



INNOVATION FORUM
SBIR / STTR PHASE I PROPOSAL WORKSHOP
MARCH 18, 2016 ~ PORT TECH LA

8:30 – 8:45	Coffee / Networking
8:45 – 8:50	Welcome & Introduction to AMP SoCal Innovation Forum Libby Williams, Project Manager, AMP SoCal
8:50 – 9:00	Welcome & Introduction to PortTech LA Stan Tomsic, CEO, PortTech LA
	Introduction to Workshop Presenter: Dr. Marie Talnack, Director of Technology Transfer California Polytechnic University, Pomona
9:00 – 9:20	SBIR Program Overview: “Understanding Your Target Audience”
9:20 – 9:45	Pre-proposal Planning, Partnering, and Research: Proposal Checklist
9:45 – 10:15	Objectives, Technical Solutions and Commercial Applications: “Matching the Topic with Your Technology”
10:15 – 11:00	The Workplan, Commercialization Plan, and the Project Team: “Putting it All Together”
11:00 – 11:15	Break
11:15 - 11:40	Budget and Subcontractors: “Building a Budget”
11:40 – 12:00	Requirements, Format, and Electronic Submission
12:00 – 12:30	Review and Questions: “Next Steps”



Sol Price School of Public Policy
Center for Economic Development

AMP SoCAL

ADVANCED MANUFACTURING PARTNERSHIP
FOR SOUTHERN CALIFORNIA

LED BY THE USC CENTER FOR ECONOMIC DEVELOPMENT



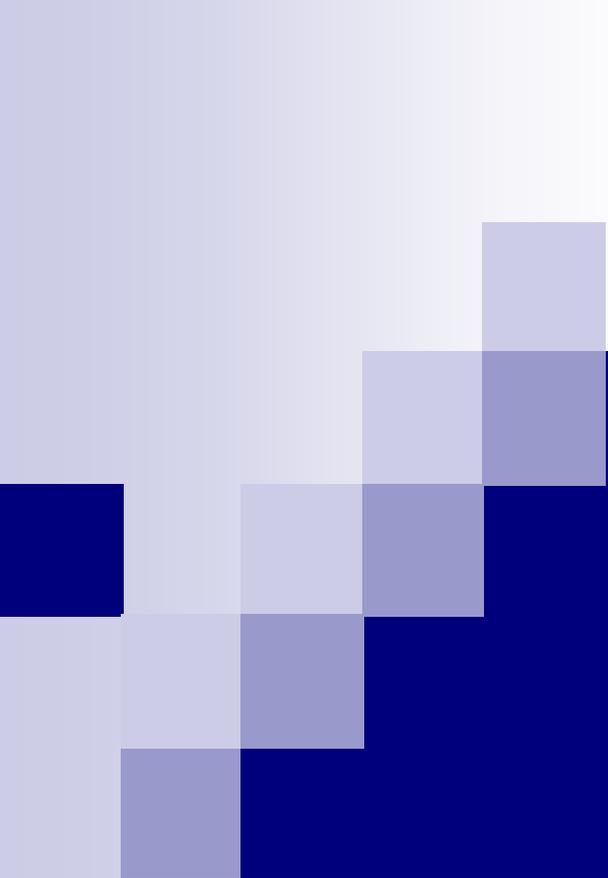
WELCOME TO THE SBIR/STTR PHASE I PROPOSAL WORKSHOP

MARCH 18, 2016



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SBIR/STTR Proposal Workshop

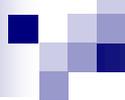
Dr. Marie Talnack

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Small Business Innovation Research

- Small Business < 500 employees
- Innovation (i.e. unique approach)
- Research-capable of conducting research
- SB is prime contractor and inventor
- 11 Participating Agencies, each with their own requirements



Small Business Technology Transfer

- University or federal research center (public-funding) is inventor
- Public research center is prime contractor
- SB is the commercialization agent
- Fewer agencies (4-5) and different requirements than SBIR



Target Audience: The Committees

- Contracts vs. Grants
- What are they looking for: their needs met
- Typical Evaluation Process
- Positioning Your Solution to their needs
- Unsolicited and Miscellaneous Topics



The Team Approach

- The Small Business
- Universities or Federal Laboratories
- Corporate Partners
- Subcontractors vs. Consultants

The Project Timeline

Submit	Award PI	Final Report	Phase II
T_0	3-6 mo.	6mo.	2 yrs.



Planning for the Proposal Submission

- Working Backwards from the Due Date
- Talking to the Agency
- Role of the Editor
- Putting Together the Team
- Pulling it altogether: the Checklist



Commercialization Discussion

- Industry Description
- Market Analysis
- Market Size, Growth, Trends
- Position in the Industry
- Proprietary Position
- Transition Plans to Next Stage



Specific Aims and the Workplan

- Defining Project Objectives
- Roles of the Team Members
- Deliverables
- Timeframe and Budgets



The Writing Process

- How to Get Started
- Format and Subsections
- The Abstract
- The First Two Pages



Building a Budget

- What do you know?
- What don't you know?
- Filling in the Gaps



The Electronic Submission Process

- Plan Ahead
- Write Separate Chapters
- Submission through [Grants.gov](https://www.grants.gov)



Next Steps

- The Tracking Number
- Committee Evaluations
- Timeframes
- Debriefing and Resubmissions



Agency Solicitation Dates: *Dates are scheduled but are subject to revision

	Release Date	Due Date	Awarded
Dept. Agriculture (1/yr.)	July/August	Sept/Oct	
Dept. of Commerce: (www.nist.gov)			
-NIST/Dept. Commerce	Feb 02, 2016	April 14, 2016	
-NIST STTR		May 6, 2016	
-NOAA (Ntl. Oceanic and Atmospheric Admin)	November	Jan 15, 2016	
Dept. of Defense: (SBIR & STTR): 3/yr.	May 23, 2016	June 22, 2016	
-Air Force, Army, DARPA			
-NAVY (usually in January Solicitation)			
-Health, Logistics, Threat Reduction, Missile Defense, Geospatial, Chemical/Biological, SpecialOps			
Dept. Education (Reg/SpED) (1/yr)	December	Jan 15, 2016	
Dept. of Energy/ARPA (1/yr.)	November	Feb 9, 2016	
Health and Human Services/NIH: (3/yr.)			
-HHS SBIR	4/19/2013	Mar 25, 2016	
-NIH, CDC, FDA,	8/5/2015	April 5, 2016	
-HHS STTR	1/23/2013	May 7, 2016	
Homeland Security (1/yr.)	December	Feb 3, 2016	
Dept. Transportation (1/yr.)	1/6/16	Mar 9, 2018	
Environmental Protection Agency	July	September	
National Aeronautics and Space Administration:			
NASA STTR 2015 Phase II Proposal Period only STTR 2015 Phase I awardees eligible to apply	May 06, 2016	Jun 17, 2016	Aug 24, 2016*
NASA SBIR 2016 Phase I Solicitation	Nov 12, 2015	Feb 01, 2016	Apr 28, 2016*
<u>NASA STTR 2016 Phase I Solicitation</u>	Nov 12, 2015	Feb 01, 2016	Apr 28, 2016*
<u>NASA SBIR 2015 Phase II Proposal Period</u> only SBIR 2015 Phase I awardees eligible to apply	Nov 05, 2015	Dec 17, 2015	Mar 15, 2016*
<u>NASA SBIR Select 2015 Phase II Proposal Period</u> only SBIR Select 2015 Phase I awardees eligible to apply	Nov 05, 2015	Dec 17, 2015	Mar 15, 2016
National Science Foundation (December & June)	May	June	



Advanced Manufacturing Related SBIR/STTR Topics

NIST: Advanced Sensing for Manufacturing Topics

9.01.01 Absolute Interferometry with Nanometer Precision

Absolute length metrology with improved repeatability and uncertainty is needed for advanced manufacturing and other applications including coordinate measuring machine/ computer numerical control (CMM/CNC) calibration and positioning [1], laser materials processing, medical materials quality assurance, gauge block calibration, and optical and UV metrology of free-form optics [2,3]. There is also a need in some metrology systems, including atomic force microscopes (AFM) [4] and scanning electron microscopes (SEM), to measure the drift in stage or probe-related components relative to the metrology loop of the instrument. Absolute interferometry can remove the ambiguity of classical interferometry without the need for continuous monitoring of a displacement. Specialize research needs can benefit from absolute distance measurement with nanometer-level accuracy. In a commercial setting, classical interferometry cannot satisfy the need for tasks such as measuring rough or high-relief surfaces, discontinuous steps, reflections from multiple interfaces, or thickness measurement; absolute interferometry potentially can overcome all of these limitations.

