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ONE HUNDRED FOURTEENTH CONGRESS

Congress of the United States
House of Representatives

COMMITTEE ON ENERGY AND COMMERCE
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MEMORANDUM

February 24, 2016

To: **Subcommittee on Commerce, Manufacturing, and Trade Democratic Members and Staff**

Fr: **Committee on Energy and Commerce Democratic Staff**

Re: **Hearing on "Disrupter Series: 3D Printing"**

On **Tuesday, January 26, 2016, at 10:00 a.m. in room 2123 of the Rayburn House Office Building**, the Subcommittee on Commerce, Manufacturing, and Trade will hold a hearing titled "Disrupter Series: 3D Printing."

I. BACKGROUND

Three-dimensional (3D) printing—also known as additive manufacturing—is the process of machine construction of three-dimensional objects from a digital model.[1] The earliest 3D printers in the 1980s used polymer filaments to build simple plastic models.[2] To build objects, 3D printers deposit building materials in thin successive layers.[3] The object's blueprint is digitally modeled with Computer Aided Design (CAD) software and programmed into the

[1] *Print Thyself: How 3-D Printing is Revolutionizing Medicine*, The New Yorker (Nov. 24, 2014) (online at www.newyorker.com/magazine/2014/11/24/print-thyself); *10 Breakthrough Technologies 2013: Additive Manufacturing*, MIT Technology Review (Apr. 23, 2013) (online at www.technologyreview.com/featuredstory/513716/additive-manufacturing/).

[2] *Id*.

[3] U.S. Government Accountability Office, *3D Printing: Opportunities, Challenges, and Policy Implications of Additive Manufacturing* (Jun. 24, 2015) (GAO-15-505SP).

printer.[4] In recent years, technology has evolved to enable printing with a variety of materials, including plastic, metal, ceramic, glass, organic matter, and human tissue.[5]

3D printing has the potential to affect the way consumer goods are produced, distributed, and sold.[6] After hosting a forum on additive manufacturing in October 2014, the U.S. Government Accountability Office reported that the technology is still in its relative infancy and that it may take years or even decades before the technology reaches its potential.[7] One financial services company, in contrast, projected that the 3D printing market will grow to $800 million in 2016.[8]

II. PRACTICAL APPLICATIONS OF 3D PRINTERS

A. Manufacturing and Small Business Innovation

Businesses in the automotive, aeronautical, medical, and technology industries have embraced the use of 3D printers to build prototypes, custom parts, and final products.[9] 3D printers offer the potential to increase efficiency, reduce costs, and offer more flexibility compared to traditional manufacturing tools.[10] Because the manufacturing process is additive rather than subtractive like conventional manufacturing processes that cut away material from larger piece, 3D printers can reduce waste of raw materials.[11] They can also make production less labor intensive.[12] 3D printing technology is versatile; printers are able to quickly produce a single intricate structure or an exact replica of an existing object.[13] By enabling small and speedy production runs, 3D printers can improve turnaround times and allow for easier product customization.[14]

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[4] *Id*.

[5] *Print Thyself: How 3-D Printing is Revolutionizing Medicine*, The New Yorker (Nov. 24, 2014) (online at www.newyorker.com/magazine/2014/11/24/print-thyself); *3D-Printed Wonder Ceramics are Flawless and Super-Strong*, Popular Mechanics (Dec. 31, 2015) (online at www.popularmechanics.com/science/a18801/3d-printed-wonder-ceramics-wont-shatter/).

[6] *See* note 3.

[7] *Id*.

[8] *Credit Suisse: The 3-D Printing Market is Going to Be 357% Bigger than We Initially Thought*, Business Insider (Jan. 23, 2014) (online at www.businessinsider.sg/credit-suisse-on-3d-printing-2014-1/#.Vo8-xZMrKLI).

