

3D PRINTING

SIMPLE TRUTHS BEHIND THE HYPE

Believe it or not, 3D printing is still in its infancy. While it may not make sense for your business right now, it can't hurt to learn more about it.

BY EILEEN FRITSCH

In the beginning of large-format digital color printing there was hype. Lots of hype. About dazzling new printing capabilities that would lead to billion-dollar opportunities in many different fields. Then reality hit. Some major technical hurdles had to be resolved before any of the optimistic forecasts fueling the hype could be realized.

If your business persevered through the dawn of large-format digital color printing, then you know what challenges I'm talking about. To use wide-format printers for applications other than engineering drawings, new inks and materials had to be developed for outdoor-durable signs, vehicle wraps, archival art reproduction, color-accurate proofs, high-resolution photo enlargements, photo merchandise, garments, textiles, and wallcoverings. Potential users had to be educated. Skeptics had to be convinced. Inkjet printers had to become faster and more reliable. Print resolutions had to go up while printer costs came down. And software had to simultaneously become more powerful and easier to use.

The early adopters of large-format printing equipment took big risks, navigated steep learning curves, and educated customers about new creative possibilities. In the process, they also advised printing equipment and material manufacturers about specific problems that needed to be resolved in order to grow the market for large-format color printing.

A similar cycle is underway with 3D printing. While industrial designers have used 3D printers since the 1980s to make concept models and functional prototypes, 3D printing entered a new phase of innovation as the patents on the first generation technology expired. Now, a host of new printing devices are being developed for personal, professional, and production use.

Mark Blundell, CEO of SA International explains, "3D printing is moving from the world of rapid prototyping to distributed manufacturing." Design files for various products can be stored in the cloud, then downloaded and manufactured wherever the products are needed.

You can already find 3D printing services at some Staples and UPS stores, on Amazon.com, and even at your local library. Design libraries are springing up on sites such as CGTrader.com, Thingiverse, and Shapeways. And government agencies such as NASA, the National Institutes of Health, and the Smithsonian are making 3D scans available for printing in schools and museums. Users of Adobe Photoshop CC can tweak design files for 3D printing and send them to service bureaus such as Shapeways and Sculpteo (See sidebar, pg. 25).

The Consumer Electronics Association introduced a 3D Printing Marketplace at the 2014 International CES in Las Vegas and plans to double the amount of exposition space devoted to 3D printing at the 2015 International CES from January 6-9 in Las Vegas.

McKinsey and Company estimates that 3D printing and additive manufacturing will be among the top 10 disruptive technologies over the next decade. They estimate it will have a potential global impact of between \$230 and \$550 billion a year. The largest impact will come from consumer uses,

followed by direct manufacturing of finished goods, and the use of 3D-printed molds for manufacturing.

In addition to making prototypes for manufactured products, 3D printing is being used in fields such as architecture, archaeology, surgery, medical devices, fashion, home goods, and moviemaking. On these pages and on news sites such as 3ders.org or 3dprintingindustry.com, you will see dozens of potential applications, as well as plenty of new printers.

But now that the hype cycle has been fully ramped up, what challenges must be addressed? More specifically, should print-for-pay service providers consider adding 3D printing services? Let's look at six simple truths behind the hype.

1 IT'S ABOUT TRANSFORMING MANUFACTURING MORE THAN REVITALIZING PRINTING

3D printing is a catch-all term for multiple methods of generating 3D physical objects from a digitally created model. Industrial designers and engineers refer to 3D printing as "additive manufacturing" because materials are added layer by layer until the object is built. ("Subtractive manufacturing" equipment, such as routers for sign fabrication, removes layers from solid blocks of materials. Roland DGA markets its MDX benchtop milling machines for "subtractive rapid prototyping.")

But outside of manufacturing plants, it's the term "3D printing" that has captured the public's imagination. Let's face it: 3D printing sounds so much simpler and more futuristic than "additive manufacturing." Unfortunately, the term "3D printing" also suggests that it would be a natural extension of a 2D printing business. That's not necessarily the case.

In reality, the hype surrounding 3D printing is really related more to transforming manufacturing than revitalizing printing. Leaders at the U.S. Department of Commerce and engineering associations believe 3D printing offers a way to bring more manufacturing back to the U.S. They believe 3D printing is inspiring a new "maker generation" of Americans and have launched initiatives to revitalize high school shop classes and excite young people about careers in manufacturing.