The goal is affordable, accurate, and rapid absolute interferometric length measurement with improved repeatability and uncertainty, for precision measurement or research applications. Desired is development of an instrument that can absolutely measure the distance between two parallel surfaces with resolution and accuracy as high as possible— better than 10 nm for measuring short lengths and better than 1 part in 10⁷ for longer lengths (ideally up to 500 mm) exclusive of uncertainties associated with air refractive index (i.e., it should be better than 1 part in 10⁷ measuring a separation in vacuum). The parallel surfaces may be pointing in the same direction but laterally separated (such as a gage block measurement) or might be facing each other but made of transparent material allowing transmission of a laser beam, as in the case of optical thickness measurement. Measurement update rates should exceed 1 kHz. For metrology of rough surfaces, such as many unpolished metals, the repeatability and uncertainty should approach the material surface roughness. Moreover, the solution should be able to achieve specification from both shiny and dull surfaces, should be able to achieve diffraction limited lateral resolution, and should be able to accommodate co-alignment with a processing beam for cases such as laser materials processing (welding, drilling, cutting).

Phase I expected results: Experimentally prove the feasibility of a non-contact length metrology system that can provide measurement repeatability and expanded uncertainty better than $10 \text{ nm} + 1 \times 10^{-7} * L$, where L is the measured length (surface separation) up to 500 mm, at >1 kHz update rates, exclusive of uncertainties associated

with air refractive index. The system should be able to also measure non-specular surfaces to within approximately the surface roughness.

Phase II expected results: Design, construct, and demonstrate a prototype of the non-contact length metrology system for which the feasibility was proven in Phase I.

9.01.02-R Design of fiber-coupled waveguide difference frequency generation devices

NIST seeks to determine the technical feasibility of fiber-coupled waveguide devices for the highly efficient ($\geq 10\%$ $W-1$) difference frequency generation (DFG) of mid-infrared laser radiation. The proposed compact photonic device would enable the deployment of optical sensors that operate in the important “molecular fingerprint” region of the electromagnetic spectrum (3000-5000 nm) thus meeting present and future demands for air-quality monitoring, gas metrology, and atmospheric monitoring. The demonstration of highly efficient fiber-coupled waveguide devices for frequency conversion, specifically at a wavelength ≈ 4500 nm, would allow the transfer of mature frequency-agile rapid scanning technology from the telecommunication bands into the mid-infrared where strong molecular transitions promise ultrasensitive detection limits. Compact mid-infrared optical sensors with frequency agility would be of great interest to various stakeholders within the U.S. gas sensors market, which is expected to increase to \$550 million by 2018 [1].

The goal of this subtopic is to determine the technical feasibility of fiber-coupled waveguide devices for highly efficient DFG of mid-infrared radiation through proof-of-concept demonstrations. The frequency conversion process performed by these proposed devices should create an output photon with frequency $f_{out} = f_1 - f_2$, where f_1 and f_2 are unique input laser frequencies in the near-infrared. Specifically, NIST seeks to determine the feasibility of a waveguide device capable of creating free-space continuous-wave (cw) radiation at an output wavelength of 4530 nm from the combined fiber-coupled input of cw lasers operating at 1572 and 1167 nm, respectively. Beyond a fiber-coupled waveguide device for DFG of coherent 4530 nm radiation, NIST has identified a long-term need for fiber-coupled waveguide devices (either narrowband or broadly tunable) that cover the entire midinfrared region from 3000-5000 nm.

Phase I expected results: Report on the feasibility and design of a proof-of-concept fiber-coupled waveguide device for DFG with $\geq 10\%$ $W-1$ conversion efficiency.

Phase II expected results: Construct prototype waveguide devices and demonstrate their highest achievable conversion efficiency at an output wavelength of 4530 nm.

NIST may be available to provide technical guidance, work collaboratively on design concepts, discuss goals, and to aid in prototype evaluation.

9.01.03 High-Accuracy Angle Generator for Precision Measurements

More accurate angle generators would allow NIST and other metrology laboratories to lower uncertainty in high-precision angle measurements. These generators would provide a needed tool for NIST and other world leading metrology laboratories to understand how surface flatness affects the measurement of angle using autocollimators, which is the defacto tool for high accuracy angle measurements at

NIST. These effects are the limiting uncertainty component in angle measurements that support R&D in critical technology intensive sectors.

X-ray studies at synchrotron light sources of the atomic structure of materials, biological molecules, etc. are currently limited by the quality of the x-ray spot focused onto the specimen. The quality of the focused spot is determined by the form accuracy of the mirrors used to focus the beam, typically a pair of elliptically-shaped mirrors used at grazing incidence. Improvements to the form accuracy of these mirrors are limited by the current abilities of metrology techniques. Specifically, improvements to the measurement of the local surface slope are needed. Metrologists at these synchrotron light sources are now using an autocollimator-based scanning technique to measure the surface profile for large (up to 1.5 m length), curved mirrors [1,2]. Effects of the curvature of the surface under test on the accuracy of the autocollimator used to measure the local surface slope need to be characterized to achieve the required tolerances of the mirrors.

Next-generation photonic devices incorporate various components whose geometry must be well characterized. NIST is currently measuring the angular attributes of these artifacts for industrial customers using autocollimators. Uncertainty components due to non-flat surface for these measurements are not well understood and published reports in this area are not exhaustive [3].

The goal is to develop precision angle generators that have accuracies that are better than what is currently commercially available. It is desired that the angle generator be able to accommodate mirrors with clear apertures between 2 mm and 35 mm that are up to 300 mm x 50 mm x 50 mm in size (i.e., approximate size of curved mirrors used at synchrotron light sources).

Phase I expected results: Experimentally prove the feasibility of fabricating an angle generator with an expanded uncertainty ($k=2$) of less than 0.01 arc-seconds over an angular range of 2.5 degrees.

Phase II expected results: Provide a prototype automated precision angle generator with a rigorously documented uncertainty budget demonstrating that the target uncertainty requirements, an expanded uncertainty ($k=2$) of less than 0.01 arc-seconds over an angular range of 2.5 degrees, are met.

9.01.04 High-Density Cryogenic Probe Station

Electrical probe stations are ubiquitous tools in the semiconductor electronics and data storage industries [1-6]. These instruments enable the probing of electrical properties of microfabricated electronics on silicon wafers or other planar substrates. This probing is used to determine whether the microfabrication was successful; if so, the silicon wafers are then cut into smaller pieces called dies that are packaged and integrated into more complex electronic assemblies. Typically, a silicon substrate contains many identical die so the electrical probes are translated over the substrate, aligned to the relevant features, placed in contact with the substrate, used for measurements, and then translated to the next die location. Probe station technology is well developed for electronics that function at room temperature. In particular, so-called probe cards allow a large number (hundreds) of temporary electrical connections to be made to a

substrate using only mechanical pressure. However, there is an unmet need for a probe station with numerous closely packed electrical probes that can operate at temperatures near 4 K.

In recent years, the need for and variety of electronics that operate at temperatures near 4 K have expanded greatly. Examples include sensors for industrial materials analysis, nuclear security, concealed weapons detection, and astrophysics. The next generation of instruments to study the cosmic microwave background, for instance, may require 10s to 100s of silicon wafers containing cryogenic circuitry. Another example is classical computing using high speed, low power superconducting elements. Still another example is quantum computing using novel circuit components also based on superconducting films. Both research and commercial activity based on cryogenic electronics are growing. In order to aid the manufacture of cryogenic electronics, NIST is soliciting proposals for the development of a probe station optimized for this emerging market area.

Cryogenic electronics must be tested at low temperatures near their planned operating temperatures. Testing after microfabrication but before dicing and integration can save manufacturers and customers the enormous expense of packaging, shipping, cooling, and attempting to use flawed electronic components.

