Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR)

Innovation in Manufacturing Annual Report Fiscal Year 2018

The Small Business Act, 15 U.S.C. § 638(ss), requires that the annual report contain information about Executive Order (E.O.) 13329. Pursuant to E.O. 13329, Agencies must give priority to small business concerns that participate in or conduct R/R&D "…relating to manufacturing processes, equipment and systems; or manufacturing workforce skills and protection." Each Agency includes in its Annual Report to the SBA a synopsis of its implementation of these requirements. Agencies utilized a variety of approaches in addressing the E.O. 13329 directive. For most, these requirements are assessed within the scope of each Agency's R/R&D needs with tangible numbers of solicitation topics, awards, and dollars. Mechanisms commonly used by Agencies to give priority to manufacturing-related work include: adding manufacturing-related topics in solicitations; requesting in solicitations that proposals address any possible manufacturing-related elements of the small businesses' proposed work, technological approach, delivery or resulting technological applicability to manufacturing processes; and, noting in solicitations that including such elements in proposals may provide a competitive advantage in the award selection process. Additionally, cross-Agency collaborations, targeted outreach efforts, and other Agency-specific activities related to manufacturing contribute to addressing the objectives of E.O. 13329.

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Agency Compliance with E.O. 13329 Encouraging Innovation in Manufacturing

The Small Business Act, 15 U.S.C. § 638(ss), requires that the annual report contain the following information about Executive Order (E.O.) 13329:

1) A description of efforts undertaken by the head of the Federal agency to enhance United States manufacturing activities;
2) A comprehensive description of the actions undertaken each year by the head of the Federal agency in carrying out the SBIR or STTR program of the agency in support of Executive Order 13329 [note to this section] (69 Fed. Reg. 9181; relating to encouraging innovation in manufacturing);
3) An assessment of the effectiveness of the actions described in paragraph (2) at enhancing the research and development of United States manufacturing technologies and processes;
4) A description of efforts by vendors selected to provide discretionary technical assistance under subsection (q)(1) to help SBIR and STTR concerns manufacture in the United States; and
5) Recommendations that the program managers of the SBIR or STTR program of the agency consider appropriate for additional actions to increase the effectiveness of enhancing manufacturing activities.

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Department of Agriculture (USDA)

Outreach

The USDA National Institute of Food and Agriculture (NIFA) administers the USDA Small Business Innovation Research (SBIR) program.

The USDA SBIR program will work closely with the Small Business Administration (SBA) to ensure that upcoming National SBIR conferences highlight the importance of manufacturing to the U.S. economy. In addition, opportunities will be emphasized to submit appropriate R&D proposals to the different USDA SBIR topic areas that deal with manufacturing issues of significance to the mission of the USDA. A similar effort will be made to highlight this focus on manufacturing R&D in talks that are presented at the various SBIR meetings.

Funding Opportunities

The USDA SBIR program issues a request for application or program solicitation each fiscal year that lists 10 broad topic areas that encompass the full range of research and development priorities for USDA. From the beginning of the USDA SBIR program, topic areas have been discipline-specific, not technology specific. The 10 topic areas contained in the program solicitation are: forests and Related Resources; Plant Production and Protection – Biology; Animal Production and Protection; Air, Water and Soils; Food Science and Nutrition; Rural and Community Development; Aquaculture; Biofuels and Biobased Products; Small and Mid-Size Farms; and Plant Production and Protection – Engineering. Technology-specific topics such as nanotechnology, biotechnology, information technology, or manufacturing technology are not listed separately, but may be submitted to one of the ten topic areas. Numerous projects in these technology areas have been supported and will continue to be supported.

The USDA SBIR Phase I and II Program Solicitation contains a statement that encourages applicants to include Agriculturally – Related manufacturing technology as an area of focus. The inclusion of this statement has resulted in an increase of applications that deal with manufacturing issues that are relevant to the USDA mission and the SBIR topic area.

Award Selection

The USDA SBIR external review panels will be instructed to consider the existence of manufacturing-related proposals as a tie breaker during the evaluation process. When two proposals are considered approximately equal in merit and one proposal has a focus on manufacturing, that proposal will be given priority in both the Phase I and Phase II selection process.

Reporting

As required by the SBIR Policy Directive, the USDA SBIR program will provide manufacturing-related SBIR data in the annual report that is due to SBA by March 15th of each year.

Future Years

USDA SBIR staff will coordinate with SBA and if there are any additional requirements, the USDA will update this plan to accommodate the changes.

Department of Commerce (DOC)

National Institute of Standards and Technology (NIST)

The NIST SBIR program supports manufacturing-related research projects through its solicitations and awards. In NIST's FY 2018 annual Phase I solicitation, 9 of the subtopics were manufacturing related. NIST made five Phase I and four Phase II awards that involve manufacturing.

The solicitation included a notice describing Executive Order (EO) 13329 and encouraged innovation in manufacturing by giving high priority, where feasible, to projects beneficial to the manufacturing sector. A Manufacturing-related R&D Emphasis in the SBIR web page is available. The NIST SBIR Program Office provides proposer contact and project information to NIST's Manufacturing Extension Partnership (MEP) as authorized by applicants.

National Oceanic and Atmospheric Administration (NOAA)

Like NIST, the NOAA SBIR program supports manufacturing-related research projects through its solicitations and awards. In FY 2018, roughly 21 out of the 31 Phase I awardees provided projects (or some component) related to manufacturing. In addition, the FY 2018 SBIR Phase I Solicitation included a notice describing Executive Order (EO) 13329 and encouraged innovation in manufacturing by giving high priority, where feasible, to projects beneficial to the manufacturing sector. Lastly, in order to promote manufacturing in SBIR projects, NOAA utilizes them as tiebreakers during the evaluation of proposal. Per the FY 2018 SBIR Phase I Solicitation (Page 36, Section 4.3), "*In the event of a "tie" between proposals, manufacturing-related projects as well as those regarding energy efficiency and renewable energy systems will receive priority in the award selection process*."

Department of Defense (DoD)

Innovation in manufacturing, through small businesses, is the key to improving the United States economy. This is why, on February 26, 2004, President George W. Bush enacted Executive Order (EO) 13329, to ensure that Federal agencies properly and effectively assist the private sector in its manufacturing innovation so as to sustain a strong manufacturing sector. EO guidelines state that all government agencies with one or more Small Business Innovation Research (SBIR) programs or one or more Small Business Technology Transfer (STTR) programs give high priority to manufacturing related research and development (R&D) processes, systems, and workforce protection. This includes manufacturing processes, equipment and systems, or manufacturing workforce skills and protection. The DoD SBIR/STTR program has worked to integrate manufacturing related projects into their program since EO 13329 was signed. The pages that follow provide a full report of the DoD's findings of the implementation of EO13329 across participating DoD components.

Procedures and Mechanisms Used to Give Priority to Manufacturing Related Projects

DoD SBIR/STTR releases three solicitations per year. Included in these solicitations are topics related to and promoting manufacturing technology. Some examples of promoting manufacturing related projects by participating DoD components are as follows:

a. The Air force identifies manufacturing technology as a tie-breaker in solicitations, stating the Air force will evaluate proposals in descending order of importance with technical merit being most important, followed by the Commercialization Plan, and then qualifications of the principal investigator (and team) and that, where technical evaluations are essentially equal in merit, and the cost and/or price is a substantial factor, then cost to the Government will be considered in determining the successful offeror. The next tiebreaker on essentially equal proposals will be the inclusion of manufacturing technology considerations.

b. The Army collaborates with the U.S. Army Manufacturing Technology (ManTech) Program to integrate and align SBIR efforts directly into ManTech projects. The ManTech Program Management Office (PMO) reviews, evaluates, and endorses manufacturing-related topics for manufacturing-relatedness against the following five categories:

1. Core Manufacturing Innovation Topic.
2. Addresses manufacturing process, technique, or innovation.
3. Addresses manufacturing development, application, and tools used in advanced processes.
4. Targets manufacturing manufactures for related equipment, systems, or production lines.
5. Addresses the affordability, and reproducibility of demonstrated technology.

c. Of specific concern to the Chemical and Biological Defense Program is unit cost of technologies having the potential for distribution to individual Warfighters. Therefore, SBIR topics that address the affordability, producibility, or manufacturing of an

innovative technology are of particular importance and given greater priority for inclusion into future SBIR solicitations. CBD SBIR topics are assigned to one of the following seven categories:

1. Research for a process or product that has significant manufacturing implications, although not the sole purpose of the topic.

2. Topic addresses the development or application of advanced technologies for manufacturing processes, tools, and equipment.

3. Topic includes manufacturing issues associated with technology under development.

4. Research Topic that has Product or System Focus, Addressing Manufacturing Aspects of that Product.

5. Primary objective of topic is to develop a system or weapon-specific capability.

6. Manufacturing, producibility, cost and yield are referenced but not the primary objective of the task.

7. Manufacturing-related activities may be part of Phase II.

d. DARPA leverages their Open Manufacturing program to solve this problem by building and demonstrating rapid qualification technologies that comprehensively capture, analyze and control variability in the manufacturing process to predict the properties of resulting products. Success could help unleash the potential time- and cost-saving benefits of advanced manufacturing methods for a broad range of defense and national security needs.

e. DLA seeks drastically lower unit costs of discrete-parts support through manufacturing revolutions that also have applicability to low and high-volume production from commercial sales. This will result in an improvement in the affordability of these innovations to DLA and its customers and the development of cost-effective methods to sustain existing defense systems while potentially impacting the next generation of defense systems.