[9] Computer Sciences Corporation, *3D Printing and the Future of Manufacturing* (Fall 2012) (online at assets1.csc.com/innovation/downloads/LEF_20123DPrinting.pdf).

[10] *See* notes 3 and 9.

[11] *See* note 9.

[12] *Id*.

[13] *See* note 3.

[14] *See* notes 3 and 9.

With relatively low overhead and start-up costs, 3D printers have the potential to lower the barriers to entrepreneurship for small and community businesses.[15] Initiatives, such as mobile technology workshops (i.e., buses equipped with computers, 3D printers, and other technology), are underway to leverage 3D printing as a way to reduce income, gender, and racial disparities in technology and manufacturing.[16] One survey found that women are more likely to use 3D printers than men.[17]

3D printing has opened doors for small-scale innovation and experimentation. The range of possibilities for building materials and printing methods is continually expanding.[18] 3D printers have been used to produce jet engines, bionic human ears, and food for astronauts.[19]

B. Health and Medicine

Potential for lifesaving treatments and market growth in the health industry has driven a particular focus on 3D printing in the medical field.[20] 3D bioprinting uses both organic (such as ink made of human cells) and biocompatible (such as the synthetics used in absorbable sutures) materials.[21] Customized replacement heart valves, skin grafts, veins, and artificial joints can all

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[15] *See* note 9.

[16] Intel Corporation and Girl Scouts USA, *MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing* (2014) (online at www.intel.com/content/www/us/en/technology-in-education/making-her-future-report.html); *The Magic School Bus,* Slate (Oct. 22, 2015) (online at www.slate.com/articles/technology/future_tense/2015/10/using_buses_to_bring_technology_to_underserved_communities.html).

[17] Intel Corporation and Girl Scouts USA, *MakeHers: Engaging Girls and Women in Technology through Making, Creating, and Inventing* (2014) (online at www.intel.com/content/www/us/en/technology-in-education/making-her-future-report.html).

[18] *See* note 9.

[19] *GE Fires Up Fully 3D-Printed Jet Engine,* Gizmag (May 13, 2015) (online at www.gizmag.com/ge-fires-up-all-3d-printed-jet-einge/37448); Princeton University, *Printable 'Bionic' Ear Melds Electronics and Biology* (May 8, 2013) (online at www.princeton.edu/main/news/archive/S36/80/19M40/index.xml?section=topstories); National Aeronautics and Space Administration, *3D Printing: Food in Space* (May 23, 2013) (online at www.nasa.gov/directorates/spacetech/home/feature_3d_food.html#.VpNK65MrKLI).

[20] *Print Thyself: How 3-D Printing is Revolutionizing Medicine,* The New Yorker (Nov. 24, 2014) (online at www.newyorker.com/magazine/2014/11/24/print-thyself).

[21] *Id.*

be 3D printed.[22] Some doctors are using 3D printing to produce customized biodegradable or biocompatible scaffolds for tissue replacement to support cells while they regrow.[23]

3D printers can also be used to produce pharmaceuticals.[24] In August 2015, the antiepileptic drug Spritam became the first 3D-printed prescription tablet to be approved by the U.S. Food and Drug Administration (FDA).[25]

In addition to pharmaceuticals, the FDA has approved 3D-printed prosthetics and supportive braces.[26] 3D-printed prosthetics and braces can be printed more quickly at a lower cost and offer better customization than traditional prosthetics.[27] The National Institutes of Health (NIH) created an online repository for digital blueprints of 3D-printed prosthetics to share ideas and increase access to different models.[28] Using scans and molds, surgeons can also create polymer replicas of a patient's body parts to practice and improve outcomes for particularly complicated procedures.[29]

Dental health is another growth area for 3D printing. Invisalign orthodontic aligners provide an alternative to traditional metal braces by printing a series of removable trays that gradually realign the teeth based on a scan of the patient's dentition.[30] Patients who have lost teeth may soon be able to have replacement teeth printed out of antimicrobial plastic that combats tooth decay.[31]

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[22] *Id*.

