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Letter of Intent to Submit a Technology Asset Grant Proposal

November 19, 2013

Project Title: Metals Manufacturing by Design

Lead Applicant: rp+m, LLC

Collaborators: The Timken Company (Timken), Case Western Reserve University (CWRU), MAGNET

Total Project Cash Costs over a three year period: \$20 million

Requested Technology Asset Grant funds: \$5 million **Total Cost Share:** \$15 million

Project Overview/Problem Statement

Ohio is home to a world-leading metals manufacturing supply chain that relies on innovation and new technology to compete in the global marketplace. Additive manufacturing (AM) has evolved past rapid prototyping of commodity polymers to where it now has the potential to revolutionize the way metal components are manufactured. The ability to print almost any designable object locally would have strong impacts across society. Development of metal AM could enable component manufacturers to provide solutions that enable finished product weight reduction, increased service performance, cost reduction, and new product capabilities.

Ohio is hanging in the balance of taking advantage of the promise of AM with metals. As we have seen with the startup of America Makes (formerly NAMII), companies in industries across the country are waking up to the potential of this technology, and America Makes is making Ohio proud by building a strong organization in Youngstown to help shepherd this new technology forward, from the heartland of manufacturing. America Makes' mission is focused on helping proliferate 3D printing technology and grow a robust community, not on developing specific niches within AM. Other states and regions across the country—such as Connecticut, Texas, and California—are building upon this national momentum behind AM technologies and running fast to grab the market space in metals additive technologies.

Some of the key problems confronting states that are trying to build an industry supply chain around metals AM include material characterization and availability, methods for improving part consistency and repeatability, models to better predict material properties such as surface finish and fatigue. A wide variety of other problems have also been identified by various customers as areas for improvement. rp+m believes that some of these challenges would greatly benefit from increased coordination with industry and academic partners with a focus on metals. Current “out



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of the box” metals equipment has yet to be fully explored to determine how best to use different metal chemistries and related processes to meet large scale manufacturing needs. To date, metals processing has been an art; to move to full-scale industrial level manufacturing, we need to drive that art to a science.

rp+m, Timken, and CWRU believe that we have a set of unique approaches and skill sets that can be combined to move Ohio to the front of the metals AM race:

- rp+m is a world-leader in AM processes creating solutions to support customers from ideation through production by mastering a wide array of technologies and understanding the capabilities and technical maturity of each. rp+m advises and assists customers by applying the right technology, engineering experts and materials. rp+m has already committed to begin tackling this effort as demonstrated by participation in America Makes and OTF grants, hiring of additional technical staff positions, acquiring additional AM machines and expanding our current manufacturing facility.
- Timken, headquartered in Canton, Ohio, is a world-leading industrial company with expertise in ferrous-based metals processing. Timken utilizes open innovation, seeding the Ohio manufacturing and higher education landscape with technology infrastructure to support its business goals. Timken recognizes that combining its metallurgical requirements and performance knowledge with rp+m’s AM experience and equipment expertise could lead to rapid advances in AM metal technology to serve Timken’s markets. That pace could be further accelerated by adding the capabilities of CWRU in the areas of metallurgy and sensor and process control to develop new material solutions and ways to optimize processing. The end result would be product development advances that would be commercialized to the economic advantage of the State of Ohio.
- CWRU has metals expertise in materials science and engineering (and characterization labs) as well as process expertise in mechanical and aerospace engineering. CWRU can provide faculty and student expertise to problems confronting the integration of assets to allow the metal industry to explode. Additionally, CWRU is developing a distinct, on-campus environment, called think[box], where hands-on education, design and development, and product commercialization can all take place. think[box] connects advanced technologies and expertise to the new economy pipeline by providing a physical space and supporting infrastructure that allows our region’s talent to turn its creativity into product ideas, and through entrepreneurial vision into new companies.

Therefore, with this foundation of expertise, this TAG project will purchase and centralize assets that can immediately be used by the two companies while working with CWRU, MAGENT and others to build a foundation of growth for Ohio’s metals supply chain.

Assets to be Acquired with Technology Asset Grant Funds



The TAG project will result in the acquisition of specialized equipment and the supporting infrastructure for the metals-based ecosystem, allowing rp+m and Timken, along with other companies specializing in metal-based products, to implement AM within unique market niches.

- **Equipment:** For industrial companies implementing AM processes, a set of equipment will be purchased, allowing quick movement toward product development. This includes a Powder Bed Fusion machine, a Binder Jetting system, a Direct Material Deposition system, and post-processing equipment such as furnaces and hot isostatic presses. A key criterion for selecting the equipment is that there are no other openly-accessible, industrially-focused resources that are supplying this mix of technologies and targeting the specific market niche of AM of structural metals for demanding applications. This will complement the attention being raised with metals at America Makes, where the Youngstown equipment is available for introductory applications and awareness, but not for full-scale industrial production and product development.
- **Supporting Infrastructure:** Purchasing and operating metals AM equipment is not a trivial matter. These assets are complex and demanding, require specialized processing conditions such as vibration isolation and HVAC. To create an effective system, these assets must be complemented by other non-additive metals finishing and characterization equipment as well as deep expertise in supporting the equipment. This infrastructure is expensive, and centralization of this equipment and access is critical to developing a successful ecosystem. As such, CWRU has agreed to provide dedicated space in its renovated think[box] Lincoln Storage building so that all of the equipment can be under one roof, with access to existing CWRU labs (i.e., materials characterization facilities) that will complete the product development scale-up of the metals pieces. A portion of the Technology Asset Grant funds will be devoted to building renovations to house these metal AM assets. Locating the assets on the CWRU campus also provides an opportunity for rp+m and Timken to collaborate with faculty and student researchers and entrepreneurs, as well as sets the foundation for both new and existing companies to engage with the equipment in the future.