While cryogenic probe stations are already commercially available, these units do not have performance suitable for emerging applications. For example, niobium is a crucial material in cryogenic superconducting electronics. The transition temperature of niobium is 9.2 K and devices containing niobium must be probed at temperatures well below this value in order for the tests to accurately predict device behavior. Hence, the silicon substrate being tested should be at a temperature near 4.2 K or colder. Existing cryogenic probe stations are not able to achieve temperatures this low for the large substrates (up to 150 mm in diameter) that are now used to make superconducting circuits. As the complexity of cryogenic electronics has increased, so too has the number of circuit elements that need to be probed on a single die. However, existing cryogenic probe stations have only small numbers of probes (typically less than 10) that are physically large and therefore cannot be used to contact the closely spaced features that are increasingly used in cryogenic electronics. Further, existing probes are often optimized for much higher signal bandwidth than is now needed for basic tests of circuit functionality. Finally, these probes often contact the substrate under test from a warmer temperature stage and therefore are a major heat load that makes temperatures near 4.2 K difficult or impossible to achieve.

To aid the manufacture of cryogenic electronics for sensing and computing, NIST seeks proposals for a high-density cryogenic probe station that meets the following technical goals:

- Sample cooling to 4.5 K or below. This value refers to the temperature of the substrate under test and not the temperature of the underlying metal. Use of a mechanical cryocooler is preferred but liquid or gaseous helium are also acceptable.

- Rapid cooling and warming are desirable. A cool-down time from 300 K to base temperature below 2 hours is preferred. A warm-up time from base temperature to 300 K below 1 hour is preferred.
- Compatibility with substrates up to 150 mm in diameter.
- The ability to simultaneously make 100 or more electrical contacts to a die under test. Contacts to be made using mechanical pressure only, not wirebonding or other contact schemes that mechanically alter the test substrate.
- Electrical contacts must be pre-cooled at the cold stage of the probe station before contacting the substrate under test so as to preserve a sample temperature below 4.5 K.
- Electrical contacts should be low resistance with a best-effort goal of 10 milliOhm contact resistances.
- Electrical contacts should also be high-density with a best-effort goal of center-to-center pitches as small as 150 μm . Metallic contact features on the substrate are expected to be as small as 100 μm in diameter. The mechanical pattern of the contacts can be fixed so long as it is reconfigurable via use of alternate probe cards.
- Electrical contacts to be compatible with signal bandwidths below 500 kHz.
- Mechanical provisions to move the electrical contacts over the complete substrate under test while cold in order to probe multiple identical contact patterns on the substrate.
- Optical or other provisions to align the electrical connections to the contact pattern on the substrate.
- Provisions at room temperature to perform basic electrical measurements (continuity, current-voltage curves, etc.) among any combination of the electrical contacts.

Phase I expected results: Develop a mechanical and electrical design that addresses the project goals described above.

Phase II expected results: Construct a prototype high-density cryogenic probe station that is able to achieve the project goals described above.

9.01.05 High Temperature In Situ Pressure Sensor

There is a need to measure pressure accurately. Chemical manufacturers need process sensors that are able to monitor changes in manufacturing systems. These systems need to have a low uncertainty and high sensitivity to change. Often accurate pressure measurements in the chemical manufacturing industry are necessary to keep manufacturing processes safe. Sometimes, these changes affect other parameters, such as a flow measurement, and are necessary to maintain good manufacturing processes. At NIST, the need for highly accurate pressure measurements is prominent when determining the thermophysical properties of fluids, especially because these measurements lead to the development of theoretical models for industry. NIST researchers have developed methods to achieve better-than-quoted uncertainty in today's pressure transducers through good practices, but the market is still limited. In order to meet the high standards NIST has for metrology measurements, we seek a

high temperature in situ pressure sensor that achieves better resolution than the current pressure transducers available today.

The goal of this SBIR subtopic is to develop an in situ pressure sensor for fluid systems that operate up to 200 °C and pressures up to 7 MPa. Here, “in situ” means that the sensor is either attached directly to the system being measured (e.g., attached to a standard pipe fitting) or in very close proximity to the system; in either case it would be at the same temperature as the system. The sensor shall have remarkable temperature stability, control over drift, a small wetted volume (less than 5 mL), and be manufactured from materials that are highly corrosion resistant. On the market today, there are sensors that can reach the desired temperature of 200 °C, but these sensors often have large volumes or high uncertainty. The desired pressure sensor is expected to have a small volume to allow for easy coupling to a variety of precision measurement systems at NIST [1,2] as well as being able to act as a sensor in the chemical industries.

NIST envisions at least two basic design approaches, and either would be acceptable, as would other proposed designs. In the first approach, the sensor would directly measure the pressure and transmit a signal to a control computer. In the second basic approach, the sensor would measure the difference between the pressure of the fluid system and a reference pressure. In this embodiment, the reference pressure would be that of an inert gas or a hydraulic fluid, which would then be measured by a conventional pressure sensor that would be located remotely, e.g., at ambient temperature.

NIST is interested in a system with the following performance metrics:

- The pressure sensor shall operate in thermostated conditions of –70 °C to 200 °C.
- The pressure measurement must reach equilibrium in a reasonable time (< 5 minutes).
- The uncertainty in pressure must be better or equal in pressure to current pressure transducers, i.e., 0.7 kPa or 0.01% of range. The uncertainty shall include all effects, including hysteresis with increasing or decreasing pressures, compensation for temperature over the full operating range, and drift in the zero point.
- The measurement pressure range shall be ambient up to 7 MPa. The sensor shall provide a direct pressure measurement up to 7 MPa or be able to withstand differential pressures up to 7 MPa (if a differential pressure measurement).
- Electronic signals (both raw signals and computed pressure) shall be accessible to the user through a standard interface (e.g., USB, IEEE-488, or RS-232).
- Any electronic coupling within the thermostated area (i.e., wiring, connectors) shall be temperature compatible up to 200 °C. Other components (such as read-out electronics) may operate at room temperature.
- All wetted parts of the sensor shall be fabricated of corrosion-resistant materials.
- The sensor should be able to be calibrated and maintain its calibration with minimal drift. It is desired that NIST scientists should be able to calibrate it at regular intervals.
- Drift: The sensor must meet the uncertainty specification with calibration intervals of no more than 4 months.

- Hysteresis: Any hysteresis associated with changes in temperature or pressure must fall within the overall uncertainty specification.
- The internal volume shall be less than 5 mL.
- The overall size of the sensor within the thermostated zone shall be 1 L or less. Electronics, however, may reside outside of this area.

Phase I expected results: Provide a complete design of the pressure sensor. It is expected that CAD drawings of the sensor will be produced. It is also expected that theory and calculations relevant to the sensor function will be explained and provided. The awardee shall address their expected values for each one of the metrics above and describe how they designed their sensor to meet them in their final report for Phase I.

Phase II expected results: Construct a fully-functional, tested prototype. The prototype shall be cycled over the full range of temperature and pressure at least 10 times to demonstrate the stability and performance metrics and the data from these tests shall be provided. Documentation on drift, stability and chemical stability shall also be made available. Each metric in the bulleted list above must be measured and addressed. The prototype will be made available to NIST for testing prior to the end of the SBIR Phase II award.

9.01.06 Iron Corrosion Detection Technology Using THz Waves: A field-operable Unit Based on NIST Spectroscopic Technology

Corrosion of steel cost the U.S. several \$100B per year. Early detection of this corrosion, most of which is buried under some kind of protective coating like concrete or polymers, would reduce this remediation cost and improve the safety of infrastructure and factories. Current detection methods cannot sense a particular corrosion product, only the presence of something, and especially at early stages when not much corrosion is present. NIST had a Corrosion Detection Innovative Measurement Science project from 2010-2014, in which a 0.1-1 THz wave technology based on antiferromagnetic resonance detection was successfully developed. Two of the most common iron corrosion products, hematite and goethite, are antiferromagnetic, and thus can be detected by this method: hematite through several centimeters of concrete and goethite through polymer layers. This laboratory-based technology needs to be taken to the field in order to have practical commercial use. From talking to government and industry, there is certainly a large need for this technology and apparently a large commercial market exists, too. NIST desires to see this technology commercialized, which involves some technical challenges in translating the laboratory technology into the field.

The goal of this project is to demonstrate a field-operable measurement system, using 0.1 - 1 THz waves, that identifies the presence of the iron corrosion compounds hematite and goethite under a variety of protective coverings, including concrete (hematite) and polymers (hematite and goethite). NIST has demonstrated this technology in the laboratory – the goal is to be able to move this technology into the field for application to corrosion detection problems in factories and physical infrastructure. To be able to detect specific iron corrosion products through protective barriers is an unmet need in the US.