[23] *Doctors 3D-Print 'Living' Body Parts*, BBC (Feb. 16, 2015) (online at www.bbc.com/news/health-35581454).

[24] *3-D Printed Drugs Are Here*, The Atlantic (Aug. 19, 2015) (online at www.theatlantic.com/technology/archive/2015/08/3d-printing-pills-spritam-drug-industry/401177/).

[25] *Id*.

[26] *Why It Matters that the FDA Just Approved the First 3D-printed Drug*, The Washington Post (Aug. 11, 2015) (online at www.washingtonpost.com/news/innovations/wp/2015/08/11/why-it-matters-that-the-fda-just-approved-the-first-3d-printed-drug/).

[27] *See How Kids Are Getting 3D-Printed Hands for Free*, Time (Aug. 31, 2015) (online at time.com/4016974/3d-printed-hands-e-nable).

[28] National Institutes of Health, *3D-Printable Prosthetic Devices* (online at 3dprint.nih.gov/collections/prosthetics) (accessed Dec. 22, 2015).

[29] *See* note 20.

[30] *See* note 20.

[31] *3D Printed Teeth to Keep Your Mouth Free of Bacteria*, New Scientist (Oct. 16, 2015) (online at www.newscientist.com/article/dn28353-3d-printed-teeth-to-keep-your-mouth-free-of-bacteria).

III. CONSUMER PROTECTION AND PUBLIC SAFETY ISSUES

A. 3D-Printed Weapons

The first 3D-printed gun was successfully fired in May 2013, and blueprints of 3D-printable guns are available online.[32] All of the components of 3D-printed guns, except a standard nail used as a firing pin, can be printed in plastic.[33] The Undetectable Firearms Act currently prohibits the manufacture of guns with less than 3.7 ounces of metal content and that are undetectable by walk-through metal sensors.[34] In June 2015, Rep. Steve Israel introduced H.R. 2699, the Undetectable Firearms Modernization Act, which would expand the law to require crucial functional components be made of detectable metal, effectively prohibiting the production of a fully 3D-printed gun.[35]

3D metal printers are able to produce solid metal guns that are more durable than plastic prints and able to fire thousands of rounds.[36] Metal printers are still chiefly industrial and prohibitively expensive for individual purchase, but they are likely to become affordable and accessible for home use.[37] Other advances in 3D printing capabilities, such as the continued development of more durable plastic or ceramic materials that will negate the need for metal parts, and of unconventional firearm designs that are easier to durably 3D print, likely will also help lead to corresponding advances in 3D-printed weapons.[38]

3D printers have also been used to make knives out of metal and hard plastic.[39] Concerns have been raised regarding nonmetal weapons for a number of reasons, including that they might be more difficult for standard security scanners to detect.[40]

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[32] *Printing Insecurity? The Security Implications of 3D-Printing of Weapons*, Science and Engineering Ethics (Dec. 2015) (online at link.springer.com/article/10.1007%2Fs11948-014-9617-x#/page-1); *The Rise of 3-D Printed Guns*, New York Times (Aug. 13, 2014) (online at www.nytimes.com/2014/08/14/fashion/the-rise-of-3-d-printed-guns.html).

[33] *How the World's First 3-D Printed Gun Works*, Popular Science (May 6, 2013) (online at www.popsci.com/technology/article/2013-05/worlds-first-fully-3-d-printed-gun-here).

[34] 18 U.S.C. § 922.

[35] H.R. 2699.

[36] *Solid Concepts Announces Another 3D-Printed Metal Gun*, TechCrunch (Oct. 27, 2014) (online at techcrunch.com/2014/10/27/solid-concepts-announces-another-3d-printed-metal-gun).

[37] *See* note 35.

[38] *Id*.