Aerospace and automotive firms and defense contractors have already started moving beyond rapid prototyping and are using it to make usable parts and actual devices. And researchers in universities and labs worldwide are studying 3D printing's potential to reduce the cost of everything from construction materials to custom prosthetics.

Some proponents of 3D printers envision that consumer-grade 3D printers will lead to the rise of "domestic manufacturing," in which individuals will be able to print items such as tableware, shoes, children's toys, sex toys, or repair parts in the comfort and convenience of their own homes. (See makexyz.com.)

3D printing might also enable "distributed manufacturing," in which more products will be manufactured locally at sites equipped with a mix of 3D printing and subtractive manufacturing devices, such as CNC milling and laser-cutting tools. (See syncfab.com.)

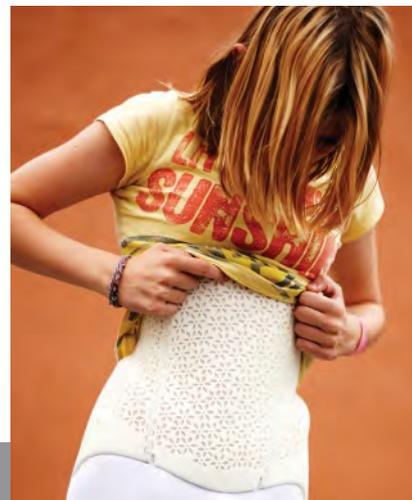
2 ENTREPRENEURS ARE STILL SEARCHING FOR THE NEXT KILLER APP

Currently, most 3D printers are used for rapid prototyping and modeling. Rapid prototyping speeds up the cycle of innovation by enabling companies to design quicker, fail faster, and fail cheaper. Designers can quickly figure out which concepts don't work, then move on to find those that do.

Architects have traditionally hand-built models of their designs, so they have been quick to see the benefit of printing models from their CAD files. But as the product literature for Konica Minolta's ProJet line of 3D printers points out, "Printed models benefit transportation, energy, consumer products, recreation, healthcare, education, and other vertical markets. The printed parts can be sanded, drilled, tapped, painted, and electroplated, which further expands the options available for finished part characteristics."

The possibilities of 3D printing have stirred the entrepreneurial dreams of all sorts of would-be inventors and designers.

3D Systems' Bespoke Brace is a personalized, 3D-printed brace for children and young adults with scoliosis. During a pilot program, patients at Children's Hospital of Oakland responded favorably to the enhanced aesthetics of the brace and reported strong levels of wear and compliance. "I've never seen children respond so positively to a brace," says Dr. James Policy, who collaborated on the project. "It was so cool that once they were fitted, many were showing the brace off to their friends." (3dsystems.com)



MEDICAL DEVICES

PROPS



Propshop, a UK-based producer of models, set pieces, and props for high-profile films, used LightWave 3D software and 3D printing to create models of cars and helicopters that were used in crash scenes in the James Bond movie Skyfall. (lightwave3d.com)

Maker fairs and sites such as Shapeways, Ponoko, and Sculpteo are cultivating Etsy-like communities of designers who create 3D-printed products for sale to the public.

Crowdfunding sites and 3D news portals are suggesting hundreds of different ways 3D printers could be used. For example, new businesses are being built around custom-printed eyewear and CPAP devices for sleep apnea sufferers. Some ideas are related to fashion (dresses, headwear, shoes, compression athletic apparel) and accessories (jewelry, cell phone cases, belt buckles). Artist Ioan Florea (floreaart.com) demonstrated a 3D-printed house and car, as well as 3D-printed paintings and sculptures. People have also printed molds for manufacturing designer chocolates and have even 3D printed ice cream, meatless hamburgers, and pizza.

Manufacturers of appliances, cars, and trucks envision a day when they no longer have to maintain inventories of parts for outdated models. Instead, owners could simply download files from design libraries and print replacement parts as needed.

3D printing has also started taking off in the healthcare field, where it can reduce costs while improving the quality of care. Models printed from data captured on medical scanners can help surgeons prepare for reconstructive surgeries that involve inserting metal plates in the skull or custom-fitting hip or knee replacements. Models of bone structures can reduce the use of actual cadavers in medical schools. 3D printing can also be used to make biocompatible organs and personalized prosthetics.