Actions Taken Toward Promoting and Supporting Manufacturing-Related Research Projects

DoD continues to take an active approach to promoting and supporting manufacturing-related research projects. This is done through attending outreach event, collaborations with various organizations and offices such as ManTech, etc. Some examples of this promotion are:

a. The Army and Air force SBIR/STTR programs publish and advertise success stories for outstanding manufacturing related projects. These websites bring together the small business communities, component researchers, Program of Record, prime contractors, and the ManTech community for possible collaboration on new and

ongoing SBIR/STTR projects.

b. Transition assistance is offered by various DoD components in support of their manufacturing related projects. Army SBIR/STTR employs transition assistance to firms whose proposals have met and/or exceeded all Army SBIR criteria. Transition assistance is available through Phase II Commercialization Readiness Program (CRP). Similarly, the DARPA Small Business Programs Office has contracted with Strategic Analysis, Inc. Technology Transition and Commercialization team (T2C Team) to implement the Transition and Commercialization Support Program (TCSP). The T2C Team is providing high level review companies' transition and commercialization strategy, transition and commercialization strategy, transition and commercialization planning support, identification and introduction to potential collaborators, potential partners and potential sources of Phase III funding, and identification of thought leadership opportunities.

c. Several components, including Army, OSD, DLA, work closely to incorporate the ManTech program during topic writing and Phase I and Phase II source selection processes.

d. DoD Components regularly participate in manufacturing related conferences including: Beyond Phase II, Defense Manufacturing Conference (DMC), and Nanotechnology for Defense (NT4D). During these conferences one-on-one discussions were conducted between SBIR program personnel and small business representatives to investigate application of their technologies to the mission and requirements of the DoD community.

e. Almost the entire DoD community promotes EO 13329 through posting various links to manufacturing related documents and websites including:

1. The Department of Commerce (DOC) "Manufacturing in America" article.
2. Establishing a link to EO13329 on their respective SBIR/STTR public website.

An Assessment of the Effectiveness of the Actions Taken at Enhancing the R&D of U.S. Manufacturing Technologies and Processes

The DoD is extremely interested in continuing to improve the effectiveness of the R&D of U.S. manufacturing technologies and processes. DoD SBIR/STTR programs are a few of the ways in which the R&D of U.S. manufacturing technologies and processes are successfully enhanced as it represents a direct investment in the development of this essential focus area. Through the advancement of grand ideas, innovative technologies and processes that would never have been nurtured are discovered and developed, improving U.S. manufacturing's standing throughout the world.

Much of the DoD community conducts internal evaluation to assure topics are apportioned to manufacturing innovation. For example, MDA continues to experience success in soliciting manufacturing technology proposals. MDA's primary focus has been on improved manufacturing of structural components of missiles, manufacturing of light-weight batteries, and manufacturing of focal plane array sensor systems. All developed products are manufactured in the U.S.

Description of Efforts Undertaken by Vendors Selected to Provide Discretionary Technical Assistance to help SBIR/STTR Business Concerns Manufacture in the U.S.

When applicable DoD components makes use of the additional $5,000 dollars allotted per year to SBIR awardees for discretionary technical assistance through contractors with expertise in this area.

Recommendations from the Agency's SBIR and STTR Program Manager of Additional Actions to Increase Manufacturing Activities in the U.S.

The DoD recommends utilizing resources available to increase manufacturing activities in the US and encouraging organizations to focus on topics that will highlight manufacturing. Closer collaboration regarding topics at the very beginning stages of topic development should kindle an increase in the successful transition of future projects to the commercial market. Further, coordinating activities with manufacturing technology programs already existing within the Services, such as U.S. Army ManTech program must continue. ManTech focuses on transitioning projects from Phase II to Phase III, the ultimate goal of the SBIR program. Some additional component recommendations are as follows:

a. CBD SBIR recommends OSD Office of Small Business Programs continue to facilitate a relationship between SBIR/STTR and the Defense Manufacturing Conference; this is a synergist outreach event that will improve manufacturing opportunities between small businesses and industrial partners.

b. DLA SBIR suggests streamlining the contracting process to increase timely investment in U.S. manufacturing. Long procurement times negatively impact the small business concern's ability to form and maintain commercialization partnerships necessary for manufacturing invests to be successful. Consolidating contracting activities that can focus on understanding SBIR contract awards will expedite manufacturing-based awards.

c. MDA states that the key to increasing manufacturing activities in the U.S. is worker productivity. Productivity must exceed the high financial liability of labor overhead to be successful. If we are to make a contribution in this area, some portion of the research budget must be set aside for component design simplification and process automation. Each worker must be empowered to produce products more economically and at a faster rate. Further, simplified designs will enable faster and more reliable assembly techniques. Relevant systems must also rely on common components for common functions. This will increase the scale of production for individual parts and make manufacturing more economical.

d. Navy SBIR supports providing vendors with training on manufacturing risks and mitigation strategies.

Department of Education (ED)

The U.S. Department of Education (ED) operates its SBIR program at the Institute of Education Sciences (IES).

The ED SBIR Program uses a contracts mechanism to provide up to $1,100,000 in funding ($200,000 for Phase I; $900,000 for Phase II) to small business firms and partners for the research and development (R&D) of commercially viable education technology products for use by students and teachers in education and in special education settings.

Broadly speaking, ED's SBIR program is designed to support and encourage R&D in manufacturing through "environment or societal, and systems level technologies" (as defined by SBA, 2005). These projects encompass a range of manufacturing topics, such as artificial intelligence, information technology devices, software, systems, devices, and product design.

In 2018, attention was paid in identifying projects that were manufacturing-related. Of the 21 contracts awarded, several are conducting R&D of software and hardware components, which if feasible could potentially be manufactured and commercialized on a broader scale during Phase III of the SBIR program.

Examples of ED manufacturing-related SBIR/STTR projects in the 2018 Portfolio

With a 2018 Phase II award, Myriad Sensors is developing *CloudLab*, a web-based dashboard that presents data captured by sensors on scientific properties such as altitude, speed, and temperature. *CloudLab* will consist of a portal for middle school science students, so that they can record and store data from their individual experiments, analyze, and present findings to classmates and as course assignments. *CloudLab* will include a portal for teachers to manage lab groups, to aggregate results at the class and individual student level, and to share or find content on lessons, lab templates, and coding activities. *CloudLab* will be used by students in and out of classrooms to supplement learning of course content aligned to NGSS topics in physics, chemistry, biology, Earth science, engineering, design, and technology. The sensor that collects data for *ClouldLab* is being manufactured in the United States to enable wide scale commercialization and distribution to schools. To do so, Myriad Sensors contracts with manufacturer, Javad EMS, in San Jose, CA to build the circuit boards. Myriad Sensor then does their own assembly, programming, testing, and packaging of devices in house, before providing to the end customers.

Actions Taken Toward Promoting and Supporting Manufacturing-Related Research Projects

In FY 2018, ED SBIR implemented the following procedures to give priority to manufacturing related projects: 1) Placed a notice in FY 2018 SBIR program solicitations that details Executive Order 13329; 2) Placed a forced-choice question in the 2018 SBIR program solicitations for applicants to indicate (yes or no) whether their proposed project is "manufacturing-related;" and 3) Placed language in the solicitation advising potential applicants that ED SBIR offices will give priority to manufacturing-related projects in the event of a tie in the award selection process. (Note: This "tie-breaker" specification allows the ED SBIR program to apply an additional preference without compromising the quality standards or established criteria of the program).

In FY 2018, ED SBIR used the following procedures and mechanisms to promote and support Executive Order 13329: 1) Maintained the notice on the ED SBIR website that describes Executive Order 13329,

provides a definition of manufacturing-related projects in education, and provides a web-link to the Executive Order; 2) Continued tracking and reporting success stories demonstrating the impact of the SBIR program on manufacturing; 3) Placed a notice in FY 2018 SBIR program solicitations on manufacturing; and 4) ED SBIR will continue to discuss how to best implement Executive Order 13329 related to manufacturing.

