million manufacturer and supplier of high-performance remote-control cars.

are currently capitalizing on these capabilities.

Ford, for example, recently needed complex support brackets in four weeks — a seemingly impossible deadline. Engineers, however, decided to skip the time-consuming process of developing a wax pattern and simply 3D printed patterns in plaster. The patterns went straight to the foundry where they were cast with aluminum.

These parts had a 100% success rate with no surface problems or deformation. Ford met the deadline by avoiding the time-consuming hard tooling required for creating the wax patterns. “The Z Corp. 3D printer has really allowed us to push the envelope of 3D product design and has been a perfect fit in our design process,” says Erik Johnson, an engineer with Ford’s Automatic Transmission Operations.

Beyond manufacturing

All of these applications — concept prototypes, multicolor models, scan-to-3D print, and moldmaking — just scratch the surface of what a 3D printer can actually do today. There’s another big world of 3D printing beyond the engineering workstation and the manufacturing company.

Architects, for example, are using 3D printed models as project management tools from concept through construction, distributing 3D printed models to every stakeholder in a project — the client, the contractors, and permitting agencies and real estate brokers for starters.

The military and other government agencies are using 3D printed land and building scapes to plan maneuvers and disaster response operations. That’s just one of many applications in the graphic information systems (GIS) world.

Artists are using 3D printing as a new sculptural medium. Health care professionals are using 3D printing to better understand body parts, organs, and other 3D scanned data. Entertainment companies are using 3D printing to create figurines of avatars for gamers. Museums are using 3D printing to preserve rare artifacts, and archeologists are replacing missing bones in skeletons. Leading high schools, colleges, and universities are using 3D printers to efficiently pump out design prototypes and expose students to state-of-the-technology.

So next time you hear about the wonders of 3D printing in the future, know that in many industries the future is now.

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