3 PROFESSIONAL-GRADE MODELS NEED TO BE IMPROVED

With all of this hype, it's easy to assume that 3D printing technology is further advanced than it actually is. In truth, the field is still in its infancy. The 100 or so materials that can be processed with 3D printers represent a fraction of the thousands of materials used in different types of manufacturing.

And rapid prototyping isn't as rapid as you might think. It can take hours to produce a single 3D object. Some designers will upload their files at the end of the day and let the printer complete the job overnight.

But rapid prototyping became the first killer app for 3D printing; building a prototype or model overnight was much faster and less costly than injection molding or machine tooling.

Current efforts to build better printers are focusing on ways to build devices that are faster, bigger, and suitable for big area additive manufacturing (BAAM). At a manufacturing technology show this fall, an exhibitor will use a machine that is 10 times larger than most 3D printers to create an electric vehicle. The build box of the new machine will be about 2 x 4 x 0.86 meters.

One 3D printing innovation that might appeal to traditional print-service providers is the Iris 3D Printer from Mcor Technologies (mcor technologies.com). It creates solid, full-color photorealistic 3D models from everyday office paper. This means that Iris operating costs are a fraction of the operating costs of 3D printers that use plastics or chemically infused powders. Plus, the machines are very environmentally friendly. They run with paper, using water-based adhesives and water-based inks, and the printed objects can be tossed in a recycling bin when no longer needed. According to Mcor Technologies CEO and co-founder Conor MacCormack, the Iris also doesn't generate dust or fumes: "In a regular printing business, our 3D printers can sit side by side with other printers because they don't release any powders that could damage the workings or output from the other machines."

Unlike devices that jet color powder onto a binder, the Mcor Iris uses a modified 2D color inkjet printer to preprint the color outline of the part on each sheet of paper that will be layered and adhered to form the finished model. The undersides, overhangs, and sidewalls of the models are fully colored. The pre-printed stack of paper is then inserted into the 3D printer which uses a Selective Deposition Lamination process to create the model, using water-based adhesives in selected areas of the model. The finished models are as sturdy and solid as a piece of wood or ream of paper.

"We print a high-resolution image on the top and bottom and use a specially modified ink that permeates through the

Using 3D scans and 3D Systems' SLS technology, the first 3D printed presidential portrait was created. It will be displayed in the National Portrait Gallery as part of the Smithsonian's collection of presidential representations.



PORTRAITS

INVENTIONS



AirDog, the world's first automated drone designed to track and photograph outdoor sports and activities was made entirely from 3D-printed parts using the Stratasys' FDM technology. (stratasys.com)

model,” MacCormack says. By using ink and paper, they can achieve a high color gamut and use ICC profiles.

Mcor’s Iris 3D printer is being distributed in the U.S. by Wynit (wynit.com), a well-known master distributor of large-format digital printing equipment and specialty photo products.

According to Wynit business development specialist Sarah Segrest, the company has been investigating 3D printing equipment for more than a year. She agrees the hype about 3D printing is similar to that in the first days of wide-format graphics printing because the new machines enable companies to do things that couldn’t be done before. And like in the early days of wide-format printing, 3D printing machines can be finicky to operate.

To spare equipment resellers and end users some unpleasant surprises, the Wynit business-development team is doing a lot of hands-on testing with 3D printers. For example, equipment calibration is very important, and in some cases, the temperature of the print bed and the room temperature can also make a difference. With printheads that move back and forth and in a third dimension, materials can get jammed up and you have to know how to clear them. And some models generate particulates that could affect the quality of 2D prints being generated by wide-format printers in the same room.

4 MORE PEOPLE NEED TO LEARN HOW TO DESIGN 3D OBJECTS

If you know you will be printing in 3D, you have to start thinking differently, says Mcor’s MacCormack: “Designing in 3D is a skill set that takes years to get really good at. You actually have to think in terms of real-world physics.” For example, designs for gaming avatars and cartoon characters with massive shoulders and tiny legs might look fine onscreen, but when you print them in plastic, they topple if you don’t understand how to design objects for printing.

Because the Iris printer can output full color, it’s only natural that Mcor would want to connect with users of Adobe Photoshop CC. Creative professionals who had been using Photoshop’s 3D design capabilities to produce 3D onscreen visualizations can now use Photoshop to choose which print engine they want to output to. When they select the Mcor IRIS print engine, they can preserve all of the color, and even soft proof it with ICC profiles.