Department of Energy (DOE)

Examples of SBIR/STTR projects related to manufacturing processes, equipment and systems, or manufacturing workforce skills and protection

Topic	Subtopic	SBC Name	Project Title
4. Design and Manufacturing Advances for Space-Based Sensors	a. Diffractive Optics Design & Manufacturing	Voxtel Inc.	Compressive 3D imaging spectrometer
6. Advanced Manufacturing	b. Novel Energy-Efficient Dewatering Methods for Cellulosic Nanomaterials	Physical Optics Corporation	Dielectrophoretic Enhancement of Dewatering
6. Advanced Manufacturing	b. Novel Energy-Efficient Dewatering Methods for Cellulosic Nanomaterials	TDA Research Inc.	A New Process for Energy-Efficient Dewatering Methods for Cellulosic Nanomaterials
6. Advanced Manufacturing	b. Novel Energy-Efficient Dewatering Methods for Cellulosic Nanomaterials	Faraday Technology Inc.	Electro-dewatering of Cellulosic Nanomaterials
6. Advanced Manufacturing	c. Thermal Process Intensification for Productivity Improvements	Sep-All LLC	Low-heat Process for the Production of High-value Micro- and Nano-materials from Metallic Wastes
6. Advanced Manufacturing	c. Thermal Process Intensification for Productivity Improvements	3D Array Technology LLC	Microwave Irradiation Intensified Process for Scalable Functional Device Assembly
6. Advanced Manufacturing	d. Technology Transfer Opportunity: Process for the Synthesis of Precision Nanoparticles	Voxtel Inc.	Precision Nanoparticles for High Performance Devices
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	b. Additive Manufacturing of Extreme Environment Materials for Large Parts	ATS-MER LLC	Large Parts Additive Manufacturing
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	c. High Value Products from Coal	Minus 100 LLC	U.S. Coal to Conductive Inks
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	c. High Value Products from Coal	Physical Sciences Inc.	Efficient Process for the Production of High Conductivity, Carbon-rich Materials from Coal
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	c. High Value Products from Coal	Semplastics EHC LLC	Coal Core Composites for Low Cost, Light Weight, Fire Resistant Panels and Roofing Materials
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	c. High Value Products from Coal	Touchstone Research Laboratory Ltd.	Silicon Carbide (SiC) Foam for Molten Salt Containment in CSP-Gen3 Systems
18. Advanced Manufacturing & Materials for Fossil Energy Technologies	d. Novel Materials or Processes to Support Transformational Carbon Capture Technologies	Advanced Energy Materials	Novel CO2 Sorbent Materials for Advanced Carbon Capture Technologies
27. High-Speed Electronic Instrumentation for Data Acquisition and Processing	f. High Density Chip Interconnect Technology	UHV Technologies, Inc.	An Innovative Additive Manufacturing Technology for High Density Interconnects
30. Advanced Technologies for Nuclear Energy	g. Advanced Methods for Manufacturing	PolarOnyx Inc	Controllable 3D Manufacturing System
30. Advanced Technologies for Nuclear Energy	g. Advanced Methods for Manufacturing	Brimrose Technology Corporation	Ultrasonic Scattering Inspection Approach for Improved Methods of Additive Manufacturing
30. Advanced Technologies for Nuclear Energy	g. Advanced Methods for Manufacturing	Ler Technologies Inc.	Real Time Non-Destructive Evaluation during 3D Manufacturing of Metal Parts

30. Advanced Technologies for Nuclear Energy	g. Advanced Methods for Manufacturing	Innovative Technologies International	Additive Manufacturing of BWR Lower Tie Plates

Procedures and mechanisms your Participating Agency used to give priority to SBCs that participate in manufacturing-related projects; and, Specific actions your Participating Agency has taken toward promoting and supporting manufacturing-related projects

The Advanced Manufacturing Office within the Office of Energy Efficiency and Renewable Energy (EERE) leads manufacturing innovation for the Department of Energy (DOE).

Enhancement of United States Manufacturing Activities by the Department of Energy

Through research, development, and demonstration (RD&D) activities, the Advanced Manufacturing Office (AMO) program brings together manufacturers, research institutions, suppliers, and universities to develop cutting-edge manufacturing process, information, and materials technologies critical to efficient and competitive domestic manufacturing of clean energy products and to support energy productivity across the entire U.S. manufacturing sector.

Manufacturing generates 12 percent of U.S. gross domestic product (GDP)[1] and employs more than 12 million Americans[2]. The U.S. manufacturing sector also has an annual energy bill of about $200 billion and uses roughly one-third of primary energy in the U.S.[3] DOE works to improve the energy efficiency and productivity of U.S. manufacturers, which helps keep manufacturers of all kinds more competitive in the global marketplace, creating good jobs for Americans while helping all Americans enjoy cleaner air and a healthier environment. The program accomplishes this by focusing on the development of cross-cutting, cutting-edge, platform materials and manufacturing process technologies relevant to multiple clean energy technologies, helping ensure that clean energy technologies and processes invented in the U.S. ultimately result in the manufacture of high-quality clean energy products in the U.S.

AMO supports RD&D projects and technical assistance for manufacturers, research institutions, suppliers, and universities through competitive, merit reviewed funding opportunities designed to investigate processes, information, and materials technologies in line with the program goals.[4,5] The program addresses early stage manufacturing technologies through three different modes of support as sub-programs: individual R&D projects, pre-commercial R&D facilities, and technology assistance through partnership participation, assessment, and evaluation tools.

AMO's efforts in the R&D Projects and R&D Facilities subprograms are organized around a limited set of major high priority technical focus areas that have been developed through extensive engagement and consultation with private sector firms, non-profits, universities, and National Laboratory partners, and others across the Department. The AMO technical focus areas support manufacturing process, information and materials technologies and directly align with the fourteen high priority energy-related

[1] "Gross Domestic Product by Industry: Third Quarter 2016," Charts & Tables, Table 5, available from https://www.bea.gov/newsreleases/industry/gdpindustry/gdpindnewsrelease.htm (accessed 1/20/17).
[2] "Industries at a Glance: Manufacturing: NAICS 31-33," available from: https://www.bls.gov/iag/tgs/iag31-33.htm (accessed 1/20/17).
[3] Consumption and Efficiency, Recent Data, U.S. Energy Information Administration, available from: http://www.eia.gov/consumption (accessed 1/20/17).
[4] EERE Strategic Plan (2016-2021): http://energy.gov/sites/prod/files/2015/12/f27/EERE_Strategic_Plan_12.16.15.pdf
[5] Advanced Manufacturing Office mission and goals: http://energy.gov/eere/amo/mission-and-goals

advanced manufacturing technologies identified through the 2015 DOE Quadrennial Technology Review (QTR).[6]

Each AMO subprogram activity leverages collaborative research communities, including small business, to bridge the technology development gap and capture the benefits of government investment in R&D Following is a discussion of each subprogram.

Advanced Manufacturing R&D Projects: Through competitively-selected R&D project investments in foundational energy-related advanced manufacturing technologies, the program increases the impact of its work in thrust areas relevant to energy-intensive and energy-dependent industries as well as materials and technologies widely applicable across multiple clean energy manufacturing industries. The Advanced Manufacturing R&D Projects subprogram supports innovative manufacturing projects cost-shared with companies and research organizations that focus on specific high-impact manufacturing technology and process challenges in order to increase energy productivity. Through a combination of merit based competitive FOA solicitations and peer-reviewed national laboratory based partnerships, these projects fund the development of next generation manufacturing materials, information, and process technologies that facilitate the transition of emerging clean energy technologies to domestic production and improve energy efficiency in energy–intensive processes. The program identifies the specific research challenges based on stakeholder input, alignment with the program's technology thrust areas, and potential energy, environmental, and economic impacts.

Advanced Manufacturing R&D Facilities: The Advanced Manufacturing R&D Facilities subprogram helps the U.S. position itself as a world leader in manufacturing by bringing together manufacturers, research institutions, suppliers, and universities in public-private RD&D partnership consortia. These public-private partnerships facilitate the transition of innovative advanced materials, information, and process technologies to industry and enable manufacturing scale-up. The technology development efforts help develop national capabilities that enable future global leadership in clean energy manufacturing. The Program's facilities, including the Clean Energy Manufacturing Innovation Institutes and Energy Innovation Hubs, accelerate the development and implementation of cutting edge energy efficiency technologies as well as materials and process technologies broadly applicable to the manufacturing of clean energy products. The advanced manufacturing R&D facilities have spillover benefits from clean energy sectors into multiple industries and improve U.S. competitive advantage, especially for small- and medium-sized enterprises (SMEs).

Industrial Technical Assistance: The Industrial Technical Assistance subprogram provides critical support to the deployment of advanced energy efficiency technologies and practices. The Industrial Technical Assistance subprogram assists in the deployment of 40 gigawatts (GW) of new, cost-effective CHP by 2020, helps individual manufacturers reduce their energy intensity by 25 percent over ten years; demonstrates the viability of improved energy management approaches; and provides targeted energy efficiency, productivity, and waste/water use reduction technical assistance to small and medium-sized manufacturers.

[6] 2015 Quadrennial Technology Review, Chapter 6 "Innovating Clean Energy Technologies in Advanced Manufacturing" http://energy.gov/downloads/chapter-6-innovating-clean-energy-technologies-advanced-manufacturing.

FY 2018 Department of Energy/EERE/AMO SBIR/STTR Activities in Support of Executive Order 13329

The following subtopics were included in the FY 2018 DOE SBIR/STTR Phase I Release 2 Funding Opportunity Announcement, ultimately provided funding for 12 Phase I awards.

Intelligent Systems for Materials Design and Discovery

Combinatorial and other high-throughput methods of materials screening provide rapid analyses of large numbers of samples of diverse materials such as coatings, catalysts, and pharmaceuticals. Although these methods provide vast amounts of information, they are unable to elucidate any underlying mechanisms nor the process for discovering new materials.

The availability of increasing digital computational capabilities and algorithms has dramatically expanded the possibilities for artificial intelligence and machine learning applications in materials design and discovery. Combining advanced computing capabilities physics based models in a single platform would greatly aid in advanced materials research and discovery.

Investigators from small businesses are invited to collaborate with researchers in the materials and computational sciences to develop systems that are aided by artificial intelligence to expand the ease and scope of high throughput discovery methods. This subtopics' objective is to make materials discovery methods more accessible to investigators who need to develop or improve new materials. This subtopic aims to allow for the interpretation of data with machine learning to direct the materials search toward desired objectives.

It is expected that the result of this effort will be a system that can be commercialized and sold to investigators with specific, proprietary materials development objectives and needs. In addition, an open source platform can be developed to share with the greater research community, hosted in a forum such as GitHub.

