

AM Challenge for Small Businesses

In conjunction with America Makes, the nation's leading and collaborative partner in additive manufacturing (AM) and 3D printing technology and the Manufacturing Extension Partnership (MEP) of the National Institute of Standards and Technology (NIST), Penn State's Center for Innovative Materials Processing through Direct Digital Deposition is sending an open invitation to Small to Medium Enterprises (SMEs) across the nation to present ideas for how Additive Manufacturing can revolutionize their business. The challenge will be focused on concepts that utilize additive manufacturing for improving a current product or developing a new product. Although the Challenge will focus on additive manufacturing of metals, applications involving polymer printing will also be considered depending upon the impact of improving or developing a product through additive manufacturing. The top five submissions will be awarded stipends and access to Penn State and America Makes' world class facilities and research personnel in order to validate, demonstrate, and showcase their ideas. Because great ideas also need support and nurturing, the MEP has also agreed to collaborate with small businesses having an interest in participating.

Additive Manufacturing:

Additive manufacturing (AM), as it pertains to metallic materials, represents a group of novel, formative, manufacturing processes by which functional components are produced directly from a digital part description. In contrast to the conventional subtractive (machining) process, metallic components or structures are manufactured in a sequential manner through a layer-wise addition of material, in the case of the directed energy deposition process, or selective consolidation of preplaced powder, such as with the powder bed fusion process. Components produced using these processes may comprise volumes of material ranging from a single cubic centimeter to upwards of a cubic meter.

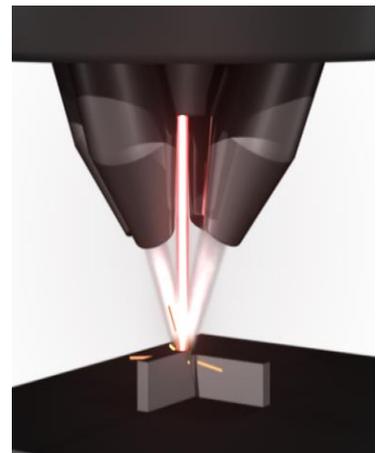


Figure 1: Artist's render of Directed Energy Deposition.

Why AM and SMEs?



Figure 2: GE LEAP Engine Nozzle produced by the powder bed fusion process (courtesy of General Electric Corporation).

Additive manufacturing can provide many significant advantages over traditional processes: design is no longer limited by traditional machining constraints, fine-tuned customization can be implemented on small production lots, and components which previously had to be constructed from multiple parts may be consolidated—just to name a few. Hence, AM is a highly flexible process that enables a company to be highly responsive to market needs at minimal cost. Because of these benefits, large companies having broad product and manufacturing sectors, such as GE, are rapidly developing and adopting AM for select components. An example is the GE LEAP Engine Nozzle, built entirely using AM with the powder bed fusion process. The LEAP nozzle, shown to the left, incorporates design feature that improves performance, significantly decreases manufacturing steps and cost, and extends the useful life of nozzle.

As a disruptive technology, AM may play an important role in expanding markets and developing new products, which should include SMEs. Over 90 percent of manufacturing firms within the United States represent small businesses, and SMEs hold more patents than large organizations. They tend to be agile and responsive to market demands, are very knowledgeable of customer requirements, and also form a strong second and third tier supply chain for larger organizations. Although these attributes make AM a natural fit for SMEs, in most instances smaller organizations lack the vast technical resources of huge companies and this can hinder implementation of new technology. Hence, the SME Challenge is intended to identify opportunities and practices that may be used to encourage adoption and exploitation of AM technology for small businesses, and to provide resources to SMEs for determining the viability of their concepts.



Figure 3: Heat Exchanger designed and built at CIMP-3D at Penn State using the powder bed fusion process and sliced to show internal structure.

The Challenge:

CIMP-3D and America Makes has partnered with the National Institute of Standards and Technology (NIST) to present the SME Challenge. With the potential of AM expanding each day, the objective of the Challenge is to elicit ideas and concepts from SMEs that could have broad ramifications to their particular industry, with the emphasis on increasing the market share of the small business through innovative additive

manufacturing technology. The SME Challenge proposal should include the regional NIST MEP as an integral member of the proposal team. The proposals will be judged by a team of evaluators appointed by CIMP-3D, America Makes, and NIST.

An initial SME Challenge proposal will be used to select concepts for consideration. The initial proposal should not contain information considered proprietary to the small business. Based on the initial proposals, several will be selected by the evaluators for submitting a full proposal. Prior to receiving the full proposal, nondisclosure agreements would be instituted with the SME organizations, so that proprietary information may be disclosed within the full proposal. Based on the full proposals, 5 concepts will be awarded a \$40,000 stipend to be used for technical support, laboratory validations, and materials for conducting manufacturing demonstrations of the concepts. The \$40,000 stipend will be primarily used to support technical assistance and demonstrations by CIMP-3D and America Makes, with limited funds being available for SME expenses. Resources of the regional MEP Center will also be available to support the SME within the scope of the project. Resources that are available to support the SMEs may include initial market analysis, design assistance for additive manufacturing, material selection, and economic analysis, as well as access to additive manufacturing systems, materials, and post processing characterization and inspection. The focus on the support activities and technical demonstration will be the validation of the concept to a level that would enable the SME to take the next step in the product innovation process.