“Photoshop will do some things to clean up the files so that you don’t have any problems when you hit print. It really opens up the door to new potential designers,” MacCormack says.

Other designers proficient in 3D design include users of CAD/CAM software, such as SA International’s EnRoute for sign fabrication or any of AutoDesk’s programs for engineers, industrial designers, and architects.

In June, the Society of Manufacturing Engineers (SME) and 3D Systems announced M.Lab21, a project to transform career and technical education. The program will offer 3D design, scanning, and printing starter kits to shop classes and incorporate additive manufacturing into curriculums. “M.Lab21 aims to support what the manufacturing industry has been calling for



(Above left) Dutch designer Iris van Herpen, Julia Koerner, Stratsys, and Materialise – a Belgian-based pioneer in additive manufacturing software – produced this 3D-printed dress at Paris Fashion Week in 2013.



(Above right) Iris van Herpen partnered with Materialise to produce this 3D-printed cape and skirt with Stratsys’ Objet Connex Multi-material.



FASHION

“Dita’s Gown” is a dress designed for Dita Von Teese by costume and jewelry designer Michael Schmidt. Shapeways produced the dress in 17 sections. The pieces were assembled by hand, then polished, lacquered, and encrusted with more than 12,000 Swarovski crystals.

– to rebrand manufacturing, connect industry and academia, narrow the skills gap, and accelerate innovation.”

After the first Maker Faire at the White House last June, more than 150 colleges and universities committed to taking steps to promote “maker-preneurship.” For example, the 3D Training Institute (3DTraining.com) launched hands-on workshops to help train more people in software such as 3dsMax, Maya, Revit, and Inventor.

For now, you can find designers skilled in 3D work through 3D design communities such as CGTrader.com, which has more than 60,000 members. Some design communities enable you to commission designers for specific projects.

The authors of the 2013 PRIMR report on “Emerging Printing Technologies & Applications,” note that training in 3D software is readily available: “Tech-savvy digital print operators or prepress and design professionals might easily develop the necessary expertise.”

A 3D map and house model printed on the Mcor Iris printer.



PHOTO BOOTH

FURNITURE



Neil Oxman, an architect, designer, and professor of Media Arts and Science at MIT collaborated with Professor W. Craig Carter of the Department of Materials Science and Engineering at MIT to create "Gemini," a two-part chaise lounge, produced on a Stratasys Objet500 Connex3 color multi-material printer.

5 COMPETITORS WON'T NECESSARILY COME FROM THE PRINTING BUSINESS

The hype about 3D printing is attracting interest from a variety of fields, including managers of other businesses and organizations that need to reinvent themselves. As public libraries evolve into community centers, some are making 3D printers freely accessible tools to students and educators. The US Postal Service has explored how they might benefit from 3D printing. Options discussed include leasing unused space for new startups or serving as a logistics partner for delivering the printed products.

Some of your best prospects may already be buying 3D print services from firms that have been serving manufacturers and industrial designers for years.

At a recent event sponsored by the PODi association for digital printing and marketing, Jim Corliss of Braintree Printing in Massachusetts discussed lessons he learned since adding 3D printing services to his traditional printing business. He said the challenges of becoming a profitable 3D print provider have been twofold: customers and competition. He had to expand his sales outreach to target designers, engineers, medical professionals, and product developers. He also had to compete with 3D print-service providers who were already well established.

Digital marketing agencies may soon be getting into the act, too. High Rock, a digital marketing agency based in Hagerstown, Maryland, has acquired Baltimore-based Pylot Studios, a firm that specializes in 3D renderings and 3D animations for major brands. The establishment of a new 3D division at High Rock is expected to advance the company's advertising and marketing services.

6 SOME LARGE-FORMAT GRAPHICS FIRMS MAY BE WELL-PREPARED TO SELL 3D PRINTING SERVICES

Whether 3D printing makes sense for your business depends partly on your experience and partly on your existing customer base.

Don Carli, CEO of the Nima Hunter consulting firm believes "there is very little synergy between a graphic-arts printing business and additive manufacturing." He regards 3D printing as a process that's more aligned with functional printing than graphic arts and believes printing firms would need to hire experts in materials sciences and engineering: "You can't take the pressroom foreman and suddenly shift him over to manufacturing." Plus, if you aren't using the biggest, best, and most expensive models on the market, your customers will buy their own devices as the equipment becomes more robust and less expensive.