[39] *3D Printed Plastic Knives Can Bypass Courtroom Security Detectors, Dutch Students Discover*, International Business Times (Apr. 29, 2015) (online at www.ibtimes.co.uk/3d-printed-plastic-knives-can-bypass-courtroom-security-detectors-dutch-students-discover-1498936); *3D Printing Creates High-Tech Chef's Knife*, FOX News (June 25, 2015) (online at www.foxnews.com/tech/2015/06/25/3d-printing-creates-high-tech-chef-knife.html).

[40] *Id.*

B. Intellectual Property

CAD software makes it possible to produce a blueprint for duplicating an object by scanning the original.[41] The potential for violations of copyright and trademarks increases as the ease of reproduction increases.[42] Making 3D-printed copies of protected toys, for example, is a violation of intellectual property law.

Innovators in the world of 3D printing have an interest in protecting their intellectual property. Under copyright law, physical objects (i.e., the 3D-printed product itself) is treated differently than written words, photographs, and code.[43] The copyright in the digital files representing 3D-printed objects may require a different copyright analysis than the one for the objects themselves.[44] Additionally, some 3D-printed objects are entirely copyrightable, while others are not.[45]

IV. FEDERAL AND CONGRESSIONAL ACTION

The Administration prioritized federal support for 3D printing innovation as part of its efforts to bolster domestic manufacturing.[46] America Makes (also known as the National Additive Manufacturing Innovation Institute) in Youngstown, Ohio, is the flagship institute of the President's National Network for Manufacturing Innovation (NNMI).[47] America Makes seeks to foster additive manufacturing and 3D printing research and development by working with its partners in industry, academia, government, and other related resources.[48] America Makes and four other institutes are sponsored by the Department of Defense, while other NNMI institutes are being awarded by the Department of Energy and the National Institute of Standards and Technology.[49]

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[41] *Views Split on Innovation Impact of Proposed 3D Printing DMCA Exemption*, Bloomberg BNA (Apr. 15, 2015).

[42] *As 3-D Printing Becomes More Accessible, Copyright Questions Arise*, NPR (Feb. 19, 2013) (online at www.npr.org/sections/alltechconsidered/2013/02/19/171912826/as-3-d-printing-become-more-accessible-copyright-questions-arise).

[43] *3 Steps for Licensing Your 3D Printed Stuff*, Public Knowledge (Mar. 10, 2015) (online at www.publicknowledge.org/assets/uploads/documents/3_Steps_for_Licensing_Your_3D_Printed_Stuff.pdf).

[44] *Id*.

[45] *Id*.

[46] Congressional Research Service, *The National Network for Manufacturing Innovation* (Feb. 9, 2016) (R44371).

[47] *Id.*

[48] America Makes, *About America Makes* (online at americamakes.us/about/overview) (accessed Feb. 22, 2016).

[49] *See* note 20.

The House Committee on Small Business held a hearing on 3D printing and small businesses in March 2014.[50] The bipartisan Congressional Maker Caucus, established in 2014, seeks to support and promote the "maker movement," focusing on small-scale technological innovation and creativity within communities in the United States.[51]

V. WITNESSES

Alan Amling
Vice President, Global Logistics and Distribution Marketing
UPS Supply Chain Solutions

Edward Herderick
Additive Technologies Leader, Corporate Supply Chain and Operations
General Electric

Ed Morris
Vice President and Director
National Additive Manufacturing Innovation Institute
National Center for Defense Manufacturing and Machining

Neal Orringer
Vice President, Alliances and Partnerships
3D Systems

[50] House Committee on Small Business, *Hearing on The Rise of 3D Printing: Opportunities for Entrepreneurs*, 113th Cong. (Mar. 12, 2014).

[51] Representative Mark Takano, *Rep. Takano and Three Additional Members of Congress Announce "Congressional Maker Caucus"* (Feb. 27, 2014) (online at takano.house.gov/newsroom/press-releases/rep-takano-and-three-additional-members-of-congress-announce-congressional-maker-caucus).