Testimony before the Subcommittee on Commerce, Manufacturing, and Trade

Hearing on "Disrupter Series: 3D Printing"

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Summary

Additive manufacturing, more popularly known as 3D printing, is disruptive in multiple positive ways:

- It is an incredible fulcrum to reinvigorate the manufacturing economic engine in the United States.
- It can revolutionize STEM education by bring a whole new meaning to "hands-on," from the skills training for engineering and the sciences to the revenue-generating production of new and enhanced products that cannot be made using traditional manufacturing techniques.

America Makes – The National Additive Manufacturing Innovation Institute is a public-private partnership charted to accelerate the use of additive manufacturing through technology development, technology transition, and workforce and educational outreach. A public-private partnership is an essential national policy and business model if the United States is to continue to excel in the evolving, highly competitive global economic environment. A key element in an effective public-private partnership is cost sharing, especially when the national objectives and business risks are too much for industry to bear on its own. When industry and academia provide cost share that matches the public R&D investment, the taxpayer receives double the normal output from the public investment. Industry is able to stay competitive as other nations continue to invest heavily in technologies such as additive manufacturing.

Quoting the Honorable Stephen Welby, Assistant Secretary of Defense for Research and Engineering (ASD(R&E)), "Let's Disrupt Ourselves Before Others Disrupt Us."

3D Printing / Additive Manufacturing – Accelerating the Positive Disruption

Who are we? America Makes is the National Additive Manufacturing Innovation Institute, the national accelerator for additive manufacturing and 3D printing. 3D printing allows for production of never-before-possible products and for producing many existing products quicker and cheaper. The vision for America Makes is to accelerate additive manufacturing innovation to enable widespread adoption by bridging the gap between basic research and technology commercialization. As a public-private partnership, America Makes fosters game-changing collaboration between multiple government agencies and over 160 companies, universities, community colleges, and non-profit organizations. In addition to technology development and commercialization, the core mission includes engaging with small and medium-sized businesses, fostering education initiatives, and conducting STEM outreach to both stimulate job creation and train a highly skilled workforce. America Makes is operated by the National Center for Defense Manufacturing and Machining (NCDMM), a not-for-profit 501(c)(3) company.

Why a Public-Private Partnership for Additive Manufacturing? America Makes exists as a public-private partnership because a combined public and private investment is the most efficient and effective method to enable U.S. federal agencies, industry, and academic institutions to collaborate and coordinate. The public-private partnership is invoked via a Cooperative Agreement with the Department of Defense (DoD) executed through the Air Force Research Laboratory. In addition to the DoD, our federal department and agency partners include the Department of Energy (DoE),

the Department of Commerce (DoC), the Department of Education (DoEd), the National Aeronautics and Space Administration (NASA), the National Science Foundation (NSF), the Federal Aviation Administration (FAA), and the Food and Drug Administration (FDA).

Without this joint public and private collaboration and pooling of resources, U.S. companies may suffer tremendous technological disadvantages against global competitors that are receiving significant public investments from their governments. Additive manufacturing was invented in the United States in the early 1980's, and like many U.S. innovations that have a strong impact on a nation's economy and industrial base, the U.S. lost the lead due to Europe's long-term governmental investments to develop and market advanced additive manufacturing printing equipment and materials. Other nations, from China to Singapore, are now focusing their national R&D investments in additive manufacturing technology R&D because of the impact it will have on their manufacturing economic engines.

A key element in an effective public-private partnership is cost sharing, especially when the national objectives and business risks are too much for industry to bear on its own. The value proposition is simple. The public-private partnership model with cost share provides the ability to leverage the investment by the public and private funding sources in areas of mutual specific interest that benefit the nation. When industry and academia provide cost share that matches the public R&D investment through the Cooperative Agreement with America Makes, the taxpayer receives double the normal output from the public investment. That's a strong business case for the public. The public partners further reduce their risk as a result of ready access to a vetted additive manufacturing supply chain network of industry and academic leaders and subject matter experts.