Interdisciplinary teams of investigators are invited to submit research proposals for intelligent systems development in the following areas:

1. Heterogeneous catalyst discovery: All types of heterogeneous catalysts are covered by this subtopic area, including but not limited to fuel cell electrocatalysts and catalysts used in industrial chemistry.
2. Polymer discovery: Large numbers of polymer samples are typically analyzed for various coatings and other applications. Intelligent systems would greatly reduce the time needed in combinatorial searches of polymeric materials for a desired end use.
3. Thin films for energy applications: Applications for thin film semiconductor and dielectrics used in photovoltaic applications, fuel cells, etc. are solicited. • Other energy related materials: Including but not limited to materials for thermoelectrics, thermocalorics, magnetic materials, and supercapacitors.
4. Specialty organic compounds: Compounds that have application in diverse end uses, such as the food and drug industries, and exhibit subtle differences in their specific chemistries by their composition and configurations. Questions – Contact: Brian Valentine, Novel Energy-Efficient

Dewatering Methods for Cellulosic Nanomaterials

Cellulosic nanomaterial (CNC and CNF) production has transitioned from laboratory to pilot scale, making it feasible for their use in a variety of industrial applications; including oil and gas, wastewater treatment, electronics and others. A significant hindrance for further advancement is their difficulty when drying, as CNCs and CNFs are not economical to ship long distances while containing significant water content. We seek novel, energy-efficient, dewatering or drying methods that would maintain material properties, such as particle size, when dried and redispersed.

Applications are welcome to propose novel heating systems, heat transfer systems, dehumidification, or chemical treatments, however; it is reported that mechanical dewatering techniques do not appear to be economical. Applications must focus on the production of dewatered/dried product at high yield using an economic energy source that is available at competitive industrial rates. The novel method should not be primarily dependent on heat recovery, and must not include production of byproduct power for sale to achieve the proposed energy efficiency and cost metrics. That is, factors such as heating method, heat transfer, containment device, dewatering/drying system design, and material treatments should be novel. Material handling systems, storage, material supply and shipment requirements should be considered. The application should include a clear initial economic analysis and methodology to estimate drying cost per unit of product produced and compare to an existing drying method. Successful applicants must demonstrate experience with drying technology.

The materials, when ready for shipment, should be suitable for high volume applications, such as fiber reinforcements for thermoplastic products. The application(s) must define the intended end use(s) for the dried product, and demonstrate knowledge of the manufacturing and end use requirements of those applications. The preliminary economic analysis should include an estimate of product demand, while the Phase I work would include a task for a detailed economic analysis as well as a concept design for the novel dewatering/drying technology. The application should identify the key technical challenge(s) and show how proof-of-feasibility with statistically meaningful data to support yield, efficiency, and drying capacity capabilities will be developed.

Thermal Process Intensification for Productivity Improvements

Process heating accounts for more direct energy use than any other energy consuming processes in manufacturing, but traditional industrial (thermal) processes can be inefficient, difficult to control and result in materials and products with compromised quality and performance. As such, new and innovative approaches are sought that use low/no direct application of heat to transform materials into higher value products. For example, since electromagnetic (EM) energy interacts with different materials in unique ways, EM technologies (electro technologies) have the potential to unleash enhanced or entirely new manufactured products and materials as well as new approaches and processes for producing such materials. While there are some examples of electro technologies that have been adopted by the manufacturing sector where mechanisms are well understood (e.g. dielectric heating as the mechanism for rubber curing by microwave and adhesive curing by radio-frequency), but uptake is limited. In addition, there is a vast EM spectrum that can be harnessed, there are other wave/material mechanisms that could enable new applications, and the potential of hybrid technologies has not been capitalized upon. For example, the development of integrated, enhanced and compact process equipment to synergistically intensify thermal, mass and momentum processes, has the potential to significantly improve advanced manufacturing energy productivity. There are a number of inter-related opportunities for greater utilization of EM technologies and other low/no thermal budget technologies; grant applications are sought to develop new approaches targeting areas/issues including:

1. Process/Equipment Co-Development: Since the material (to be processed) becomes an integral part of the overall system, the equipment design is far more critical than in traditional (heating) processes, leading to increased up-front costs. Modeling and Simulation is an integral part of this process.
2. Modeling and Simulation: Complex EM wave/material interactions plus coupled heat and mass transfer that varies by material hinders uptake by industry, especially for new applications, as special skills are required to for simulations, design, engineering, etc.
3. Process Scale-Up: There are different low TRL technological barriers that exist at different scales; e.g., solving a technological barrier at small-scale does may not address a barrier at large-scale.
4. Equipment Scale-Up: To date, equipment scale-up has been limited. Advances in cost effective user friendly equipment for industrial and manufacturing markets are needed. For example, cost effective production-scale solid-state power supplies need to be integrated during process/equipment co-development.
5. Equipment Scale-Down: In some cases, more compact, more efficient and less expensive technologies – such as small-scale accelerators – could lead to advances in precision, user-friendly equipment for industrial and manufacturing markets.
6. Integral Control Systems: Real-time, in-situ and integrated process monitoring and control systems for thermal process intensification that are part of a broader Smart Manufacturing strategy.

Grant applications are sought to develop novel means for thermal process intensification technologies to improve manufacturing energy productivity. Successful applicants should: (1) identify what fundamental science gaps exist and what new knowledge will be acquired; (2) specify which industry is targeted and provide a clear and concise justification of why the new process/technology best meets the specific requirements of that application; (3) demonstrate that the proposed approach will have an impact on overall energy productivity; (4) include an economic analysis that accounts for long-term implications; and (5) demonstrate the ability of the applicant to proceed to a demonstration of technology viability under a Phase II project.

TECHNOLOGY TRANSFER OPPORTUNITY: Process for the Synthesis of Precision Nanoparticles

Supercritical fluid extraction offers a more environmentally friendly, cost-competitive process for producing nanoparticles than traditional methods, which include attrition, pyrolysis and hydrothermal synthesis. By exposing single-source precursors — molecules containing elements connected by a single chemical bond — to carbon dioxide in a supercritical state, researchers at Idaho National Laboratory and Idaho State University have developed a process to produce uniform nanoparticles at desired sizes ranging from 1nm to 100nm (+/- 0.2nm). Instead of using high temperature, the process takes place at around 65 degrees Celsius, saving significant amounts of energy. While the patented method using supercritical fluids was originally conceived as a process for making nanomaterials for cost-effective and high efficiency photovoltaic cells, the process is recognized to have potential in producing nanoparticle based materials for microelectronics, magnets, thermoelectric devices, and also for catalysts in the advanced manufacturing of platform chemicals. The promise of this breakthrough technology was recognized in 2009 with an R&D 100 Award.

This Technology Transfer Opportunity seeks to leverage the precision nanoparticle technology developed at INL and ISU for the commercialization of a process to synthesize new catalyst, thermoelectric and/or semiconductor materials. The ideal candidate for this TTO opportunity will have identified target material compositions with the desired stoichiometry and crystalline structure(s) of the desired nanoparticle

product(s). The targeted outcome will be demonstrating the feasibility of using the precision nanoparticle process for the production of nanoparticle based materials.

For more information please visit:
https://techportal.eere.energy.gov/technology.do/techID=886
https://factsheets.inl.gov/FactSheets/Precision_Nanoparticles.pdf

Licensing Information
Idaho National Laboratory Information
Contact: Ryan Bills (ryan.bills@inl.gov; 208-526-1896)
License type: Exclusive or Non-Exclusive, please include description of intended field of use in proposal.
Patent Status: U.S. Patent No 8,003,070 - Methods for forming particles from single source precursors, Issued August 23, 2011.

Molecular Machine Advances

Molecular machines have received considerable attention in recent years, notably for the 2016 Nobel Prize in Chemistry and the Nano car race competition. In biological systems, molecular machines such as ribosomes, DNA polymerase, and ATP synthase are able to process molecules to build new molecules. The bacterial flagellar motor is an elegant example of an atomically precise molecular machine that is able to convert the transport of ions into motion. Molecular machines such as the actin-myosin system in human muscles operate as part of a coordinated network to effect motion at the macroscale. In similar fashion, it is the integration and coordination of molecular machines that will propel key advances in atomically precise manufacturing. Advances in molecular machine design and integration will be considered for funding. A 5-year goal could be an integrated nanosystem that would:

- transport individual feedstock molecules to a workspace (actively or passively);
- modify or chemically activate the feedstock (if required) to prepare it for an assembly operation;
- manipulate or transport the feedstock to the attachment point at a specified atomic position;
- chemically bind the feedstock to a growing structure or device at that attachment point; and
- repeat the operation a sufficient number of times to synthesize a product with no defects.

By addressing a critical pathway toward enabling new materials with an order of magnitude improvement in strength (near the theoretical limits), this research provides the platform to enable the military of the future with materials that can't be engineered today. These ultra-strong materials would similarly find application in transportation light weighting. Other high impact energy applications include atomically precise catalysts for chemical processes and atomically precise membranes for desalination (Energy-Water Nexus). This foundational technology also supports American security by enabling advanced molecular electronic computer circuits and quantum computer circuits for cryptographic applications, by advancing high sensitivity molecular sensors for chemical threat detection, and by enabling new chemical processing methods for chemical threat remediation.