Phase I expected results: Demonstrate the feasibility of taking the laboratory-based technology to the field, with identification of the technical problems that need to be solved and the current equipment that is available for doing so. A plan for how the field equipment would be operated and a list of sample applications is part of the Phase I expected results.

Phase II expected results: Demonstrate, in the field and on an important application, of a portable antiferromagnetic resonance –based THz system for corrosion detection of hematite and goethite. This system should be capable of being commercialized.

9.01.07 Object Identification and Localization via Non-Contact Sensing for Enhancing Robotic Systems in Manufacturing Operations

This project seeks to advance new low-cost, non-contact sensing technologies for identifying and localizing manufactured-part types of objects to improve the adaptability and ease of use of robots in manufacturing. Quantitative assessment of system performance is an essential project component.

Robots are expensive and complex. With steep learning curves and high adoption costs, small- and medium-sized enterprises (SMEs), which account for 98% of all manufacturing entities, find it difficult to justify their inclusion in everyday operations. Despite this difficulty, robot installations are expected to increase by 12% on average per year between 2015 and 2017. This sustained increase in adoption is expected to occur principally in the automotive, electronics, and materials sectors, where manufacturing applications involve structured environments with high-volume throughput and low mixtures or variations of parts. However, the International Federation of Robotics states that future product lifecycles will decrease alongside an increase in product variety. Unfortunately, the cost of automation is expected to grow exponentially in these low-volume, high-mixture part environments. Therefore, the new era of factory automation requires the adoption of a different technological paradigm where robotic systems can quickly adapt and reconfigure for high variations in parts. Many key technologies are required to unlock these desirable qualities in robotic systems including “human-like” dexterity and robust perception. This topic focuses on robust perception technology for part identification and localization [1-7]. A cornerstone of robot adaptability is perception. Like people, robots need to see and locate parts in the environment to efficiently interact with them. Using expensive tooling, current high-volume manufacturing robots operate under the assumption that parts are predictably placed, and therefore the robot does not need to perceive the object. This automation structure is counterpoint to environments with low-volume, high mixture parts, where automatic part-finding capabilities using non-contact sensing such as cameras and laser scanners become necessary. To adapt, robots need to quickly and accurately identify and locate parts in their environment so that they can make informed operational decisions.

Despite much progress, robotic object perception has yet to reach capability levels that are both robust and easy-to-use. Seamless integration necessitates a perception system capable of variable part identification and localization in six degree-of-freedom Cartesian space without the aid of reference markers or other specialized indicators in the environment. However, use of Computer Aided Design (CAD) model data is

justifiable since all parts are assumed known in a manufacturing environment. These perception systems should leverage calibration and registration techniques that are conducive to the re-configurable and re-tasking environments associated with SMEs. Moreover, the solution must be comparatively low-cost, using commercial off-the-shelf hardware to make perception solutions easily accessible for SMEs. Finally, the system should be robust to lighting conditions, surface properties, part geometries, and occlusions. Performance levels should be reported using clear and concise verification and validation metrics and methodologies. Given that these specifications can be met, robot perception would help reduce integration costs, yielding conditions for improving adoption rates by SMEs.

The goals for this project are three-fold: 1) develop a non-contact perception technology, conducive to the reconfigurable and frequently re-tasked environments associated with SMEs, that is capable of identifying and localizing a variety of part types (e.g. spheres, cuboids, prisms, cylinders, gears, fasteners, hand tools) in six degrees of freedom (leveraging part CAD data to improve system performance is acceptable), 2) benchmark the performance measurement of said technology under a formal approach such as ASTM E2919-14 “Standard Test Method for Evaluating the Performance of Systems that Measure Static, Six Degrees of Freedom (6DOF) Pose,” and 3) work with NIST in constructing new test methods to benchmark robotic system performance for smart manufacturing using the developed perception technology.

NIST is currently developing test methods and metrics for measuring robot system performance in next-generation manufacturing environments. Meeting these project goals will foster innovation in robot perception and aid in the development of performance tests by applying state-of-the-art technology to challenging, dynamic manufacturing operations.

Phase I expected results: Develop a prototypical non-contact perception technology for identifying and localizing parts with a methodical documentation of performance and conditions (e.g. ASTM E2919- 14).

Phase II expected results: Demonstrate honing perception performance, and provide the necessary tools for simplifying its integration and ease-of-use for non-expert commercial SME users. Develop task-level metrics and test methods with application to empirically convey the performance and significance of perception in SME environments. Demonstrate a hardened product ready for adoption by industry and commercialization in the marketplace.

9.01.08 Pre-Concentration Technology for Analysis of Halocarbon Gases at Trace Levels

Halocarbons are widely used in manufacturing of semiconductor and related nanoscale devices. These compounds are also greenhouse gases that can contribute significantly to warming of the atmosphere. Although emitted to the atmosphere from manufacturing processes in relatively small quantities, fluorinated halocarbon gases contribute approximately 3% of the approximately 6,670 million metric tons of greenhouse gases emitted to the atmosphere.

Effective measurement of these gases in the atmosphere is a measurement challenge due to their very low concentrations, typically in the picomole/mole or lower concentration region. In recent years there have been major advances in instrumental methods to measure the concentrations and isotopic compositions of the fluorinated gases in air and in other gaseous media by optical (e.g. cavity ring-down spectroscopy, Fourier transform infrared spectroscopy), mass-spectrometric (e.g. quadrupole, magnetic sector, time-of-flight) and other types of detection methods. Full advantage of these measurement advances can be significantly improved through sample pre-concentration prior to introduction to the measuring instrument of choice. In some cases separation from interfering compounds can also be accomplished in the pre-concentration step, significantly improving detection and quantification capabilities. Sample pre-concentration enables detection and measurement of fluorinated gases present in the atmosphere at concentration levels that are difficult to realize currently, picomole/mole and below levels, and over collection times that can facilitate the emission source identification and estimation of the quantity released.

The goal of this project for atmospheric monitoring applications is to demonstrate a fieldable prototype pre-concentration methodology for fluorinated gases used in the manufacture of advanced devices suitable for application with commercially available technologies, e.g., quadrupole mass spectrometry or similar, for 20 or more gases at the 1 picomole/mole level or below.

Phase I expected results: Demonstrate a laboratory prototype capability for at least 5 fluorinated gases having detection limits of 10 picomole/mole or below.

Phase II expected results: Demonstrate a fieldable pre-concentration prototype in an atmospheric monitoring setting using a commercially-available quadrupole mass spectrometer for 20 or more fluorinated gases at a detection limit of 1 picomole/mole or below for at least half of these trace gases sampled from the atmosphere.

NIST may be available to provide advice concerning various types of expertise available at NIST, e.g., NIST expertise in advanced refrigeration technologies likely to be used by any pre-concentration approach.

9.01.09 Quantitative Magnetometry of Single Nanoparticles with High Throughput

Magnetic nanoparticles have diverse applications in biomedical analysis and therapy, environmental remediation, and nanoscale and microscale manipulation. However, it is difficult to quantitatively measure the magnetic properties of single nanoparticles with high throughput. This measurement problem limits the ability to perform quality control in manufacturing processes for magnetic nanoparticles, which in turn limits the ability to obtain reproducible and predictable results in commercial applications of magnetic nanoparticles. Through its ongoing inter-OU Nanoparticle Manufacturing Program and recent workshop, Advancing Nanoparticle Manufacturing [1], NIST has clearly identified the need of its stakeholders for new measurement technologies to solve this problem. Because of the widespread use of magnetic nanoparticles, there is a particular need for economical technologies that are commercially available to the many manufacturers and users of magnetic nanoparticles with diverse properties. NIST in general, and the Center for Nanoscale Science and Technology in particular, is interested in enabling

innovative commercial research to close this measurement gap and fulfill its mission to support the U.S. nanotechnology enterprise from discovery to production by providing industry, academia, NIST, and other government agencies with access to nanoscale measurement and fabrication methods and technology.

The general goals of this project are to increase private sector commercialization of an innovative measurement technology, to use small business to meet federal research and development needs, and to stimulate small business innovation in technology. The specific goals of this project are to develop an innovative measurement technology that enables quantitative magnetometry of single nanoparticles with diverse properties with high throughput, and to develop a manufacturing process that enables the mass production of this measurement technology.