For those doing the work and providing cost share, the ability to spread the cost share across the performing team further reduces their risk and increases their return on investment. This business model aligns perfectly with the Department of Defense's Better Buying Power 3.0 initiative to increase the productivity of industry Independent Research and Development (IR&D) and Contracted Research and Development (CR&D).

To help the U.S. stay competitive, America Makes is creating both face-to-face and online mechanisms for broad-based collaborative efforts to identify capability gaps, solve shared problems, coordinate investments, and share knowledge in 3D printing. With the combined and integrate public and private investments, America Makes is establishing a culture of collaboration that is developing into a strong engine for innovation and technology commercialization in the United States.

What have we accomplished? Since being launched over three years ago in August 2012, America Makes – the National Additive Manufacturing Innovation Institute has taken long strides in achieving its mission. These are a few highlights:

- Established the America Makes Innovation Factory in Youngstown, OH with over 20 additive manufacturing machines entrusted by members, plus collaboration & education workspaces.
- Engaged 163 dues-paying members from industry, academia, and non-profit organizations.
    - 43 Industry Large Business Partners
    - 85 Industry Small Business Partners
    - 38 Academic Partners
    - 13 Government Partners

- 10 Non-Profit Organizations
- 4 Manufacturing Extension Partnership (MEP) Members

- Developed the second version of our member-driven Additive Manufacturing Roadmap that drives the technology investment strategy for America Makes. Roadmapping is accomplished via multiple workshops with our industry, academia, and government partners to identify and prioritize research and development required to meet the needs of our additive manufacturing community and accelerate the use of the technology in the United States.
- Launched and executing a strong portfolio of research and development (R&D) projects that attack the numerous technical challenges and roadblocks hindering the accelerated use of additive manufacturing. With the addition of our 2016 Project Call about to be released to our members, America Makes will soon have a portfolio worth more than $96 million in public and private funds invested in advancing the state-of-the-art in additive manufacturing for the United States. The 58 R&D projects initiated to date address additive manufacturing design, materials, processes, the supplier value chain, and the additive manufacturing genome of modeling and simulation analysis tools.
- Implemented a secure, virtual collaboration section within our website (www.AmericaMakes.US) for America Makes members which links to a repository for project information, including materials and processing data, central to companies being able to design new products to be produced using additive manufacturing.
- Led and supported numerous workforce training and STEM outreach programs, including an Additive Manufacturing Certificate program, providing mentoring and equipment to FIRST Robotics teams, and co-creating the privately-funded “3D Printer in Every School” initiative.

The R&D projects are producing results that are impacting multiple product sectors, from aerospace and defense to life-saving medical applications. Use of additive manufacturing for aerospace products improve performance, reduce cost, and shorten manufacturing lead-times. Few technologies are capable of delivering improvements in all three areas. One project is focused on the use of additive manufacturing in the Foundry industry, reducing the cost and cycle times to produce castings in the United States while also enhancing product performance. This is a critical action to preserve and strengthen the Foundry industry in the United States. One medical project is optimizing the design and manufacture of cranial implants for head injuries using the technology. This takes additive manufacturing from being a game-changer to a life-saver.

Why Additive Manufacturing Workforce and Education?

The balance of this testimony will focus on America Makes' public-private partnerships to accelerate and improve additive manufacturing workforce and education activities across the United States.

Additive manufacturing is one of the fastest-growing manufacturing trends and calls for new ways to educate and train both the current and future workforce, in an industry where change is constant and nearly 3.5 million manufacturing jobs will need to be filled in the next decade. America Makes is working with partners from across industry, academia, non-profit organizations, and the federal, state, and local government levels to build a comprehensive workforce and education roadmap and to support and execute strategic programs and projects that include building knowledge and awareness, fostering hands-on learning, strengthening industrial experience through trainee programs, and building the talent pipeline across sectors and diverse populations.