Responsive proposals will identify specific technological hurdles in their approach to design, synthesize, and demonstrate an integrated system of molecular machine components, and show how the milestones and deliverables proposed for the project will overcome these hurdles. Physical realization of integrated molecular machine components is the preferred deliverable, however the Phase I proposal may experimentally demonstrate overcoming issues at the subcomponent level that eventually lead to the desired advance in integrated nanosystems. For example, designing and building a critical molecular

machine component would be responsive, if the proposal shows how this component would function as part of an integrated nanosystem for molecular assembly in a Phase II demonstration. Theoretical studies alone will not be considered responsive to this solicitation, although may be proposed in complement to experimental demonstrations.

Additional Manufacturing Activities for SBIR/STTR Awardees through Participation in AMO R&D Facilities and National Laboratory-Led Programs

The AMO collaborative R&D facilities provide opportunities for small businesses to leverage novel domestic manufacturing capabilities. There are opportunities for Federal SBIR/STTR programs to utilize supplemental or sequential Phase II awards to help build relationships between small business concerns receiving SBIR/STTR awards and the collaborative R&D facilities to promote domestic manufacturing. The R&D facilities supported by DOE and managed by the Advanced Manufacturing Office include:

- **Manufacturing Demonstration Facility**
  Work conducted by partners and users at the **Manufacturing Demonstration Facility** (MDF) provides real data that is used to reduce the technical risk associated with full commercialization of promising foundational manufacturing process and materials innovations. The MDF, focused on Additive Manufacturing and Low-cost Carbon Fiber and located at Oak Ridge National Laboratory, is organized to foster an open exchange of pre-competitive manufacturing best-practices and know-how—including design and processing tools, qualification and certification approaches, and fabrication costing methods—while still protecting a company's proprietary intellectual property. MDF staff include designers, manufacturing experts, and product evaluators to guide and train users. The MDF may also host interns and guest workers from industry, academia, and government

- **Critical Materials Hub**
  The **Critical Materials Institute** (CMI), an Energy Innovation Hub led by Ames National Laboratory and a team of research partners, is a sustained, multidisciplinary effort to develop solutions across the critical materials lifecycle as well as reduce the impact of supply chain disruptions and price fluctuations associated with these valuable resources. Critical materials, including some rare earth elements that possess unique magnetic, catalytic, and luminescent properties, are key resources needed to manufacture products for the clean energy economy. By bringing together scientists and engineers from diverse disciplines, the CMI will address challenges in critical materials, including mineral processing, manufacture, substitution, efficient use, and end-of-life recycling; integrate scientific research, engineering innovation, manufacturing and process improvements; and find a holistic solution to the materials challenges facing the nation.

- **America Makes**
  America Makes, the National Additive Manufacturing Innovation Institute, advances additive manufacturing technology and products, and serves as a nationally recognized additive manufacturing center of innovation excellence, working to transform the U.S. manufacturing sector and yield significant advancements throughout industry. America Makes is focused on helping the United States grow capabilities and strength in additive manufacturing, also known as 3D printing, by facilitating collaboration among leaders from business, academia, non-profit organizations and government agencies. Focusing on areas that include design, materials, technology, workforce and more, America Makes helps the nation’s 3D printing industry become more globally competitive.

- **Power America**

Power America will create, showcase, and deploy new power electronic capabilities, products, and processes that can impact commercial production, build workforce skills, enhance manufacturing capabilities, and foster long-term economic growth in the region and across the nation. Power electronics convert and control electrical power across the grid and in a growing array of products used by industry, consumers, the military, and utilities. Wide bandgap (WBG) semiconductors—the same materials used in LED light fixtures and many flat screen TVs—can improve energy efficiency in the next generation of power electronics while also reducing cost and system size. WBG semiconductors used in variable frequency drives (VFDs), for example, increase the efficiency of industrial motor systems and expand the range of motor applications in which these energy-efficient drives are cost-effective. Moreover, WBG-based power electronics are more compact and reliable—even as they function at higher power loads, operating temperatures, and frequencies than today's widely used, silicon-based power electronics.

- **Institute for Advanced Composites Manufacturing Innovation**
  Led by the University of Tennessee and headquartered in Knoxville, the Institute for Advanced Composites Manufacturing Innovation will work to develop new low-cost, high-speed, and efficient manufacturing and recycling process technologies that will promote widespread use of advanced fiber-reinforced polymer composites. At the new Institute, a team of organizations from leading industrial manufacturers, material suppliers, software developers, government and academia will focus on lowering the overall manufacturing costs of advanced composites by 50 percent, reducing the energy used to make composites by 75 percent, and increasing the ability to recycle composites by more than 95 percent within the next decade.

- **Rapid Advancement in Process Intensification Deployment Institute**
  The Rapid Advancement in Process Intensification Deployment (RAPID) Institute, led by the American Institute of Chemical Engineers, will focus on developing breakthrough technologies that maximize manufacturing processes at the molecular level to boost domestic energy productivity and energy efficiency by 20 percent in five years. The new Institute will leverage approaches to modular chemical process intensification — like combining multiple, complex processes such as mixing, reaction, and separation into single steps — with the goal of improving energy productivity and efficiency, cutting operating costs, and reducing waste in industries such as oil and gas, pulp and paper, and various domestic chemical manufacturers. In the chemical industry alone, these technologies have the potential to save more than $9 billion in process costs annually.

- **Reducing Embodied-energy and Decreasing Emissions Institute**
  Led by the Sustainable Manufacturing Innovation Alliance and headquartered in Rochester, NY, the Reducing Embodied-energy and Decreasing Emissions (REMADE) Institute will focus on driving down the cost of technologies needed to reuse, recycle and remanufacture materials and aims to achieve a 50 percent improvement in overall energy efficiency by 2027. Extracting raw materials like steel and aluminum for manufacturing is energy intensive as is the manufacturing process used to make products with these materials. By enabling recycling and remanufacturing technologies (the rebuilding of original products using a combination of reused or recycled parts), the Institute will dramatically reduce life-cycle energy consumption for products and improve overall manufacturing efficiencies. The focus also includes new ways for information collecting; gathering, identification and sorting of end-of-life and waste materials; separating mixed materials; removal of trace contaminants and robust and cost-effective reprocessing and disposal methods. These efficiency measures could save billions in energy costs and improve U.S. economic competitiveness through innovative new

manufacturing techniques, small business opportunities, and offer new training and jobs for American workers.

In addition to the R&D Facilities listed above, AMO and EERE provide unique opportunities for U.S. businesses to leverage the technical expertise at the national laboratories to help bring technologies to the market faster and gain a competitive advantage in the global economy. All opportunities are available to small business but some of these programs are designed specifically for small business and small business entrepreneurs. Lab-Industry activities established since 2015 include the following:

- High Performance Computing for Manufacturing (HPC4M) – enables targeted collaborations between the national laboratories and the U.S. manufacturing industry that will serve to de-risk future investments. Under the program, selected projects apply modeling, simulation and data analysis to industrial products and processes to lower production costs and shorten the time to market by optimizing device designs, predicting device performance, and reducing the number of testing cycles in product development. The industry partner identifies the manufacturing challenge to ensure there is a direct commercial impact.
- **Technologist in Residence Program** (TIR) – streamlines engagement and increases collaborative research and development between national laboratories and private-sector companies. The program partners a senior technologist from a national laboratory with an industry professional from a manufacturing company or consortium of companies to better understand and tackle important problems and discover the lab capabilities that can best solve them.
- Small Business Vouchers Program (SBV) – connects small businesses with national laboratories to overcome the technical challenges inherent in bringing innovations to market.
- Lab Embedded Entrepreneurship Program (LEEP) – provides an institutional home within the U.S. national laboratories for entrepreneurial scientists and engineers performing applied R&D with the express goal of launching a clean energy business. LEEP trains innovators to develop entrepreneurial acumen and skills, while introducing them to the ecosystem partners needed to facilitate commercial and investment opportunities. Three laboratories are currently acting as LEEP hosts, including:
    - Lawrence Berkeley National Laboratory: Cyclotron Road
    - Argonne National Laboratory: Chain Reaction Innovations
    - Oak Ridge National Laboratory: Innovation Crossroads
- Technology Commercialization Fund (TCF) – advances promising energy related technologies with commercial potential developed at the national laboratories and helps strengthen partnerships between the national laboratories and private sector companies that can deploy energy technologies to the marketplace. TCF funds will be used to match 50% non-federal funds from private sector partners.

SBIR/STTR Technical Assistance to Promote United States Manufacturing

Additional programs supported by the Department of Energy to promote domestic manufacturing includes DOE's promotion of the Manufacturing Extension Program (MEP) of the National Institute of Standards and Technology. The following paragraph is incorporated into our SBIR and STTR Funding Opportunity Announcements:

Technical Assistance for Proposal Preparation and Project Conduct – SBCs may wish to contact their local National Institute of Standards and Technology (NIST) Hollings Manufacturing Extension Partnership (MEP) for manufacturing and other business-related support services. The MEP works with small and mid-sized companies to help them create and retain jobs, increase profits, and save time and money. The nationwide network provides a variety of services, from business development assistance to innovation strategies to process improvements and the identification of commercialization opportunities. MEP is a nationwide network of locally managed extension centers with over 1,400 technical experts – located in every state. To contact an MEP center, call 301-975-5020 or visit MEP's website at www.nist.gov/mep.