Nanoparticles require routine characterization for quality control to obtain reproducible and predictable results in research and development, manufacturing, commerce, and standardization. But there are no commercially available technologies to quantitatively measure functionally relevant magnetic properties of single nanoparticles, such as hysteresis loops and magnetic anisotropy, with industrially relevant throughput. Most existing instruments for magnetometry are intended for measurements of macroscopic sample volumes. Application of these instruments to nanoparticle samples requires measurement of many particles in an ensemble, complicating a quantitative interpretation of the data and obscuring the distribution of particle properties. More specialized instruments for magnetometry can resolve single nanoparticles, but the throughput of such measurements is low, limiting the rapid analysis of a large number of single particles to populate a distribution of properties. Measurement of distributions of magnetic properties is essential to characterize sample heterogeneity for quality control in nanoparticle manufacturing.

Commercial development of an innovative and economical measurement technology will benefit manufacturers and users of magnetic nanoparticles, as well as manufacturers of scientific instruments. The widespread availability of this measurement technology will enable nanoparticle manufacturers to improve quality control of magnetic nanoparticles, allowing users to obtain reproducible and predictable results using the samples and potentially implement the measurements themselves. Growth in this overall market will motivate instrument manufactures to further develop the technology to serve the market better.

Phase I expected results: Demonstrate quantitative magnetometry of nanoparticles with high throughput, as defined by the following performance metrics: measurements of coercivity with a limit of uncertainty of less than 1 mT; measurements of isotropic or anisotropic nanoparticles with at least one critical dimension of less than 100 nm; measurement of more than 100 single ferromagnetic nanoparticles in less than 100 minutes.

Phase II expected results: Demonstrate broad applicability of the measurement technology to a variety of commercially relevant magnetic nanoparticles with diverse magnetic properties. Demonstrate different forms of magnetometry including vector magnetometry. Increase the precision of the measurement technology by an order of magnitude. Increase the throughput of the measurement technology by an order of

magnitude. Develop an economical manufacturing process for the measurement technology that is suitable for production and commercial venture. NIST staff may be available to work collaboratively to develop the technology.

National Science Foundation:

Advanced Manufacturing (M)

The Advanced Manufacturing (MN) subtopic aims to support all current and emerging aspects of manufacturing innovations that have the potential to rejuvenate the nation's manufacturing sector and also improve its efficiency, competitiveness, and sustainability. Proposals should be driven by societal/market needs and opportunities, and should identify both the end users of the proposed technology and the proposed pathway to commercialization. Proposals that are responsive to strong societal needs while meeting commercial sustainability thresholds are also encouraged.

M1. Personalized Manufacturing

Proposals centered on innovative, new-to-the-world manufacturing methods and machines leading to mass customization are invited. The applications may include (but are not limited to) clothing, footwear, furniture, ear buds, headbands, hearing aids etc. The resultant products may need to be cost competitive with the relevant mass manufactured products. Technologies focused on rapid and lower cost production of personalized biomedical implants, and human assistive products that support the unique needs of individuals with disabilities are also encouraged. Proposals may include development of software-as-a-service or workflow-as-a-service tools to assist young personalized manufacturing businesses.

M2. Maker Manufacturing

Makers represent a wellspring of innovation, creating new products and eventually manufacturing them. Proposals having roots in such activities, involving innovations in one or more stages of design, engineering, and manufacturing and having significant commercialization potential are solicited. Commercially sustainable ideas that seek to address significant local, national, or global societal problems (e.g., energy/water/resource conservation, youth unemployment), or enable spreading of citizen science through such innovations are especially encouraged.

M3. Additive Manufacturing

Innovations in processes or machines that permit manufacturing through a layering process, including 3D printing, to achieve fabrication of a range of products including near net shape products. Proposals by young companies to develop sustainable businesses based on 3D printing including those in architecture, design, and construction are especially encouraged. Proposals are also encouraged that permit the manufacturing of complex multi-scale and/or multi-functional products for superior performance and productivity.

M4. Manufacturing for Emerging Markets

Transformative technological innovations that enable the manufacturing of ultra-low-cost products designed to tap into the vast commercial potential of global underserved markets. The proposals must aim to produce products that are affordable and that have significant societal impact in the intended markets such as enhancing accessibility, reducing environmental impact, improving health etc.

M5. Modeling & Simulation

Innovations in the modeling and simulation of enterprise operations, manufacturing processes for intermediate or finished products, machines and equipment, predictive modeling of tooling and machine performance and discrete event simulation of manufacturing systems. Innovative approaches that bring the benefits of cloud computing and/or big data analytics to the manufacturing sector are especially encouraged. Virtual manufacturing software products that allow designers to create a three-dimensional (3-D) model of a product and then virtually test the efficiency of its performance are also relevant. Technologies enabling real-time prediction or optimization are also encouraged.

M6. Sustainable Manufacturing Technology

Proposals may cover technologies that present new process and system design paradigms, employ internet-of-things to dynamically optimize complex industrial manufacturing processes, enhance environmental sustainability with reductions in carbon footprint and/or water usage, and promote the sourcing, use, and recycle of materials and energy streams; technologies that take a systems approach to green engineering for industrial, residential, and commercial infrastructure, industrial manufacturing infrastructure design innovations; novel tools for the real-time analysis of system performance and the dynamic global optimization of system performance; innovations in technologies for the improved efficiency, control; new technologies (involving materials, sensors, devices, and control systems) that support smart infrastructures to ensure efficient and sustainable energy transmission, distribution, monitoring, and management.

M7. Manufacturing Processes

Innovative technologies for the processing of a variety of materials, including metals, alloys, ceramics, polymers, and novel composites using processes such as casting, forming, machining, and joining. Proposals that lead to significantly improved efficiency (in terms of materials, energy, time, or money) and sustainability are encouraged. The topic also includes on-line detection and/or control of defects in those processes. Unique approaches using augmented reality for teaching and implementing manufacturing procedures are also welcome.

M8. Rare Earths and Critical Materials Processing Technology

Proposals of interest would involve production technologies enabling the development of new sources for rare earths, metals, and critical materials of strategic national importance; improving the economics of existing sources; accelerating the development

and deployment of alternatives to rare earths and critical materials currently in use; technologies and processes for more efficient use in manufacturing; recycling and reuse; new processes for critical and strategic metals and minerals extraction; novel purification processes; recycle and recovery by separation of rare earths and strategic materials from waste; novel ways to reduce the amount of critical materials currently utilized in current and emerging technology products.

M9. Transportation Technologies

Proposed projects might include (but are not limited to) the reduction of engine emissions; the reduction of greenhouse gases resulting from combustion; vehicle weight reduction; vehicle components; improved engine and fuel efficiency; reduction of SO_x, NO_x, and particulates resulting from combustion; reduction in wear and environmental pollutants. Projects may include technologies of commercial importance for low-temperature combustion, flexible fuel and fuel blends for automotive applications, improved atomizers and ignition characteristics, low heat-loss (coatings, materials, etc.) engines, on-board energy harvesting (e.g., thermoelectric generators), energy conversion and storage, improved catalyst systems, and other alternative technologies to improve fuel efficiency, reduce energy loss, and reduce environmental emissions; advanced batteries for transportation, including radically new battery systems or breakthroughs based on existing systems with a focus on high-energy density and high-power density batteries suitable for transportation applications.

M10. Manufacturing Technologies involving Chemical Transformations

New process technologies for the production of novel materials include (but not limited to) high-performance bio-materials, inorganic and composite materials, alloys, novel materials with optimized design at an atomic scale, nano- and micro-scale metallic materials, and nano-materials and metallurgical products of commercial relevance.

M11. Machines and Equipment

Innovative machines and equipment in a range of operations for making nano-, micro-, and macro-scale products in all industries, from biomedical engineering and flexible electronics, to manufacturing, mineral processing, agriculture, construction, and recycling. Innovative equipment modification or retrofitting to enable manufacturing of completely new products is encouraged.

Nanotechnology (N)

The Nanotechnology subtopic addresses the creation and manipulation of functional materials, devices, and systems with novel properties and functions that are achieved through the control of matter at a submicroscopic scale (from a fraction of nanometer to about 100 nanometers). Proposals should be driven by market needs and demand and should identify both the end users of the proposed technology and the pathway to commercialization.

N1. Nanomaterials

Proposals may include material innovations in scalable synthesis, purification, and processing techniques for hierarchical nanostructures, nanolayered structures,

nanowires, nanotubes, quantum dots, nanoparticles, nanofibers, and other nanomaterials.