How to Enter the SME Challenge:

The initial SME Challenge proposal must be submitted by March 27, 2016 using a suitable format (text document) submitted electronically to Dr. Richard Martukanitz of the Center for Innovative Materials Processing through Direct Digital Deposition at the Pennsylvania State University. The initial proposal should be forwarded to rxm44@arl.psu.edu with the caption "SME Challenge Submission". No proprietary information should be included in the initial proposal.

The initial proposals should clearly state the project title and objective, define the contact person at the small business (title, phone number, and email address), as well as identify the regional NIST MEP team member and the contact person at the MEP.

The initial proposal should also include one or two paragraphs discussing each of the following items.

- the SME organization proposing the concept and the market that they serve,
- the product, either being developed or improved,
- the innovative concept that is being proposed,

- a proposed project that would validate the innovative concept, and
- the ramification of the innovation on market development or increased market share.

Based on the initial proposal, several SMEs will be invited to provide a full proposal for support. In evaluating the initial SME Challenge proposal, three primary factors will be considered. These factors are listed below, along with their weighted importance for evaluation. The initial proposal will not need to address each of these categories in detail but should present enough information within the proposal to indicate the potential in each area.

Category	Ideal Project	Weight
Likelihood of success within constraints	<ul style="list-style-type: none"> • Is the project feasible given the current state of AM technology and the capabilities within CIMP-3D and America Makes? • Does the initial proposal include a clear description of the proposed project that may be accomplished within the scope of the budget? • Is the concept innovative and able to be transitioned to market? 	40%
Potential impact on business	<ul style="list-style-type: none"> • Will the project make a significant and quantifiable impact on developing a new market or increasing the market share of an existing product? • Does the proposal clearly indicate how the SME will implement the innovation? • Does the SME indicate how the partnering MEP Center will participate in the conduct of commercializing the results of the project? 	30%
History of implementation	<ul style="list-style-type: none"> • Does the SME submitting the proposal have a strong history of developing and implementing innovations? • Does the proposal provide tangible examples of the SME's prior successful implementation of innovative technologies or products? 	30%

It is anticipated that respondents selected to submit a full proposal will be contacted by April 17, 2016. The full proposal will include the initial proposal, along with a detailed plan for validation of the concept. The request will also include a nondisclosure agreement

used to define information that may be provided by the SME in the full proposal that may be considered proprietary. The full proposal will build upon the initial proposal and include a detailed plan for validating the innovative concept using the assistance, support, and laboratories of CIMP-3D and America Makes. As part of the request for the full proposal from the SME, CIMP-3D, America Makes, and Regional MEP will provide input for developing the validation plan.

Additional Information on Additive Manufacturing of Metallic Materials:

The following descriptions and videos may be used to gain greater insight into the potential opportunities for creating innovative designs and components through additive manufacturing of metals.

Directed Energy Deposition (DED) additive manufacturing processes are used to create near net shapes, typically requiring post process machining. It is applicable to a wide range of metals and alloys. The process utilizes either a moving laser beam or electron beam to consolidate feedstock, layer by layer, to form a bulk shape that may be used to produce the final component. Advantages of the DED process are its ability to easily modify the shape of the form being built, change alloys to impart improved properties and characteristics locally, and scale to larger sizes (up to 1 cubic meter or 3 cubic feet). An animation of laser-based DED can be seen by [clicking here](#) that illustrates the process. The video provided by RPM Innovations Inc. of Rapid City, SD and found by [clicking here](#) offers a good overview of the laser-based DED process. The use of DED to selectively add material to an existing shape may also be highly advantageous. An example of this application may be found at [clicking here](#), courtesy of Fraunhofer, USA. Advances in additive manufacturing has also resulted in the integration of the laser-based DED process with subtractive (machining) processing. An example of this exciting technology may be found at [clicking here](#), provided by DMG Mori.

Similar to DED, **Powder Bed Fusion (PBF)** additive manufacturing processes may also utilize either a laser beam or electron beam; however, these processes are capable of producing good surface finish and feature quality. The PBF process is referred to by many trade names, such as selective laser sintering (SLS), selective laser melting (SLM), and direct metal laser sintering (DMLS), to name a few. For the PBF processes, a thin layer of powder, between 20 and 100 μm (0.0008 inch and 0.004 inch) in thickness, is uniformly distributed, and a laser or electron beam is quickly manipulated in a predefined pattern to melt and fuse the material to produce a layer. Many layers are used to create a three-dimensional part that may possess complex internal and external features. The PBF process is normally utilized for producing components in the size range

of 280 by 280 by 280 mm (11 by 11 by 11 inches). The process enables a large degree of flexibility in design since it is not constrained by traditional metalworking processing, it allows significant customization of part geometry, and as mentioned previously, it is capable of producing complex internal channels and features. The PBF process may utilize a wide variety of metal alloys. The video found at [clicking here](#) and courtesy of Erasteel provides an animated description of the PBF process. An ideal video provided by GE may be found at [clicking here](#). This video offers a portrayal of how GE plans to use PBF to dramatically improve the performance of their next generation jet engine fuel nozzles.