The technical assistance program operated by the Department of Energy to provide commercialization assistance to SBIR/STTR awardees is currently operated by Dawnbreaker. Although Dawnbreaker provides a number of services (e.g. commercialization planning, competitor analysis) that indirectly provide support and justification for those who wish to manufacture, their services are not intended to duplicate the nationwide network of manufacturing expertise offered by MEP. Because of the flexibility offered to SBIR/STTR awardees in choosing their technical assistance provider, applicants can opt not to use the services offered by Dawnbreaker, and instead propose to use available technical assistance funding ($5000 in Phase I; $5000/year in Phase II) towards other organizations such as MEP.

Contribution of Department of Energy SBIR/STTR Awardees to Enhancement of United States Manufacturing

In summary, the SBIR/STTR program provides AMO with strategic opportunities to engage with the private sector to advance scientific discoveries and develop and commercialize manufacturing solutions. The awardees have saved Americans several million dollars in energy costs over the past two decades. These savings are projected to dramatically increase as emerging and new energy technologies are developed and commercialized. The energy savings are accompanied by parallel reductions in environmental impacts that affect human health.

Recent Manufacturing SBIR/STTR Success Story
https://science.energy.gov/~/media/sbir/pdf/Success%20Stories/Flash_Steelworks_SFP_Works_LLC_EERE_2019.pdf

Department of Homeland Security (DHS)

No special action was taken by DHS SBIR in this area.

Department of Human and Health Services (HHS)

Following are examples of projects funded in FY 2018 that illustrate the beneficial impact that the Department of Human and Health Services (HHS) SBIR/STTR programs have on U.S. manufacturing.

Examples of HHS manufacturing-related SBIR/STTR projects

Award	Project Title	SBC Name
1 R41 GM130205-01	Cell-Free Protein Synthesis (CFPS) Devices with High-Yield for Synthetic Biology	Dasfanh Biosciences LLC
1 R43 HL140748-01A1	Factor VIII (FVIII) – Specific Therapeutic Tregs and Related CGMP Manufacturing Process for Hemophilia A Patients with Inhibitors	TeraImmune LLC
1 R43 NS108905-01	Deep Learning Enhanced Seizure Monitoring from Wearable Sensors	Vigilant Medical, Inc.

Procedures and mechanisms HHS has used to date to give priority to manufacturing-related projects

HHS SBIR/STTR announcements encourage development of new technologies as well as application of existing technologies. When appropriate, plans for manufacturing and clinical evaluation of developed technologies, drugs, devices and innovative approaches should be included in the application.

a) HHS released in the ***NIH Guide for Grants and Contracts*** several funding opportunity announcements (FOA) for manufacturing-related research:

NIH Funding Opportunity Announcement (FOA):

SBIR Phase IIB Bridge Awards to Accelerate the Development of Cancer Therapeutics, Imaging Technologies, Interventional Devices, Diagnostics, and Prognostics Toward Commercialization (R44)

http://grants.nih.gov/grants/guide/rfa-files/RFA-CA-16-008.html

This solicitation includes broad topic areas for HHS that is considered relevant to manufacturing-related R&D. Additional solicitations were issued as noted below:

Announcement Number	Title
PA-18-574	PHS 2018-02 Omnibus Solicitation of the NIH, CDC, and FDA for Small Business Innovation Research Grant Applications
PA-18-591	Administrative Supplements to Existing NIH Grants and Cooperative Agreements
PA-18-837	Administrative Supplements to Promote Diversity in Research and Development Small Businesses-SBIR/STTR

b) Manufacturing-related SBIR/STTR research projects funded in FY 2018 awards (485 records) that were made in response to these solicitations and in response to the Omnibus SBIR/STTR Program Solicitations are appended to this report.

January 2018 SBIR/STTR Program Solicitations - Included within an IC's topic listings, topic areas specific to manufacturing-related areas in the PHS Omnibus Solicitation of the NIH, CDC, and FDA SBIR/STTR Grant Solicitation.

Specific actions HHS has taken toward promoting and supporting manufacturing - related research projects

HHS has focused on the following procedures and mechanisms to give priority to manufacturing-related SBIR/STTR projects.

- **Ongoing**: Outreach to raise awareness of **Executive Order 13329** to the small business research community - Ongoing as part of presentations to small business applicants across the United States.

- **Ongoing**: Promoting the manufacturing initiative through conferences, road tours, meetings, and website notices.

- **Ongoing**: Tracking and reporting success stories on the NIH SBIR/STTR Program website https://sbir.nih.gov/ that show the impact of the SBIR/STTR program on manufacturing. See *SBIR and STTR Success Stories*.

Department of Transportation (DOT)

In FY 2018, the U.S. Department of Transportation (DOT) report on Encouraging Innovation in Manufacturing, as required by Executive Order 13329 (see Section 9 of the Policy Directive) include:

FY 2018 Outreach

The U.S. DOT SBIR Program Office discussed manufacturing topics during briefings and one-on-one meetings conducted at the National SBIR conference and the Northeast Road Tour. The SBIR Program Office also informs prospective DOT awardees of the assistance available through NIST's Manufacturing Extension Partnership (MEP) Program and the USA National Innovation Marketplace. On the USDOT's SBIR website there is a question on the FAQ page entitled "How does the U.S. DOT's SBIR program encourage innovation in manufacturing?".

FY 2018 Award Selection

In FY 2018, DOT awarded seven manufacturing-related SBIR contracts:

Phase	**Project Title**	**SBC Name**
Phase I	Machine Vision System to Support Vehicle to Infrastructure (V21) Safety Applications	Intelligent Automation, Inc.
Phase I	Machine Vision System to Support Vehicle to Infrastructure (V21) Safety Applications	Connected Wise LLC
Phase II	Accurate and Rapid Measurement of Adsorption Capacity of Fly Ash in Concrete Mixtures	PhosphorTech
Phase II	Rapid Assessment of Air Void System in Fresh Concrete	Dynaflow, Inc.
Phase II	Rapid Assessment of Air Void System in Fresh Concrete	Creare LLC
Phase II	Detection of THC Use in Drivers	N2 Biomedical LLC
Phase II	Detection of THC Use in Drivers	N2 Biomedical LLC

FY 2018 Tracking and Reporting of manufacturing-related SBIR awards

USDOT asks every offeror if their proposal is manufacturing related and also asks every topic author if their topic is manufacturing related. We track these responses in our online proposal system and our award tracking system.

Environmental Protection Agency (EPA)

Environmental Protection Agency (EPA) submitted its EO 13329 Action Plan to SBA on July 1, 2004 and its first report on March 14, 2005.

Manufacturing-related research and development (R&D) encompasses improvements in existing methods or processes, or wholly new processes, machines or systems. Manufacturing innovation is fostered by research and development of technologies that are aimed at increasing the competitive capability of manufacturing concerns. Four main areas include: (1) Unit process level technologies that create or improve manufacturing processes; (2) Machine level technologies that create or improve manufacturing equipment; (3) Systems level technologies for innovation in the manufacturing enterprise; and (4) Environment or societal level technologies that improve workforce abilities and manufacturing competitiveness.

Examples of Manufacturing-related SBIR Projects

In FY 2018, EPA awarded 17 new SBIR Phase I projects and 5 new Phase II projects. Five Phase I awards and two Phase II awards were manufacturing-related awards under E.O. 13329. These awards are for unit process level technologies that create or improve manufacturing processes, machine level technologies that create or improve manufacturing equipment, systems level technologies for innovation in the manufacturing enterprise or environmental or societal level technologies that improve workforce abilities and manufacturing competitiveness.

The FY 2018 Phase I and II awards related to innovation in manufacturing were:

Contract #	Project Title	Phase	SBC Name
68HE0D18C0011	Renewable Bioplastics Production	Phase I	Altex Technologies Corporation
68HE0D18C0013	Greener Plastics with High Heat Tolerance for Additive Manufacturing	Phase I	Intelligent Optical Systems, Inc.
68HE0D18C0014	Green Process for Plastic Chrome	Phase I	Vergason
68HE0D18C0015	Feasibility of rPET Lignin-Content Polylols for Significant Reduction of Halogenated Flame Retardant in Construction Spray Foam	Phase I	Resinate Materials Group
68HE0D18C0024	formulation and testing of an entirely wood-based exterior insulation board for the high-performance building market	Phase I	GO Lab
68HERD19C0006	A green and unique thermosetting-thermoplastic polycarbonate	Phase II	Instrumental Polymer Technologies LLC
68HERD19C0005	Parameter Development for the Scaled Manufacturing of Mycelium Bound Panels for Commercial Interior Products	Phase II	Ecovative Design LLC

Procedures/Mechanisms Used to Give Priority to Manufacturing-related SBIR Projects

The EPA SBIR Program continues to make manufacturing a priority in its annual solicitations. Manufacturing is very important to the EPA's mission of protecting human health and the environment as it can impact many areas that have large environmental impact including water and energy use, toxicity, pollution, waste disposal, etc. The EPA considers all of these impacts when evaluating proposals for selection.

SBIR program solicitation includes a "Manufacturing" topic shown below:

Manufacturing

Executive Order 13329 directs the EPA to properly and effectively assist the private sector in its manufacturing innovation in order to sustain a strong manufacturing sector in the U.S. economy. These innovations often involve engineering and technical solutions that make the manufacturing operation and/or the manufactured product both more environmentally and economically sound.

Greener Plastics

Greener Plastics Executive Order 13329 directs the EPA to properly and effectively assist the private sector in its manufacturing innovation in order to sustain a strong manufacturing sector in the U.S. economy. These innovations often involve engineering and technical solutions that make the manufacturing operation and/or the manufactured product both more environmentally and economically sound.