N2. Nanomanufacturing

Proposals that seek to develop innovative processes, including self-assembly, nanolithography, nano-patterning, nano-texturing, nano-3D printing etc., techniques, and equipment for the low-cost, large-area or continuous manufacturing of nano-to micro-scale structures and their assembly/integration into higher order systems are encouraged.

N3. Nano-enabled Commercial Solutions to Global Problems

Proposals focusing on global problems through innovative nano-enabled process technologies are solicited. Examples of such problems include desalination of seawater to solve the emerging water crisis, solar energy collection, storage, and conversion for contributing to energy solutions for the future, and solid-state refrigeration for reducing global greenhouse emissions.

2016 Dept. of Defense topics on Advanced Manufacturing Technologies: Examples

Research in Tool Shape Optimization for Electrochemical Machining

OBJECTIVE: Electrochemical machining (ECM) is a manufacturing technology that allows metallic work piece material to be precisely dissolved into an electrolyte solution as opposed to removal by mechanical cutting and shearing. ECM is domestically employed in the production of complex and often irregularly shaped parts including advanced jet and Army helicopter engines [1] and gun barrels through 40mm caliber [2, 3]. It also has application to artillery projectiles [4] and large caliber cannon [5,6]. Of particular current interest is the potential to apply turbine cooling channel technology [7] to cannon cooling. And the machining of rifling and chambering details in new tough cannon materials including high strength steel, nickel alloys, and tantalum alloys. It may also be employed in the fabrication of warhead liners for shaped charges and explosively formed penetrators. While ECM has many advantages, it suffers a significant impediment to wider adoption for new applications. Some aspects of the process, such as chemical kinetics, remain challenging to model. Therefore, current tooling design methods employ a combination of physics based and empirical based methods to design the shape of the cathode and determine related electrolyte chemical and flow requirements. As a consequence, it is challenging and expensive to achieve first part machining accuracy and surface finish. This is a root cause of a commonly cited drawback of ECM. The challenge of tool design[4]. Pragmatically, the implication is that tool design for accuracy and surface finish may become iterative. In effect, when implementing a new tool design, the result provides empirical data to allow a more accurate second generation tool design.

DESCRIPTION: Research in the area of tool shape for first part machining accuracy is interdisciplinary. Electrochemical texts, such as the one by Newman et al [8] provide a systematic discussion of the foundational topics of thermodynamics, kinetics and reaction rates, transport, migration, diffusion, convection, and over-all cell potential. Further, shaping the tool to achieve a desired potential distribution within the gap is a "... formidable inverse boundary problem of Laplace's equation [4]." Tool shape is also affected by hydrogen bubble generation and Joule heating in-turn affecting conductivity and temperature [4]. Research proposals should comprehensively address these and other aspects of the tool shape optimization methodology. Although undesired, it is likely that some level of empirical guidance will continue to bridge gaps in science, mathematics, and numerical computing limitations. The application of empirical methods should be clearly articulated and held distinct from first principles methods. Process design methods such as advances in pulsed ECM that are less sensitive to tool shape are also of interest. However, it is important that tool design methods compatible with existing direct current and pulsed technology to facilitate realistic commercialization. Also, a key advantage of ECM is the simplicity and reliability of the cathode tool holder that often merely sinks the tool into the workpiece at a controlled feed rate. Methods that employ new degrees of freedom to the tool holder to dynamically position the tool would forfeit this key advantage and are not sought.

PERFORMANCE METRICS: 1) Geometric accuracy: how close is the geometry of a first article test to the predictions? This may be normalized by a measure of how far parametrically removed the test is to prior runs. 2) Surface finish: how close is the surface finish of a first article test to the predictions? This may be normalized by a measure of how far parametrically removed the test is to prior runs. In addition, two less quantifiable, yet important metrics of performance are: 3) User interface: how hard is it to train operators of the new technology? 4) Technology robustness: how readily may the resulting design methods be transferred from one computational language or computer architecture to another? Experimental work conducted must demonstrate due consideration of safety and regulation compliance.

PHASE I: Phase 1 will provide a study, well grounded in existing peer reviewed literature, and extended by innovative research to develop design methods to predict die sinking ECM tool shapes to accurately and precisely achieve desired first-part geometry and surface finish. Bench scale experiments with steel parts shall be conducted to demonstrate the accuracy of the methods.

PHASE II: Phase II will document and implement a tool shape design methodology extending beyond die sinking that may be computationally implemented in diverse programming languages. Contractors are encouraged to collaborate with the Army to directly apply the methods to planned armament efforts to include traveling electrode artillery rifling and machining of patent pending mortar blast flow channels [9], die sinking of integral perforated muzzle brake's [10], electrochemical turning of mortar tubes [6], and ECM die sinking of armament components.

PHASE III DUAL USE APPLICATIONS: The contractor shall license the design technology to industry and may further develop the optimization methods to more diverse ECM challenges.

Processing of Metallic Scrap Materials for Battlefield Additive Manufacturing

TECHNOLOGY AREA(S): Materials/Processes

OBJECTIVE: The objective of this program is to develop a process for producing metallic powder from battlefield scrap, reclaimed and/or recycled materials for use with 3D printing / additive manufacturing equipment. The concept of utilizing indigenous materials in-theater, at a forward operating base (FOB) could potentially reduce the huge logistics tail needed to conduct wars on foreign soil, saving valuable resources and lives. This effort can also be leveraged by private industry for recycling goods.

DESCRIPTION: One of the Army's "Next Five" S&T Challenges addresses this, by listing the problem of "Sustainability / Logistics: Transport, Distribute & Dispose [1, 2]. The Army needs to develop processes for creating strategic materials on forward operating bases and smaller satellite bases in remote, austere, dispersed locations to eliminate supplier and equipment risk [3]. Current state-of-the-art in industrial metallic powder processing for laboratory additive manufacturing equipment includes gas or plasma atomization, mechanical and chemical processes. Atomization is the method of choice based on the fact that it yields very spherical and dense particles. Spherical geometry is essential in additive manufacturing processes for two main reasons. Consistent flowability is required to ensure uniform powder layering across the build plane, and spherical particles exhibit more uniform energy absorption; weld pool formations are more consistent and repeatable. However, it is hard to envision atomization processes occurring on a FOB based on size, energy requirements for melting stock, and inert environment constraints. Mechanical methods such as milling are currently used for industrial powder production, but spherical shaped resultant powder is not a guarantee. That being said, this may be the easiest method to employ on a FOB. Chemical methods of reducing metal oxides are known to yield irregular shaped particles with high internal porosity. Hydrometallurgy techniques such as leaching and precipitation in solution can yield particles in a spherical shape but could be difficult on a FOB with the various aggressive chemicals involved. Thermal decomposition, typically of metal carbonyls, can yield spherical to angular particles but are generally on the submicron scale and a low production rate technique. Another industrial method, electrospark erosion, has shown capabilities of producing spherical particles in the range of 0.5 - 50 μ m [4]. These result from the melt and steam quenching phase of the process. Unfortunately with the process comes some degree of mechanical disintegration, as well, which results in some larger irregular shaped particles [5]. With fine tuning of the process and powder sieving, however, this technique could yield a sizeable amount of powder (production rates up to 0.5 kg/hr for

certain cases) and the particle size/morphology required for additive manufacturing techniques. A major benefit of utilizing the electrospark erosion process is that it does not require melting of the source metal, a key issue for atomization on a FOB. Electrospark erosion's metal source is addition of 3/8-3/4 inch diameter metal chunks between electrodes in a dielectric fluid. These chunks can be produced relatively easily by a scrap metal shredding step. The Army is seeking the capability of developing metallic powder on a FOB, for potential use with additive manufacturing equipment deployed to the battlefield. As such, the processing equipment must be robust enough for shipment, storage and utilization in harsh environments, fit entirely within an intermodal container (conex), and be limited to the power available on a forward operating base (approximately 180KW for a typical 500 soldier FOB [6]). This program will focus on the development of powder for selective laser melting (SLM) equipment, or any other common metallic powder additive manufacturing technique. Issues such as particle size, particle size distribution and purity will need to be taken into account. Powders need to have tight size resolutions (+/- 10µm of mean). Also of issue is the utilization of powder processed in the field, since studies have shown that flowability of "used" powders is less than that of virgin powders [7]. The offeror will also need to provide a plan for mitigating oxidation buildup on powder production, since oxygen is deleterious during additive manufacturing.