Carli advises commercial printers who choose to get into 3D printing to launch entirely new businesses with all-new branding. But he also believes commercial printers might be more successful pursuing printed electronics because the "Internet of Things" is going to create a huge market for Internet-connected devices.

On the other hand, if your large-format graphics business has prospered by creating customized, one-of-kind museum exhibits, themed décor, custom signage, or package prototypes, then you already know how to set prices for specialized projects instead of press runs.

And if your company already serves clients in the architecture, construction, engineering, theater, or GIS fields, you might be able to help them produce 3D props, models, and maps.

You might also consider reaching out to digital marketing agencies. They are taking a lead role in advising brands how to use emerging technologies. When I visited the digital marketing agency Possible for Cincinnati Design Week, a creative director mentioned they had purchased a 3D printer to see how it could help brands engage more with their customers. The agency personnel soon discovered that the desktop 3D printer they bought was far too slow to execute the creative concept they had in mind.

But that doesn't mean that design and marketing agencies won't be open to ideas from qualified providers of more robust 3D printing services.

Kolar Design, an experiential-design firm that collaborates with architects and interior designers to incorporate branding into the built environment, has already incorporated 3D printed items into one of their designs for a healthcare organization.

Ed Perry, CEO of the Joseph Merritt Company (merrittgraphics.com) in Hartford, Connecticut, has been printing large-format graphics since the 1980s, when the company was among the first to buy a 3M electrostatic printer.

Although Merritt doesn't yet offer 3D printing services, they have added MakerBot 3D printers to the line of

wide-format inkjet printers and scanners they sell to architecture, engineering, and construction firms.

"A large portion of our AEC customers design in 3D. Our aim is to save customers time and money when it comes to rendering their design. Instead of building a 3D model from scratch, they can simply print out models of their designs." The service group at Joseph Merritt offer authorized services and repairs for all the printers they sell.

While he typically is an early adopter, Perry hasn't yet decided whether it makes sense to offer 3D printing or scanning services. He believes the hype about 3D printing has created some unrealistic expectations. For now, he plans to wait until the production-grade equipment gets better and the market matures.

PHOTOSHOP 3D PRINTING

THE NEXUS THAT CONNECTS US

Over the decades, the worlds of graphic arts and engineering have evolved their own cultures, manifested in part by different hardware and software preferences. It's not actually a law, but graphic designers and artists lean toward Apple products and the Adobe big three creative suites, while engineers and industrial designers favor PCs running Windows and software environments such as Solid Works, Maya, and even Sketchup.

But as the amorphous technology currently termed "3D printing" begins to recombine into viable commercial applications, the boundaries are developing a Gaussian blur. Seeing it all coming, the people at Adobe Photoshop CC built a common playground where visual creatives and engineering/industrial pros could work together in peace.

Rolled out in January 2014, Photoshop's 3D printing capability is included in Adobe Creative Cloud and updated in subsequent releases. It allows Photoshop users with no CAD or modeling software expertise to build 3D objects and export them to 3D printers or online to 3D printing service bureaus.

Recent Photoshop versions, such as CS5 and CS6 Extended, incorporated 3D tools, but those features were designed for conventional output on flat media such as paper. Photoshop CC is a fundamentally different proposition because files will ultimately be rendered as solids in dimensional space. To that end, Photoshop 3D is integrated with printers such as the MakerBot Replicator and Mcor Iris for direct printing, or with industry-leading 3D service bureaus such as Shapeways and Sculpteo.