The EPA is seeking the development and commercialization of innovative technologies that, when compared with currently available technologies, have dramatically better performance, decreased cost of production, and reduced environmental impacts in both production and use.

The production, use, recycle/reuse, and disposal of plastic materials and products pose significant environmental and human health problems. The EPA is seeking innovative greener manufacturing of plastics and greener plastic materials and products.

Topic Code 2A: Greener Manufacturing of Plastics. Develop for a specific plastic or family of plastics that has significant negative public health and environmental impacts an improved manufacturing process that (a) eliminates the use of one or more toxic chemicals in the process, (b) greatly reduces the amount of energy used to carry out the process, and/or (c) eliminates one or more toxic pollutants that currently result from the process. Comparison with the currently used manufacturing process and assessing the overall life cycle of the plastic(s) are integral to this topic.

Topic Code 2B: Greener Plastic Materials and Products. Develop for a specific plastic or family of plastics that has significant negative public health and environmental impacts alternative materials and products that (a) do not emit toxic fumes, (b) are not toxic if ingested, (c) rapidly biodegrade in soil and water, and/or (d) are easily recycled and reused. Comparison with the performance and cost of the currently-used plastic materials and products and assessing their overall life cycle are integral to this topic.

Outreach to promote Executive Order awareness

EPA's SBIR Program has emphasized manufacturing-related topics and priorities at National, regional and state SBIR conferences and webinars. Emphasis has been placed on opportunities for businesses to submit new critical manufacturing technologies that improve both the process efficiency and the environmental impact of the technology. Many of EPA's success stories have been in the area of manufacturing (including multiple Tibbetts awards) and EPA frequently publishes these success stories and other communications pieces on its SBIR website, www.epa.gov/sbir.

National Aeronautics and Space Administration (NASA)

National Aeronautics and Space Administration's (NASA) SBIR/STTR commitment to American manufacturing is demonstrated to be both ongoing and significant and is expected to continue in the future. The programs support the research and technology needs of the Agency's Mission Directorates – Science, Human Exploration and Operation, Aeronautics Research, and Space Technology. These needs include searching for novel concepts and advanced capabilities at ever improving levels of efficiency.

SBIR/STTR Manufacturing Related Project Examples

New topics in NASA's solicitation for Phase I awards in FY 2018 that have future application to NASA' s mission needs, but also call out the need for advanced manufacturing related technology (including the development and production of new materials) included:

Topic #	Topic Title
H4.01	Advanced Space Suit Portable Life Support System (PLSS)
H5.02	Hot Structure Technology for Atmospheric Entry Vehicles
H7.01	Development of Higher Strength Feedstocks for In-Space Manufacturing
H7.02	In-situ monitoring and development of in-process quality control for in-space manufacturing (ISM) applications
H7.03	Plasma Jet Printing Technology for Printable Electronics in Space
H8.01	ISS Utilization and Microgravity Research
H10.01	Advanced Propulsion Systems Ground Test Technology
S1.01	Lidar Remote Sensing Technologies
S1.02	Technologies for Active Microwave Remote Sensing
S2.02	Proximity Glare Suppression for Astronomical Coronagraphy
S2.03	Advanced Optical Systems and Fabrication/Testing/Control Technologies for EUV/Optical and IR Telescope
S2.04	X-Ray Mirror Systems Technology Coating Technology for X-Ray-UV-OIR and Free-form Optics
S4.03	Spacecraft Technology for Sample Return Missions
Z3.01	Advanced Metallic Materials and Processes Innovation
Z4.02	In-Space Sub-Modular Assembly
Z9.01	Small Launch Vehicle Technologies and Demonstrations
Z10.01	Cryogenic Fluid Management
Z10.02	Propulsion Systems for Robotic Science Missions
Z11.01	NDE Sensors
T1.01	Affordable Nano/Micro Launch Propulsion Stages
T3.03	Bio-inspired Concepts for the Development of Power Energy and Storage Technologies for Air and Space
T9.01	Lander Systems Technology
T12.01	Thin-Ply Composite Technology and Applications
T12.02	Extensible Modeling of Metallurgical Additive Manufacturing Processes
T15.01	Aircraft Design Optimization and Scaled Model Test

Examples of Phase I awards associated with these subtopics are listed below:

Contract Number	Project Title	SBC Name
80NSSC18P1961	Innovative, Rapidly Regenerable, Structured Trace-Contaminant Sorbents Fabricated Using 3D Printing	Advanced Fuel Research, Inc.
80NSSC18P1970	Nano Enhanced 4000°F CMC for Multiple Use Applications	Allcomp, Inc.
80NSSC18P1971	Polymer Derived Yttrium Silicate Ceramic Matrix Composite Hot Structure Materials for Atmospheric Entry Vehicles	Nanosonic, Inc.
80NSSC18P1972	Polymer Derived Ceramic Based Structural Thermal Protection Systems for Atmospheric Entry Vehicles	Sporian Microsystems, Inc.
80NSSC18P1973	High Temperature Oxidation Resistant Coatings Integrated with Carbon/Carbon Hot Structures	Plasma Processes LLC
80NSSC18P1974	C/C Manufacturing with MG Resin and 3D Preforms	Cornerstone Research Group, Inc.

80NSSC18P1982	Additive Manufacturing of PEEK and Fiber-Reinforced PEEK for NASA Applications and Custom Medical Devices	Actuated Medical, Inc.
80NSSC18P1983	Thermoplastic Feedstock for 3D Printed Parts with Metal-Like Strength	Intelligent Optical Systems, Inc.
80NSSC18P1984	Development of Fiber Reinforced Composite Feedstock for In-Space Manufacturing of High Strength Parts	GeoComposites LLC
80NSSC18P1985	In-Situ Monitoring of In-Space Manufacturing by Multi-Parameter Imaging	Ler Technologies, Inc.
80NSSC18P1986	Feedback Sensors for Closed Loop Additive In-Space Manufacturing	Cybernet Systems Corporation
80NSSC18P1987	Acoustical Signature Analysis for In-Situ Monitoring and Quality Control for In-Space Additive Manufacturing	MetroLaser, Inc.
80NSSC18P1988	In-Situ Monitoring and Process Control (AMARU)	Made in Space, Inc.
80NSSC18P1989	Automated In-Process Quality Control of Recycled Filament Production and FDM Printers	Cornerstone Research Group, Inc.
80NSSC18P1990	Plasma Jet Printing Technology for In-Space Manufacturing and In-Situ Resource Utilization	Space Foundry, Inc.
80NSSC18P1992	ISS Electrospray Production of Photovoltaics	Nanosonic, Inc.
80NSSC18P1993	Glass Alloy in Microgravity (GAMMA)	Made in Space, Inc.
80NSSC18P1995	Ultra-Lightweight, Ultra-Stable RoboSiC Additively Manufactured Lasercom Telescope	Goodman Technologies LLC
80NSSC18P1944	Additively Manufactured Dynamically Adjustable Venturi	Parabilis Space Technologies, Inc.
80NSSC18P1945	Additive Manufacturing of Integrated Sensor System	RC Integrated Systems LLC
80NSSC18P1946	Advanced Coating to Mitigate Hydrogen Embrittlement in High Temperature Environments	Summit Information Solutions, Inc.
80NSSC18P2003	Efficient Polishing of Metallic Substrates for Active Remote Sensing Applications	Welch Mechanical Design LLC
80NSSC18P2013	Elastic-Memory Composite Antenna Booms for SmallSats	Composite Technology Development, Inc.
80NSSC18P2057	Precision In-Space Manufacturing for Structurally-Connected Space Interferometry	Made in Space, Inc.
80NSSC18P2058	Near-Zero CTE 3D Printed RoboSiC Deployable Truss Core Structures with Active Precision Adjustment	Goodman Technologies, LLC
80NSSC18P2059	Additive Manufacturing of Silicon Carbide Mirrors	OptiPro Systems, LLC
80NSSC18P2061	Ultra-Stable ALLVAR Alloy Development for Space Telescopes	Thermal Expansion Solutions, Inc.
80NSSC18P2063	Improving Freeform Manufacturing using a Unique Deflectometry Enclosure	Optimax Systems, Inc.
80NSSC18P2088	Additively Manufactured Liquid Injection Thrust Vector Control System	Parabilis Space Technologies, Inc.
80NSSC18P2112	Refractory Additively Manufactured Affordable Launch Vehicle RCS	Valley Tech Systems, Inc.
80NSSC18P2131	Bio-inspired Cellular Material Optimization for the Design of Additively Manufactured Multi-Functional Lightweight Structures	Phoenix Analysis and Design Technologies
80NSSC18P2151	Ultrasonic Additive Manufacturing of a deep throttling methane injector.	TGV Rockets, Inc.
80NSSC18P2156	Regeneratively Cooled Ceramic Matrix Composite Nozzle Assembly for Reduced Weight	Physical Sciences, Inc.
80NSSC18P2157	Additive Manufacture of Refractory Metal Propulsion Components	Geoplasma LLC
80NSSC18P2114	Automated Fiber Placement of Thin-Ply Composite Materials for Large Aerospace Structures	NextGen Materials & Processing LLC
80NSSC18P2115	Validated Engineering Tools for Thin-Ply Composites	Opterus Research and Development, Inc.
80NSSC18P2116	Engineering and Qualification of Thin-Ply Composites	ROCCOR LLC
80NSSC18P2117	Ultra-Thin Ply formable Material from Reusable Short Carbon Fiber Composites	Composites Automation LLC
80NSSC18P2118	Multiscale Design Tool and Process Development of Thin-Ply Composites	Technical Data Analysis, Inc.
80NSSC18P2119	A Multiscale Modeling Suite for Process and Microstructure Prediction in Metal Additive Manufacturing	Sentient Science
80NSSC18P2120	Extensible Modeling to Create Knowledgebase for AM Processing of Alloy GrCop-84	Applied Optimization, Inc.
80NSSC18P2127	Aeroservoelastic Multifidelity Design of Biomimetic Aircraft (AMuBA)	Intelligent Automation, Inc.
80NSSC18P2128	Novel Aeroservoelastic Scaled Model Design, Fabrication, and Testing	M4 Engineering, Inc.