PHASE I: This phase is primarily intended for identifying a means of producing metallic powder for battlefield additive manufacturing. This proposed powder producing capability must be able to produce powder on a battlefield, and of sufficient size and quality to be utilized with common metallic powder additive manufacturing techniques.

PHASE II: This phase is primarily focused on the development of the metallic powder production equipment (hardware) and power / process control / containment / deployment strategies. The method of powder production is left up to the offeror, but the restrictions listed herein must be conformed to.

PHASE III DUAL USE APPLICATIONS: This phase is to miniaturize, package and transition the developed metallic powder production technology for battlefield usage. The developed technique should be demonstrated using similar materials to those that may be found as scrap on a forward operating base and/or battlefield. The developed process must be contained within an intermodal shipping container (conex), with power requirements commensurate with that supplied from a forward operating base, producing powder that has the purity, particle size, and particle size distribution that can be used with common metallic powder additive manufacturing techniques.

Reconfigurable Manufacturing: A New Paradigm for Improved Performance of Depot Processes

TECHNOLOGY AREA(S): Materials/Processes

OBJECTIVE: Given an existing manufacturing system/process, reconfigure its components, controls, communications, etc., to meet new operational requirements

DESCRIPTION: Manufacturing companies are facing unpredictable high-frequency market changes driven by global competition. The Air Force's Air Logistics Complexes (ALCs) are faced with similar problems where the complexity and tight integration of depot manufacturing processes (components, machines, controls, software) make them brittle and hard to modify in response to changing requirements. A new paradigm is recently emerging to augment or replace in some cases the classical flexible manufacturing technologies. Reconfigurable Manufacturing Systems (RMS) are viewed as an engineering technology that aims to address changes in manufactured products via rapid reconfiguration and improved flexibility of manufacturing systems-machines, controllers, design methods, software modules, etc. RMS provide exactly the capacity and functionality needed, exactly when needed. RMS is based on principles of modularity, scalability, integrability and diagnosability. It presupposes the availability of sensors and sensing strategies that monitor the health and performance of system components/modules, and software algorithms for the detection and prediction of incipient failure modes. The anticipated benefits include improved productivity, reduced machine downtime and rapid response to product changes. RMS technologies address manufacturing processes designed at the onset for rapid change in structure, as well as in hardware and software components, in order to quickly adjust production capacity and functionality within a part family in response to sudden changes in demand. We distinguish between two types of reconfiguration: off-line and on-line. Off-line reconfiguration aims to address manufacturing processes designed for rapid change in structure, as well as in hardware and software components, in order to quickly adjust production capacity and functionality within a part family in response to sudden changes in demand. On-line reconfiguration, on the other hand, attempts to reconfigure system hardware/software on-line under actual operating conditions to meet new operational requirements or compensate for internal/external stresses (fault or failure modes).

The conceptual design and performance assessment of a reconfigurable manufacturing system is desired initially to demonstrate potential benefits to the ALCs of these emerging technologies. A suitable testbed will be selected jointly by the contractor and ALC personnel. A modeling framework is necessary to represent the structural and functional attributes of the selected manufacturing process. The model must be capable of capturing critical dependencies between reconfigured components while assessing the viability, stability and performance of the reconfigured system. Appropriate performance metrics will be defined to assist in the design and performance assessment of the reconfigured system. Such performance metrics are used to assert that the reconfigured system is performing as desired/designed. Obviously, methods for

system verification and validation (V&V) come to mind as the most rigorous tools to achieve this objective. Other simpler performance criteria may be appropriate initially. An important consideration for our objective: How does reconfiguration of one component affect the operation of other (neighboring) components? What needs to be done in order to maintain desired system behavior? Dependency graphs, directed graphs and other similar tools may provide the desired modeling framework. Other candidate approaches may include hybrid automata, genetic algorithms, parametric models, etc. Furthermore, it is an important requirement for software reconfiguration purposes, that an open systems architecture be considered as a suitable framework.

PHASE I: Develop a modeling framework to represent in simulation the basic system components and their interconnections. Identify the impact of the reconfigured component(s) on other components and investigate if the reconfigured system meets design/desired performance criteria. Demonstrate the efficacy of the reconfiguration approach in simulation.

PHASE II: Develop a prototype system for reconfigurable manufacturing systems and demonstrate its applicability to a process to be designated by the ALC. Optimize reconfiguration strategy, test and evaluate an online version. Demonstrate the online reconfiguration approach in the presence of machine or component/software incipient failures.

PHASE III DUAL USE APPLICATIONS: Enhance prototype system for reconfigurable manufacturing systems to maximize systems' utility for military complex depot implementation. Prepare technology for further military and commercial transition.

2015 Dept. of Defense, Division of Logistics topic on Advanced Manufacturing Technologies

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. The proposals must include and will be judged, in part, on an economic analysis of the expected market impact of the technology proposed. This topic seeks a revolution in the reduction of unit cost metrics. Incremental advancements will receive very little consideration. DLA seeks herein only projects that are too risky for ordinary capital investment by the private sector. PHASE I: Determine, insofar as possible, the scientific, technical and commercial feasibility of the idea. Include a plan to demonstrate the innovative discrete-parts manufacturing process and address implementation approaches for near term insertion into the manufacture of Department of Defense (DoD) systems, subsystems, components or parts. PHASE II: Develop applicable and feasible prototype demonstrations for the approach described, and demonstrate a degree of commercial viability. Validate the feasibility of the innovative

discrete-parts manufacturing process by demonstrating its use in the production, testing and integration of items for DLA. Validation would include, but not be limited to, system simulations, operation in test-beds, or operation in a demonstration system. A partnership with a current or potential supplier to DLA is highly desirable. Identify any commercial benefit or application opportunities of the innovation. Innovative processes should be developed with the intent to readily transition to production in support of DLA and its supply chains. PHASE III: Technology transition via successful demonstration of a new process technology. This demonstration should show near-term application to one or more Department of Defense systems, subsystems or components. This demonstration should also verify the potential for enhancement of quality, reliability, performance and/or reduction of unit cost or total ownership cost of the proposed subject. Private Sector Commercial Potential: Discrete-parts manufacturing improvements have a direct applicability to all defense system technologies. Discrete-parts manufacturing technologies, processes, and systems have wide applicability to the defense industry including air, ground, sea, and weapons technologies. Competitive discrete-parts manufacturing improvements should have leverage into private sector industries as well as civilian sector relevance. Many of the technologies under this topic would be directly applicable to other DoD agencies, NASA, and any commercial manufacturing venue. Advanced technologies for discrete-parts manufacturing would directly improve production in the commercial sector resulting in reduced cost and improved productivity.



Ways to Find a Fit for Your Technology

National Science Foundation: Pre-Submission Feedback

You can communicate with Program Director Rajesh Mehta (rmehta@nsf.gov) to gauge if a project meets the program's intellectual merit and commercial impact criteria. Email a 1-2 page executive summary discussing the following aspects of the project: 1) the company and team 2) the market opportunity, value proposition, and customers 3) the technology/innovation 4) the competition. Please note that responsiveness will likely be limited in the 2 weeks leading up to the solicitation deadline.

Department of Defense: Each solicitation has a: pre-release, open and close. During the pre-release period the government is not accepting proposals, but small businesses can discuss technical questions directly with the topic authors (contact information available in each topic). Once the solicitation is open, direct questions with the topic authors are no longer allowed, but technical questions may be submitted anonymously through the SBIR Interactive Topic Information System (SITIS).

(<https://sbir.defensebusiness.org> then click SITIS tab at the top of the page)

Attend Conferences: In partnership with the National SBIR/STTR Conference, meet one-on-one with SBIR/STTR program managers and staff and learn how to access SBIR/STTR programs, build partnerships, and apply for funding for your technologies. Dozens of Federal SBIR program decision-makers will be participating in one-on-one meetings with conference attendees.

2016 National SBIR/STTR Conference

SBIR/STTR programs are the nation's largest source of early stage / high risk R&D funding for small businesses. At this conference you'll learn how to participate and compete for funding in these two programs that encourage small businesses to engage in Federal Research/Research and Development (R/R&D) and to commercialize your technological innovations.

http://nationalinnovationsummit.com/program/National_SBIR_Conference.html

WELCOME TO SITIS - INSTRUCTIONS

What is SITIS?