As part of these efforts, America Makes is focused on a number of activities which includes establishing infrastructure to create project based learning environments, partnering with members to educate

students and train workers in advanced manufacturing skills, identifying and engaging industry to address needs and skills gaps, providing professional education on advanced manufacturing and deploy education activities, programs and certifications, and integrate workforce and education into America Makes Project Calls.

To improve STEM and workforce training, America Makes is focused on partnering across sectors and leveraging community resources including industry, non-profits, and academic partners, including universities and community colleges. The following are a sample of partnerships, programs, and activities underway.

1. The development of Certificate Programs and trainings to expand ***individual knowledge*** of 3D printing and additive manufacturing.

    - SME, in cooperation with the Milwaukee School of Engineering and America Makes, has established a team of advisors who have strategically defined an additive manufacturing body of knowledge. This body of knowledge serves as the basis for an Additive Manufacturing Certificate Program, which includes a review course and an exam. The certificate program is designed to expand knowledge of Additive Manufacturing technologies and helps individuals to validate their knowledge in the field, upgrade knowledge, and stay current with industry standards and obtain a portable career credential in additive.

    - America Makes member, Underwriter Laboratories, has launched its first e-learning module, the Foundations of 3D printing. Geared to those who are new to this

technology, Foundations of 3D Printing is an interactive four-module course that presents comprehensive introductory knowledge of the 3D printing industry.

2. Development of Massive Online Courses (MOOCS) to educate the market on the ***business drivers*** of additive manufacturing.

    - Deloitte University Press and America Makes, in collaboration with Marquette University, Oak Ridge National Laboratory, and 3D Systems created the Massive Open Online Course (MOOC) titled *3D Opportunity: Additive Manufacturing for Business Leaders.* It is the first course of its kind to be offered by a large professional services firm and is designed to help educate the market on the business drivers of additive manufacturing (more popularly known as 3D printing). This free course has reached more than 14,000 individuals to date.

3. Partnerships to build ***internships, fellowships, and apprenticeships*** in the field of additive manufacturing.

    - ASME Fellowship: America Makes has worked with ASME to launch the *America Makes Advanced Manufacturing Fellowship Program*. The fellow participates as part of a public-private team to develop and lead high-level projects in workforce, including technical and strategic planning activities relative to the mission of America Makes. Fellows receive a career-broadening experience in program management, organizational development, and hands-on applied research.

- Robert C. Byrd Institute (RCBI) Apprenticeship Grant: Using a unique apprenticeship program to help train underserved communities learn advanced manufacturing skills such as 3D printing, the Robert C. Byrd Institute for Advanced Flexible Manufacturing is taking their approach to manufacturing education even further. RCBI has partnered with America Makes on a $4.9 million grant from the U.S. Department of Labor to help expand their apprenticeship model, curriculum, and training program guidance. America Makes is working closely with SME and RCBI to share our America Makes core curriculum and is providing advice regarding an appropriate training focus for the pre-apprentice program.

4. Partnerships to train veterans with ***workforce development*** and assistive technology skills.

    - America Makes has partnered with the U.S Department of Veteran Affairs as part of a Google.org grant to develop training for returned military veterans to learn the basics of creating personalized assistive technologies using 3D printing, rapid prototyping, and scanning technologies. These skills will be useful as veterans return to an increasingly digital job workforce. This pilot program will teach and train veterans on skills and knowledge associated with rapid prototyping, including design thinking + additive manufacturing.

      The goals of this program are four-fold:

        - <u>Develop community-based resources</u> to amplify VA's existing capacity surrounding the development of personalized assistive technologies for veterans faced with disabilities.

- Teach and train 15 veterans in the community on 21st century skills, such as Human-Centered Design + additive manufacturing, to help them obtain future job opportunities and reintegrate into their community. The training element of this program will be developed in collaboration with 3D Universal and Oak Ridge National Labs.
- Lay the foundations for a new educational and workforce development program model to scale to other communities with a curriculum, playbook, and suggested collaborations with local stakeholders to develop assistive technologies and assist with workforce development efforts at the local level.
- Enable development and scaling of assistive technology solutions through financial support from Google.org and open sourcing of designs through the National Institute of Health (NIH) 3D Print Exchange for all to use in their own communities and settings.

