

Congress of the United States
U.S. House of Representatives
Committee on Small Business
2361 Rayburn House Office Building
Washington, DC 20515-0515

To: Members, Committee on Small Business
From: Committee Staff
Date: March 10, 2014
Re: Hearing: "The Rise of 3D Printing: Opportunities for Entrepreneurs"

On Wednesday, March 12, 2014 at 10:00 a.m., the Committee on Small Business will meet in Room 2360 of the Rayburn House Office Building for the purpose of examining how additive manufacturing, or 3D printing, is creating opportunities for small businesses. 3D printing is the process of fabricating objects from a digital model, typically through the deposition of a material layer upon layer until an object is formed.¹ The technology has been around since the 1980s, but a recent shift in the affordability of these printers has led to an explosion in the use of the technology in the last few years by consumers and entrepreneurs.

I. Introduction

Traditionally, 3D printing was used by product designers, hobbyists, and for select manufacturing processes.² Businesses in the defense, automotive, aerospace, and medical industries have used the technology, and are increasingly doing so, in the process of creating prototypes, custom parts, and final products.³ But only in the last eight years, led in part by two open-source projects created in 2006,⁴ did consumers, small business owners, entrepreneurs, and

¹ <http://wohlersassociates.com/2013glossary.pdf>.

² MCKINSEY & COMPANY, DISRUPTIVE TECHNOLOGIES: ADVANCES THAT WILL TRANSFORM LIFE, BUSINESS, AND THE GLOBAL ECONOMY, At 8 (May 2013) [hereinafter McKinsey Report], *available at* http://www.mckinsey.com/insights/business_technology/disruptive_technologies.

³ COMPUTER SCIENCES CORPORATION, 3D PRINTING AND THE FUTURE OF MANUFACTURING 9-13 (Fall 2012) [hereinafter CSC Report], *available at* http://assets1.csc.com/innovation/downloads/LEF_20123DPrinting.pdf.

⁴ Both the University of Bath's RepRap project and Cornell University's Fab@Home project provided blueprints freely and available for anyone that wanted to build their own self-replicating 3D printer, and helped to spur the consumer 3D printing community. RepRap takes the form of a free desktop 3D printer capable of printing plastic objects, and in doing so is able to self replicate. For instance, if you own a RepRap, you could print another RepRap for a friend. <http://reprap.org/wiki/RepRap>. The Fab@Home project was started by Hod Lipson and Evan Malone of the Cornell University Computational Synthesis Laboratory with the goal of democratizing innovation by giving households the ability to physically create their ideas. The Fab@Home is a machine that prints 3D objects, and instructions for building one are available through the project. <http://www.fabathome.org/index.php?q=node/2>. Leslie D'Monte, *Print to Eat, Play, or Work*, BUSINESS STANDARD, Feb. 28, 2011, *available at* http://www.business-standard.com/article/technology/print-to-eat-play-or-work-111022800070_1.html.

at-home innovators begin using the technology. As 3D printers have become more accessible, small businesses and entrepreneurs have begun benefitting from this technology in a variety of ways; from using it in the production of prototypes, to the making of parts, or in some cases, to producing finished products sold directly to end-users. For instance, sales of personal 3D printers, commonly used by emerging entrepreneurs, grew 200 to 400 percent every year from 2007 to 2011, and industry analysts expect massive continued growth.⁵

Although most 3D printers generally produce objects made up of various types of plastic, there is an increasingly growing range of printable materials including: metal, ceramics, food, glass, and human tissue.⁶ While the potential for the technology to impact the economy seems almost endless, with some referring to it as the next industrial revolution,⁷ proponents of the technology are wary of future regulations that could restrict its use and stifle the ability of entrepreneurs to use the technology in innovative ways.