To facilitate greater understanding of the proposals, DoD SBIR/STTR has created the SBIR Interactive Topic Information System (SITIS), an online application that provides technical clarification on each solicitation topic. In SITIS, a questioner and respondent remain anonymous and all technical questions and answers are posted electronically for general viewing.

The SITIS Workflow

Questions posed through SITIS are directed to the appropriate Technical Point of Contact (TPOC). Questions must deal with the technical aspects of topics; any other types of questions will not be accepted. Questioner and respondent remain anonymous and all questions and answers are posted for general viewing throughout the solicitation period. Do not use this system to ask general SBIR/STTR program questions. Call the Help Desk M-F between 9:00 am - 6:00 pm ET at [1-800-348-0787](tel:1-800-348-0787) or email sbirhelp@bytecubed.com anytime if you have questions regarding proposal preparation, format, and submission. If you do not have the most recent DoD Program Solicitation, it is available online at <https://sbir.defensebusiness.org/topics>.

During the DoD SBIR/STTR solicitations pre-release period, proposers may ask technical questions about a topic by contacting the topic manager listed in the solicitation directly or by submitting questions through SITIS. Once the solicitations open to proposals, only written questions submitted through SITIS are allowed.

Key Dates

Our goal is to have answers available within seven working days of submissions. SITIS will post questions that are pending replies and will follow-up with TPOCs, if necessary. Questions posted may or may not receive individual responses, at the discretion of the responsible DoD TPOC. The success of the system is contingent on the willing participation of the TPOC. SITIS cannot guarantee that all questions will receive a reply.

SITIS will cease accepting questions two weeks prior to the solicitation close date in an effort to obtain all answers prior to solicitation closing. It is highly recommended that proposers send in queries no later than three weeks prior to solicitation closing date, and that proposers monitor the information in SITIS relative to the topic(s) to which they are submitting proposals. SITIS will maintain all topic data, including previously answered questions, throughout the solicitation period.

To Access SITIS:

<https://sbir.defensebusiness.org> then click the SITIS tab at the top of the page



CHECKLIST FOR COMPLETION OF PROPOSAL

The following is a list of items needed to complete your proposal, some of which may or may not apply to your particular project.

Need in Proposal		Item	Completed	
Y	N		Y	N
---	---	Principal Investigator Resume	---	---
---	---	Resumes-of other employees	---	---
---	---	Copy of Patent (s)	---	---
---	---	Design of Device/Schematic	---	---
---	---	Bibliography/Literature List	---	---
---	---	List of R&D Tasks/Milestone Chart	---	---
---	---	Description of R&D Tasks/Protocol	---	---
---	---	Budget Estimates of R&D Tasks	---	---
---	---	Letter from Consultant (s)	---	---
---	---	Consultant's Resume	---	---
---	---	Letter-Subcontractors, University, etc.	---	---
---	---	Subcontractor Capabilities/Equipment	---	---
---	---	C.V./Resume of Subcontractor	---	---
---	---	Letter of Interest/Investors, Partners, etc.	---	---
---	---	Testimonial Letters/Users, Customers, etc.	---	---
---	---	Market Size Estimates	---	---
---	---	Competitors/Other Technologies	---	---
---	---	Tech. Advisory Board Members	---	---



NASA’s Phase II Enhancement Program: 4 additional months for commercial applications of SBIR/STTR R&D

The objective of the Phase II-E is to further encourage the advancement of innovations developed under Phase II via an option of R/R&D efforts underway on current Phase II contracts. Eligible firms shall secure an external investor to partner with and invest in enhancing their technology for further research, infusion, and/or commercialization. Under this option, **NASA will match external investor funds with SBIR/STTR funds to extend an existing Phase II project for a minimum of 4 months to perform additional R/R&D.**

SBIR/STTR Phase II Enhancement

Applicable Period / Solicitation	Minimum Non-SBIR/STTR Funding Required	Corresponding SBIR/STTR Program Contribution	Maximum cumulative award (Phase II + Phase II-E match)	Phase II – E submission Period	Anticipated Period of Additional Performance
April 2016 - onwards	\$25,000.00	1:1 match to a maximum of \$150,000	\$900,000.00 (SBIR and STTR) \$1,650,000.00 (SBIR Select)	Starts after the 12 th month of performance and ends 60 days before contract end date	6-12 Months
2012 Solicitation	\$25,000.00	1:1 match to a maximum of \$125,000	\$875,000.00 (SBIR and STTR) \$1,625,000.00 (SBIR Select)	Starts after the 12 th month of performance and ends 60 days before contract end date	6-12 Months
2011 Solicitation	--	1:1 match to a maximum of \$250,000	\$1,000,000.00	Starts after the 12 th month of performance and ends 60 days before contract end date	6-12 Months

- **Phase II-E Guidelines** (<http://sbir.nasa.gov/content/post-phase-ii-initiatives#Phase-II-E-Guidelines>)
- **Guidance on Investors** (<http://sbir.nasa.gov/content/post-phase-ii-initiatives#Guidance-On-Investors>)
- **Application Requirements** (<http://sbir.nasa.gov/content/post-phase-ii-initiatives#Application-Requirements>)
- **Exercising Contract Option** (<http://sbir.nasa.gov/content/post-phase-ii-initiatives#Exercising-Contract-Option>)
- **Remedy Deficiencies** (<http://sbir.nasa.gov/content/post-phase-ii-initiatives#Remedy-Deficiencies>)

1.0 Phase II Enhancement Guidelines

NASA has developed the Phase II Enhancement Option (Phase II-E) to further encourage the transition of SBIR/STTR technologies into NASA acquisition programs, other Agency's programs, as well as the private sector. Under this initiative, the Program will provide an eligible Phase II small business with additional Phase II SBIR or STTR funds matching the investment funds the small business obtains from non-SBIR/non-STTR sources such as, NASA acquisition programs, other Agencies or the private sector.

1.1 General Phase II Enhancement Information

The objective of the Phase II-E is to further encourage the advancement of innovations developed under Phase II via an option of R/R&D efforts underway on current Phase II contracts. Eligible firms shall secure an external investor to partner with and invest in enhancing their technology for further research, infusion, and/or commercialization.

1.2 Matching Levels

Under this option, NASA will match external investor funds with SBIR/STTR funds to extend an existing Phase II project for a minimum of 4 months to perform additional R/R&D. The matching levels SBIR/STTR will provide will depend on matching levels offered at time of proposal; please refer to <http://sbir.nasa.gov/content/post-phase-ii-initiatives> for matching levels and other related information.

The non-SBIR or non-STTR contribution is not limited. Please refer to Definition of External Investor section for clarification of external investor.

1.3 Period of Performance

NASA expects the period of performance to be commensurate with the total NASA and external investor funding received. **A Phase II period of performance of less than 18 months will preclude the Phase II from eligibility for a Phase II-E option.**

1.4 Definition of External Investor

Investor(s) must be external to the NASA SBIR/STTR Program, which may include such entities as another company, a venture capital firm, an individual "angel" investor, a non-SBIR/non-STTR government program, or any combination of the above. An external investor cannot include the owners of the small business, their family members, and/or "affiliates" of the small business, as defined in Title 13 of the Code of Federal Regulations (C.F.R.), Section 121.103.

1.5 Government Investments

If NASA or another Government Agency is the investment-funding source, the NASA SBIR/STTR Program will initiate negotiations to exercise the Phase II-E option and will provide matching funds dollar per dollar up to the applicable matching level at time of proposal, if the Phase II-E option is exercised. Refer to <http://sbir.nasa.gov/content/post-phase-ii-initiatives> for matching levels.

For NASA to successfully exercise the Phase II-E contract option the entire intended investment funding payment from the organization should be made in full to the firm within 45 business days after receipt of notification that the Phase II-E proposal/application has been selected. The funding to the firm shall be in a funding vehicle separate from the existing NASA Phase II contract, and must be fully funded. *The NASA SBIR/STTR Program will not add your investment funding to the existing Phase II contract.*

The NASA SBIR Phase III contracting handbook and basic information have the legal statutes that pertain to award of an SBIR Phase III contract. If necessary, please provide this documentation to your procurement office. These documents are available from download from the NASA SBIR/STTR website (<http://sbir.nasa.gov>).

If you or the Agency official has further questions on how to do a Phase III contract, please contact:

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