Project Goals and Objectives

The goal of this specific TAG *is to establish a set of assets in which AM process specialists can interface with materials and application experts to select process and material combinations that will result in superior new products.* To meet the goal, this team will achieve the following objectives over a three-year period:

Objective 1: By the end of the grant period, partner companies and organizations on this proposal will see a significant increase in the number of products and clients engaged in metals-AM activities. More specifically:

- Timken will develop new products serving several industrial markets.
- rp+m will increase the number of metals-based clients receiving solution-support, from the current level of 10 companies to over 30 companies.



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- CWRU will engage at a minimum 10 projects per year emerging from the think[box] innovation space to consider the use of metals AM as a manufacturing technology in prototyping and scaling up their product ideas.
- MAGNET will support business development efforts in NEO to assist rp+m in reaching its targets

Objective 2: As new products are developed by companies accessing the TAG assets, this team expects to see growth of their respective Ohio supply chain companies.

Objective 3: By the end of the grant period, the result of achieving objectives (1) and (2) will be new and retained advanced manufacturing jobs in Ohio.

Technical and Commercial Approach and Work Plan

The team will begin by using its existing commercially available repertoire of metals and adjacent metals processes including welding, casting, etc. to interrogate and evaluate these new process variations to judge the capabilities as produced into components by AM. From there, the team will explore new processing or new material solutions to deliver the desired property and performance capability. To achieve this, the following steps will be taken:

- *Acquire, deploy, and support the equipment and infrastructure.* rp+m is charged with purchasing the necessary equipment (e.g., Powder Bed Fusion machine, a Binder Jetting system, a Direct Material Deposition system, and post-processing equipment) and preparing the facility for these assets in coordination with CWRU's renovation of its new think[box] building. CWRU is charged with renovating sufficient floor space of think[box] to host the TAG assets.
- *Perform structured/guided project work as guided by Timken and other private sector companies.* Timken has identified specific projects that include selecting shapes, AM building, post-processing, inspecting, as well as microstructural characterization and performance testing. As other companies engage to consider the metals AM assets, new project work will emerge.
- *Conduct Market-Focused Research and Development.* The team will implement an R&D plan that will prioritize investigative work to determine the developments in process selection, refinement or materials that are the most impactful to rapid deployments of technical successes. The value of those advancements will be judged by performance against industry standard tests and metrics.

Within think[box], rp+m will manage the equipment and will provide business development staff responsible for identifying market needs and future industrial users of the facility. Additionally, rp+m technical staff will lead, with guidance and input from Timken, the ongoing advancement (beyond this three-year project) of the technology offerings that maintains world leading capability and offerings. Timken will provide input to select the equipment and provide project work on an ongoing basis.



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CWRU will host the facility in think[box] and provide a pipeline of new companies and projects to the team. CWRU faculty and students will collaborate with rp+m and Timken technical staff on revolutionary advances that meet market needs for Timken and future industrial users of the assets, including access to existing CWRU laboratories as needed for market innovations and product development in metals AM.

The team will leverage and interface with critical local assets such as America Makes (NAMII) and MAGNET as appropriate to maintain not only the sustainability of this effort, but the sustainability and growth of the entire northeast Ohio specialty metals fabricator ecosystem. MAGNET's role in supporting this initiative will be to market the assets to small and medium sized manufacturers, and to assist them in applying the assets in the context of their business plans. MAGNET will also work with other organizations in the region to determine how the community can leverage the metals AM assets to realize maximum economic impact, especially in the areas of talent development, technology commercialization, and innovation.

Projected Impacts

The immediate implications of this project will be the utilization of the TAG assets by rp+m and Timken to select materials & shapes, build, determine post-processing needs, and inspect and testing the outcomes of specific work guided by Timken. rp+m will utilize the TAG assets to expand its expertise in material selection, production consistency and repeatability and many other AM process factors identified by its customers as hurdles to commercialization. Additionally, this project will result in new AM processes that will strengthen the future of the Ohio metals manufacturing supply chain beyond the initial two industrial partners.

In addition to the specific impacts noted above, the larger regional industrial footprint will experience growth as a result of having these assets deployed. The equipment being garnered and managed by rp+m is more than can be purchased or maintained within think[box] or Timken alone, thereby providing industry, students, faculty, and start-ups access to significant resources that will allow for new company growth and development. Furthermore, the combination of both AM and metals finishing machines under one roof (at think[box]) is a unique asset unto itself. This marriage between idea development and prototyping and the connection to industry-grade equipment and expertise is one of a kind and will contribute the formation of new companies. This will also spur additional curriculum development aligned directly with what the industry partners require to jumpstart their product lines.