II. Shift in Accessibility and Explosion in Use

A recent shift in the affordability of 3D printers has made them much more accessible to small businesses seeking to utilize their capabilities. For example, recent research by information technology research and advisory firm Gartner, Inc. reveals that by 2016, prices for 3D printers designed for business use will have fallen to under \$1,000, a significant drop-off from an average list price of \$20,000 in 2008.⁸ In light of this, affordable 3D printers are lowering the cost of entry into manufacturing in the same way that e-commerce removed barriers associated with the sale of goods.⁹ This factor encourages businesses to begin using and experimenting with 3D printing.¹⁰ Makerbot,¹¹ one of the world's leading sellers of consumer 3D printers, recently announced it will begin selling a printer for \$1,375.00 this spring.¹² And in the past year, Amazon dedicated a portion of its website to the creation of a 3D printing store, increasing the availability of this technology.¹³

Other inexpensive 3D printers and scanners¹⁴ have been developed by startups around the United States, often receiving funding through crowdfunding sites like Kickstarter, with most planning to ship products to customers in the near future. The Da Vinci 3D Printer, created by

⁵ McKinsey Report, *supra* note 2, at 105.

⁶ CSC Report, *supra* note 3, at 6.

⁷ *A third industrial revolution*, THE ECONOMIST, Apr. 21, 2012, available at <http://www.economist.com/node/21552901>.

⁸ GARTNER INC., HOW 3-D PRINTING DISRUPTS BUSINESS AND CREATES NEW OPPORTUNITIES 2, 4 (2013) (on file with the Committee).

⁹ *Id.* at 2, 3.

¹⁰ *Id.* at 2, 3.

¹¹ Makerbot was acquired by Stratasys in 2013 in line with the general trend of consolidation in the industry. Makerbot also owns and hosts Thingiverse, a website used by many in the 3D printing community as a repository for computer-aided designs (CAD). *3D Printing, Power Shift*, THE ECONOMIST, Jun. 21, 2013, available at <http://www.economist.com/blogs/schumpeter/2013/06/3d-printing>.

¹² Wilson Rothman, *Makerbot Unveils a 3-D Printer Nearer to \$1,000*, WALL STREET JOURNAL, Jan. 6, 2014, available at <http://online.wsj.com/news/articles/SB10001424052702304617404579305282190444544>.

¹³ http://www.amazon.com/s/ref=lp_16310091_nr_n_1?rh=n%3A16310091%2Cn%3A%2116310161%2Cn%3A6066126011&bnn=16310161&ie=UTF8&qid=1392740994&mid=16310161.

¹⁴ 3D scanners are devices that allow their users to scan, and create CAD models of real-world parts or objects.

XYZ Technologies, is designed as a “plug-and-play” printer that will allow its users to turn it on and begin printing with no added assembly, and will soon be available for a price of \$499.¹⁵ The Peachy Printer, by Rinnovated Design, recently raised over \$600,000 on Kickstarter and will soon be available as a 3D printer and scanner in one for \$100.¹⁶ The recently developed Matterform scanner will soon be available for \$579 and is intended to allow the performance of high-resolution scans in as little as five minutes.¹⁷

The accessibility to and affordability of 3D printers have paved the way for an explosive growth in the use of the technology. According to a recent report by Wohlers Associates, the total market for 3D printing grew from \$1.714 billion in 2011 to \$2.204 billion in 2012, a compound annualized growth rate (CAGR) of 28.6 percent, with the average annual CAGR over the past 25 years a robust 25.4 percent.¹⁸ The report predicts strong future growth, with expectations for a market size of \$6 billion in 2017, and increasing to \$10.8 billion in 2021.¹⁹ Entrepreneurs are a key driver of industry growth. Credit Suisse recently increased its 2016 projection for the consumer sector of the 3D printer market, which includes at-home innovators, 357 percent, to \$800 million, from its original projection of \$175 million.²⁰ The new projection is due to a potential for a near 100 percent penetration of the technology among engineers, and the large numbers of amateur tinkerers and entrepreneurs that will find it useful for creating prototypes.²¹

III. Utility for Small Businesses

Small businesses and entrepreneurs are using 3D printing in a variety of ways. From the creation of prototypes, to the making of rare-parts for assisting in product production, or producing a finished product to sell directly to the end-user, 3D printing has become, and will continue to be, a critical component of the operations of many businesses.