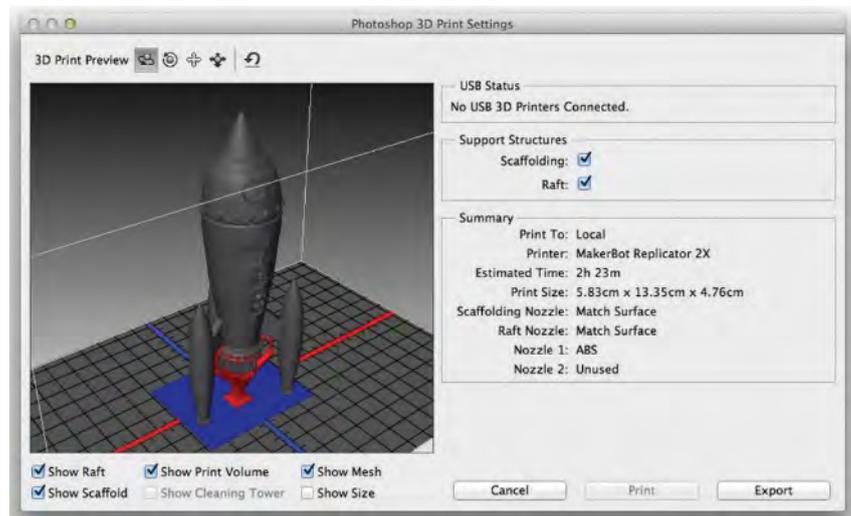
The key value of the Creative Cloud 3D printing capability is that it fast tracks the learning curve for creative types lacking the expertise to build and generate a viable 3D CAD file.

Photoshop 3D checks files for landmines, such as wall thickness and mesh integrity. If the object will be rendered in flexible plastic, for example, structural elements can be

thinner than if you print using sandstone. Photoshop alerts the designer to problems, allows re-rendering and preview, and can even automate mesh repair and modification of structural components. Non-design elements, such as rafts and scaffolding, can be automatically generated to support an object during printing.

CAD design software ultimately offers more functionality than Photoshop, so if you are producing automotive prototypes or components for the aerospace industry, Photoshop is not your best option. However, for a graphic artist, marketing director, package designer, or practitioner of a yet-to be named creative profession, Photoshop CC 3D provides more or less pain-free access to the emerging possibilities for visual communications. Think of all the conventional marketing collateral, signage, or posters that can be redesigned with a Z axis. As opposed to the "3D printing" that is really digital manufacturing, the boundaries of 3D visual communications have yet to be fully mapped.

Photoshop 3D printer-settings screen for the MakerBot Replicator printer. This object is set up to print in ABS plastic.



BY SEAN O'LEARY

PRINTROOM



Inside a "printroom" at the Sculpteo 3D printing service.

WHAT'S NEXT?

The hype about 3D printing has increased the speed with which some of the problems that exist today will get resolved. As design and maker communities continue to grow, some killer apps and innovative partnerships and business models will emerge. Students who are learning about 3D printing in high school and college today will expect to use 3D printing at home and at work.

In his blog post "What Won't Be 3D Printed?," John Hauer, president of design library 3DLT.com says, "The 3D printing ecosystem is like a snowball rolling down a hill." He writes that when 2D digital printing was first introduced, nearly everyone said it wasn't good enough, fast enough, or flexible enough, and it was too damn expensive. Yet digital printing has become a \$140 billion industry while the volume of mass-produced pages continues to drop. Hauer envisions a future in which retailers such as Home Depot offer 3D printing services right in their stores. He contends that "like books, music, and movies before, products are going digital. Offering products in 3D-printable format could help big brands remain relevant."

Sarah Segrest of Wynit believes there will always be a need for commercial providers of 3D printing services even if many consumers do end up buying 3D printers for home use. She likens it to the continued existence of photo labs. Even though everyone can now print photos at home, they still send certain files to commercial labs – for printing at bigger sizes or on special types of materials.

Like large-format graphics, 3D printing services will probably be offered through a variety of locations. Some customers will order products through Amazon, UPS Stores, and Staples. Others might use 3D printing services available at public libraries and or community centers. The best strategy for graphics providers may be to find a niche or two – and excel in making specific types of products or specific groups of product designs.

If your current customers are curious about 3D printing, cater to those interests first. For example, some architects may not care about color printing because color can distract from form. However, the ability to print in full color will matter a lot to those who want to 3D print package prototypes, brand signage, or licensed products.

To see more of the huge variety of 3D printers currently available, visit one of the trade shows devoted to 3D printing or additive manufacturing such as Inside 3D Printing or 3D Printer World Expo. At the SGIA Expo in October, companies like Roland and Afinia will be demonstrating 3D printers that can help you learn more about the process.

Mark Brundell, president of SA International, which sells EnRoute CAD/CAM software for custom signmaking, hinted that as 3D printing moves beyond rapid prototyping, "it's likely that a number of device manufacturers with whom we work will at some point have a 3D offering." **IBP**

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