80NSSC18P2188	Fabric Reinforced Metal Matrix Composite	Touchstone Research Laboratory, Ltd.
80NSSC18P2189	In-Process Temperature Measurements for Feedback Control of Solid State Joining	Industrial Measurement Systems, Inc.
80NSSC18P2190	In-Situ Fringe Pattern Profilometry for Feed-forward Process Control	Universal Technology Corporation
80NSSC18P2191	Ultrasonic Additive Manufacturing of Amorphous Alloys	LM Group Holdings, Inc.
80NSSC18P2192	Internal/External Surface Finishing of Additively Manufactured IN-625 Components	REM Chemicals Inc. dba REM Surface Engineering
80NSSC18P2193	Low Temperature In Space Additive Manufacturing of Metals and Alloys for NASA Missions	UHV Technologies, Inc.
80NSSC18P2199	Flexible Interconnecting NodEs for In-Space Structural Assembly (FINESS)	ROCCOR, LLC
80NSSC18P2230	PermiAM: Engineered Porosity In-Situ with Fully Dense AM Structure	Masten Space Systems, Inc.
80NSSC18P2164	Additively Manufactured Propellant Tanks with Integral Propellant Acquisition Device	ASRC Federal Astronautics LLC
80NSSC18P2167	3D Printing Magnetic Circuit Components for Hall Effect Thrusters	Busek Company, Inc.
80NSSC18P2169	Packaging and Manufacturing Processes to Enable Production of Very Large Solar Sails for Next Generation Missions	Nexolve Holding Company, LLC
80NSSC18P2175	Textile Strain Measurement System	Katabasis Engineering, LLC
80NSSC18P2179	Terahertz Imaging Nondestructive Tomography (TINT)	Intellisense Systems, Inc.

Phase II awards made in FY 2018 associated with subtopics solicited for Phase I in FY 2017 include:

Contract Number	**Project Title**	**SBC Name**
80NSSC18C0057	Single-Process, Unitized, Composite Fuselage	Cornerstone Research Group, Inc.
80NSSC18C0012	Precision Eddy Current Sensor for Nondestructive Evaluation of Spacecraft Structures	Eagle Harbor Technologies, Inc.
80NSSC18C0129	Impact-Resistant, Damage-Tolerant Composites with STF Energy Absorbing Layers	STF Technologies LLC
80NSSC18C0055	Impact Resistant Composite Structures for Space Suit Applications	Composites Automation LLC
80NSSC18C0031	Novel, Functionally Graded PIP Coating System for Hot Structures	Allcomp, Inc.
80NSSC18C0091	The Vulcan Advanced Hybrid Manufacturing System	Made in Space, Inc.
80NSSC18C0168	Metal Advanced Manufacturing Bot-Assisted Assembly (MAMBA) Process	Tethers Unlimited, Inc.
80NSSC18C0147	ISS Multi-Material Fabrication Laboratory Using Ultrasonic Additive Manufacturing Technology	Ultratech Machinery
80NSSC18C0123	Simplified High-Performance Roll Out Composite Magnetometer Boom	ROCCOR LLC
80NSSC18C0140	Redundant StarShade Truss Deployment Motor/Cable Assembly	Tendeg LLC
80NSSC18C0065	Additive Manufactured Very Light Weight Diamond Turned Aspheric Mirror	Dallas Optical Systems, Inc.
80NSSC18C0077	3D Printed Silicon Carbide Scalable to Meter-Class Segments for Far-Infrared Surveyor	Goodman Technologies, LLC
80NSSC18C0066	Game-Changing Photovoltaic Flexible Blanket Solar Array Technology with Spectrolab Flexsheets	Deployable Space Systems, Inc.
80NSSC18C0173	Trussed TRAC Boom for Solar Sails	ROCCOR LLC
80NSSC18C0110	3D Manufacturing of Integrated Heat Exchangers	Polaronyx, Inc.
80NSSC18C0212	Efficient Composite Repair Methods for Launch Vehicles	Luna Innovations, Inc.
80NSSC18C0213	Design and Process Development of Thin-Ply Composites	Composites Automation LLC
80NSSC18C0180	An Additive Manufacturing Technique for the Production of Electronic Circuits	Morningbird Media Corporation
80NSSC18C0214	Integrated Computational Material Engineering Technologies for Additive Manufacturing	QuesTek Innovations LLC
80NSSC18C0151	Electromagnetic Characterization of Advanced Composites by Voxel-Based Inverse Methods	Victor Technologies LLC
80NSSC18C0084	In-Line Inspection of Additive Manufactured Parts Using Laser Ultrasonics	Intelligent Optical Systems, Inc.

80NSSC18C0132	Thermoplastic forming of Bulk Metallic Glasses for Precision Robotics Components	Supercool Metals LLC
80NSSC18C0040	Reversible Adhesion Concept for In-Space Assembly	ATSP Innovations
80NSSC18C0058	Multifunctional Self-Aligning Reversible Joint Using Space-Qualifiable Structural Fasteners	Cornerstone Research Group, Inc.
80NSSC18C0119	Weaved Distributed Plastic Optical Fiber Sensor (DIFOS) SHM system	Redondo Optics, Inc.
80NSSC18C0041	Novel Spider 3D Woven Seamless ADEPT Aero-Shell	Bally Ribbon Mills
80NSSC18C0141	MakerSat	Tethers Unlimited, Inc.
80NSSC18C0183	Additively Manufactured Bimetallic Combustion Chambers for Small Launch Vehicles	ASRC Federal Astronautics LLC

Specific actions NASA has taken toward promoting and supporting manufacturing - related research projects

In further support of manufacturing related efforts, NASA's Space Technology Mission Directorate (STMD) continues to invest in lower Technology Readiness Level (TRL) development of enhanced and novel manufacturing processes and tools. Manufacturing remains critical to all NASA missions and STMD utilizes the SBIR/STTR program as one mechanism in achieving manufacturing affordability for complex components for our missions as well as providing an avenue for small businesses to push the envelope in developing multifaceted and critical materials and manufacturing tools and processes.

By leveraging NASA's in-house capabilities, industry has the opportunity to develop and use facilities and expertise as testing grounds and pathfinders for many of NASA technological needs.

NASA's SBIR/STTR programs fulfill mandated requirements encouraging innovation in manufacturing. The annual Solicitations include the following text: This solicitation complies with Executive Order 13329 (issued February 26, 2004) directing Federal agencies that administer the SBIR and STTR programs to encourage innovation in manufacturing related research and development consistent with the objectives of each agency and to the extent permitted by law. In response to this Executive Order, NASA encourages the submission of applications that deal with some aspect of innovative manufacturing technology. If a proposal has a connection to manufacturing this should be indicated in the Part 5 (Related R/R&D) of the proposal and a brief explanation of how it is related to manufacturing should be provided.

National Science Foundation (NSF)

SBIR/STTR Manufacturing Related Project Examples

Phase	Project Title	SBC Name
Phase I	Increasing Maker Manufacturing through 3D Printing with Reclaimed Plastic & Direct Drive Pellet Extrusion	RE3D, Inc.
Phase I	A scalable high-throughput cell engineering platform	Kytopen Corp
Phase I	Simulation for structural integrity of as manufactured 3D printed parts	Teton Composites
Phase II	An additive method for manufacturing customized textile products	unspun, Inc.
Phase II	An Affordable Metal Additive Manufacturing Machine	3DEO, Inc.
Phase II	Modular Manufacturing - Democratizing Functional Materials Printing	PolySpectra, Inc.

Procedures and mechanisms NSF used to give priority to SBCs that participate in manufacturing-related projects; and Specific actions taken toward promoting and supporting manufacturing-related projects:

For more than fifteen years NSF has explicitly included manufacturing as one of its top-level solicitation topics. Subtopics in our dedicated Manufacturing topic are defined broadly, so as to create a wide range of opportunities for manufacturing-related firms to participate in the program. In addition, most of our other topic areas include projects and topics that cater to manufacturing related-firms (for example, the "cell and biologics manufacturing" subtopic in the biological technologies area, the "robotics in agile manufacturing" topic in our robotics area, and the "pharmaceutical manufacturing" topic in the biomedical area).

In these solicitations NSF has considered the ability of a project to promote American manufacturing as a key factor in making funding decisions. Maintaining of a strong American manufacturing base, and the creation of American manufacturing jobs are goals that are aligned with NSF's Broader Impacts merit review criterion. An earlier SBA analysis of NSF SBIR/STTR awards showed that ~28% of the NSF awards had a manufacturing innovation component when processing was considered along with materials development. In FY 2018, the NSF SBIR/STTR Program made 121 awards with a manufacturing focus.