Given the aforementioned increase in affordability and availability of 3D printers, many small businesses and fledgling entrepreneurs are using the technology to design, test, and create prototypes. A process that previously took weeks, sometimes months, can now be reduced to sketching an idea in the morning, modeling it that afternoon, and having a prototype printed that evening.²² Patrick O’Neill, CEO of Olloclip, a company that makes clip-on lenses for Apple products, uses 3D printing to create prototypes of his own products as well as mock-ups of expected future Apple products. He points to greater product security that comes with 3D printing, since his company no longer has to send design requests to rapid prototype servicing bureaus, sometimes known to leak design files, ultimately saying, “I can’t imagine doing this

¹⁵ <http://us.xyzprinting.com/Product>.

¹⁶ <https://www.kickstarter.com/projects/117421627/the-peachy-printer-the-first-100-3d-printer-and-sc>.

¹⁷ <http://www.matterform.net/scanner>.

¹⁸ WOHLERS ASSOCIATES, INC., WOHLERS REPORT 2013 122-29 (May 2013) (on file with the committee).

¹⁹ *Id.*

²⁰ CREDIT SUISSE, ADDITIVE MANUFACTURING 2 (Jan. 2014) (on file with the committee).

²¹ Rob Wile, *CREDIT SUISSE: The 3-D Printing Market Is Going To Be 357% Bigger Than We Initially Thought*, BUSINESS INSIDER, Jan. 22, 2014, available at <http://www.businessinsider.com/credit-suisse-on-3d-printing-2014-1>.

²² John Patrick Pullen, *What 3D Printing Could Mean for Small Businesses*, ENTREPRENEUR, Mar. 14, 2013, available at <http://www.entrepreneur.com/article/225446>.

without owning our own 3D printer.”²³ Using 3D printing for prototyping is also decreasing costs. A Stratasys-conducted survey of the Japanese company Akaishi, a maker of correctional footwear and massaging footwear, demonstrates that using 3D printing saved Akaishi 73 percent compared to traditional prototyping methods.²⁴

Many small businesses are employing 3D printing technology to help them create parts not otherwise available or that are used as tools to make a final product. The Computer Science Corporation claims that 3D printing will be increasingly used in the tooling of traditionally manufactured items, saving businesses both time and money.²⁵ McKinsey & Company predicts that the 3D printing of tools and molds could generate \$30 billion to \$50 billion in economic impact per year by 2025 due to its potential to create value by shortening set-up times, eliminating errors, and producing molds that increase the productivity of the traditional injection mold manufacturing process.²⁶ Additionally, McKinsey predicts 3D printing could generate \$100 billion to \$200 billion in economic impact per year by 2025 from the direct manufacturing of parts, as the market for complex, low-volume and highly customizable parts could be \$770 billion per year by that time.²⁷

Further, entrepreneurs all over the nation are already using 3D printing to manufacture and bring products directly to end-users, often through platforms such as Shapeways. Shapeways is an online marketplace that is enabling people all over the world to become entrepreneurial, as it allows its users to design, print, and sell products directly to customers. Shapeways users upload their design file to the site, and then list for sale products that will be printed in a material of their choosing, from plastic, steel, silver, brass, or ceramics.²⁸ Almost 15,000 individuals currently use Shapeways to create and sell products, many first-time small business owners.²⁹

IV. Outlook for the Future

Government officials and policymakers are aware of the economic potential of 3D printing and there are some efforts to facilitate the widespread use of the technology in the United States.³⁰ However, as 3D printing continues to further the ability of individuals and entrepreneurs to create products, intellectual property concerns may naturally arise on the part of both observers and those using the technology. Those producing 3D-printed products might have trepidations about whether they are infringing upon another’s intellectual property, and those holders of intellectual property will likely look to solutions that prevent others from

²³ *Id.*

²⁴ <http://www.stratasys.com/~media/Case%20Studies/Consumer%20Goods/SSYS-CS-Akaishi-06-13.ashx>.