5. Partnerships to focus on bringing additive manufacturing to ***community colleges and vocational and tech education.***

- America Makes and Westmoreland County Community College (WCCC) are working in collaboration as part of an Alcoa Foundation grant to ensure young people have the skills they need to compete in a 21st century economy, and to align these skills with the growing demands of American employers, with a particular focus in additive manufacturing and 3D printing for community college students and vocational/tech education teachers in Pennsylvania, specifically in the Westmoreland and Indiana School Districts.

The goals of this project are two-fold. One is to build job-ready skills around additive manufacturing in students attending community colleges, and the second is to train teachers and educators in grades 9-12 vocational/tech education, so they can bring similar courses to their students through an initiative called *Building Manufacturing Skills for the 21st Century*. This program will use a blended learning approach by combining hands-on work with theory-based education applied to additive manufacturing. Additive manufacturing enables production of complex and customized designed parts by adding layer upon layer of material, whether plastic, metal, or even human tissue. This technology is being used to fabricate end use products in aircraft, dental restorations, medical implants, automobiles, and even food and fashion.

Specifically, this partnership includes the development of a 24-Hour Additive Manufacturing Curriculum. Developed by Westmoreland County Community College and built in partnership with 3D Systems, this curriculum will be aligned with, co-created, and reviewed by key leaders in education and manufacturing. The curriculum will include the following objectives:

- Introduce students to 3D Printing, 3D Scanning, and 3D Software Technology.
- Introduce students to the concept of reverse engineering and how it is used in Industry.
- Support teachers/educators to bring this technology to their 9-12/Vocational Tech Education Classroom.
- Develop a Community College Course for general population/community as part of the Westmoreland County Community College.

- Train 40 teachers in PA from 9-12/Vocational and Tech Education. In order to leverage this class and bring it to vocational/tech education and 9-12 grades, 40 teachers in PA will take the WCCC class, so that they are trained and comfortable with both the equipment & software.

Ultimately this program works to achieve the following goals:

- Provide students with opportunities to learn 3D design, 3D scanning, and 3D printing in the context of industries like aerospace, automotive, and biomedical, and ensure that the next generation has the skills they need to compete in the 21st century economy.
- Help to transform digital literacy in the classroom, through providing high school/vocational and tech education teachers with training, that they can then scale and bring it into their classrooms.

Conclusion

In closing, additive manufacturing is a game-changer because it brings a whole new set of rules to multiple industry sectors, from aerospace and defense solutions to life-saving medical applications. If you change the rules, you change the game. It is also an incredibly powerful teaching tool to reinvigorate STEM education in the United States. Combined, additive manufacturing is playing a critical role in ensuring a robust manufacturing-driven economy in the decades ahead. But it must be done in a public-private partnership if the United States is to continue to excel in the evolving, highly competitive global economic environment.

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About America Makes

America Makes is the National Additive Manufacturing Innovation Institute. As the national accelerator for additive manufacturing (AM) and 3D printing (3DP), America Makes is the nation's leading and collaborative partner in AM and 3DP technology research, discovery, creation, and innovation. Structured as a public-private partnership with member organizations from industry, academia, government, non-government agencies, and workforce and economic development resources, we are working together to innovate and accelerate AM and 3DP to increase our nation's global manufacturing competitiveness. Based in Youngstown, Ohio, America Makes is the first institute for up to 45 manufacturing innovation institutes to follow and is driven by the National Center for Defense Manufacturing and Machining (NCDMM). For more information about America Makes, visit http://americamakes.us.

About NCDMM

The NCDMM delivers optimized manufacturing solutions that enhance the quality, affordability, maintainability, and rapid deployment of existing and yet-to-be developed defense systems. This is accomplished through collaboration with government, industry, and academic organizations to promote the implementation of best practices to key stakeholders through the development and delivery of disciplined training, advanced technologies, and methodologies. For additional information, visit the NCDMM at ncdmm.org.