²⁵ CSC Report, *supra* note 3, at 26.

²⁶ McKinsey Report, *supra* note 2, at 111.

²⁷ *Id.*

²⁸ <http://www.shapeways.com/materials>.

²⁹ Information provided to committee staff by Shapeways.

³⁰ As part of the creation of the National Network for Manufacturing Innovation in March 2012, America Makes has launched and is managing the Network’s pilot institute, the National Additive Manufacturing Innovation Institute (NAMII). Based in Youngstown, Ohio, NAMII is a public-private partnership with the goal of bringing 3-D printing to the mainstream United States manufacturing sector. <http://www.americamakes.us/about>.

infringing on theirs. Additionally, there is concern about certain products, such as firearms, 3D printing has the capability to produce.

There is worry within the industry about how websites that host content, which include community sites for sharing 3D files, will be able to avoid liability pursuant to the Digital Millennium Copyright Act (DMCA) as they self-police for intellectual property infringements.³¹ The DMCA currently includes a safe harbor for online service providers against copyright infringement liability, provided they block access to alleged infringing material when they receive notification of an infringement claim from a copyright holder. Yet this safe harbor only covers copyrights, and not patents, potentially subjecting makers of 3D printing technology as well as online service providers such as Shapeways to liability. Michael Weinberg of the technology watchdog Public Knowledge claims that if holders of intellectual property “are allowed to hold the companies that make 3D printing possible liable for copies that individuals make, they will be unable to continue operating.”³²

Already, legislation is being discussed that would restrict the use of the technology as it relates to the manufacturing of undetectable firearms.³³ But experts in the industry, such as Cornell University Professor Hod Lipson, question the worth of such restrictions, saying they “would be very difficult to enforce in a world where anyone can make anything.”³⁴ Even if makers of printers were forced to restrict the printing of certain shapes, there are open-source, self-replicating printers available to anyone.³⁵ As McKinsey & Company notes, the challenge for policy makers in addressing regulatory issues, such as approving new materials, establishing intellectual property protections, or assigning liability for faulty 3D-printed products, entails addressing these risks without stifling innovation or limiting the value provided by the technology.³⁶

V. Conclusion

3D printing is helping small businesses all across the country. As Congress and other regulatory bodies consider policies applicable to this new technology, it will be important that they do not unduly restrict the use of the technology by small business owners, entrepreneurs, and other innovators.

³¹ <http://www.insidecounsel.com/2013/08/30/technology-will-the-digital-millennium-copyright-a?page>.

³² MICHAEL WEINBERG, PUBLIC KNOWLEDGE, IT WILL BE AWESOME IF THEY DON'T SCREW IT UP: 3D PRINTING, INTELLECTUAL PROPERTY, AND THE FIGHT OVER THE NEXT GREAT DISRUPTIVE TECHNOLOGY 14 (Nov. 2010), available at <http://www.publicknowledge.org/files/docs/3DPrintingPaperPublicKnowledge.pdf>.

³³ Michael Rosenwald, *Weapons made with 3-D printers could test gun-control efforts*, THE WASHINGTON POST, Feb. 18, 2014, available at http://www.washingtonpost.com/local/weapons-made-with-3-d-printers-could-test-gun-control-efforts/2013/02/18/9ad8b45e-779b-11e2-95e4-6148e45d7adb_story.html?hpid=z1.

³⁴ *Id.*

³⁵ *Id.*

³⁶ McKinsey Report, *supra* note 2, at 113.