The National Science Foundation is accepting proposals from small businesses with innovative technologies in the following areas**:**

The topics are:

- **Biological and Chemical Technologies (BC)**
- **Education Applications (EA)**
- **Electronics, Information and Communication Technologies (EI)**
- **Nanotechnology, Advanced Materials, and Manufacturing (NM)**

Scroll below and check out the sub-topics. If you believe you have a fit to the topic, please call Karen West 207-845-2934 or cpmgmt@fairpoint.net to find out how to submit a proposal and the pro bono services offered by MTI.

Biological and Chemical Technologies (BC)

SBIR Proposal Due Date: June 11th
STTR Proposal Due Date: June 13th

Primary Program Directors
Prakash G. Balan (pbalan@nsf.gov)
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Ruth Shuman (rshuman@nsf.gov)
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Environmental Technologies
Program Directors:
Dr. Prakash G. Balan, (pbalan@nsf.gov)
Dr. Rajesh Mehta, (rmehta@nsf.gov)

ET1. Energy Storage, Management and Use
Proposed projects might include new technology and approaches for direct conversion, storage, and use of renewable sources of energy for applications ranging from small scale (consumer level) to large grid scale energy applications. Projects may include new technology that leads to substantial enhancement in energy storage capacity, energy use efficiency, management and safety compared to currently available technologies.

ET2. Bioenergy and Renewable Fuels
Proposed projects might include new and novel methods to generate energy from marine, plant, algal, and microbial bio-energy sources; microbial fuel cells; hydrogen production; Innovations in high-yielding biomass crops for energy and chemicals production that do not compete with food supply.Proposed projects might involve development of new commercially viable renewable fuel options, including but are not limited to, drop-in replacements to petroleum-based transportation fuels that also reduce SOx, NOx, particulate, and/or other emissions that have a

negative environmental impact. Proposals could also involve novel process technologies to directly convert carbon dioxide to methanol (and further derived industrial chemicals) from concentrated and dilute sources of carbon dioxide.

ET3. Water, Waste Treatment and Environmental Sustainability
Projects might present novel process and product technologies for commercially attractive energy efficient pollution prevention, treatment and remediation, water treatment (drinking water and wastewater) as well as novel technologies for energy efficient recycle and reuse of water and waste streams. Technologies proposed should be significant breakthroughs or enhancements relative to the current state of the art, seeking to address current and emerging industrial/municipal and agricultural needs and resulting in a reduced carbon footprint and greenhouse gas emissions. The proposed projects could seek to develop solutions spanning a broad spectrum of operational scales including point of use, portable and fixed installations for municipal, industrial and agricultural waste, water and wastewater treatment, recycle and reuse. Projects could involve real-time sensing, monitoring and tracking technology of pollutants both currently regulated as well as newer emerging non-regulated contaminants that could have potentially broad and deleterious environmental, health and safety impact; Projects may involve technologies that focus on improving water capture, extraction, conservation, treatment and reuse in industrial, agricultural and municipal use.

ET4. Sustainable Energy Technologies
Proposed projects may include new critical devices, components, systems and materials in any of the following areas; energy harvesting and conversion from renewable resources, (including, for example, biological pathways)**;** sustainable energy storage solutions; nature -inspired processes for sustainable energy solutions and carbon storage; reducing carbon and resource intensity of hydrocarbon extraction, energy conversion and use; new technologies that support smart infrastructures (such as materials, sensors, devices and control systems) to ensure efficient and sustainable energy transmission, distribution, monitoring and management; nature-inspired processes for sustainable energy generation; portable energy generation technologies that completely rely on renewable sources to allow supporting industrial energy needs in remote off-grid and underdeveloped economic regions.

ET5. Environmental Pollution Monitoring and Mitigation
Such applications include but are not limited to methods to reduce human ecological and environmental impacts, microbial contamination sensing and control, removal of toxic compounds for human and animal safety, novel bioremediation technologies, air pollution monitoring and mitigation to remove gaseous pollutants and particulates improving environmental compatibility and sustainability; pathogen and toxin diagnostics technologies; systems and products aimed at decreasing the negative impact of humans on the environment. In addition, proposed projects might include sustainable replacements to non-biodegradable and toxic agricultural chemicals; increase the efficiency of plant nutrient assimilation; methods to reduce and eliminate the use of non biodegradable pesticides, and develop sustainable and commercially viable agricultural technologies that reduce carbon foot print and minimize environmental and ecological impact compared to the current state of the art. Proposals may also include environmentally sustainable approaches to mining and extraction of rare earths, critical

and strategic materials as well as oil and natural gas operations including but not limited to hydraulic fracturing ("fracking") technologies.

Chemical Technologies

Program Directors:
Dr. Prakash G. Balan, (pbalan@nsf.gov)
Dr. Rajesh Mehta, (rmehta@nsf.gov)

CT1. Bio-Based Chemicals and Renewable Chemical Process Technology
Novel chemical and biochemical processes built on sustainable, energy efficient, and waste minimization or waste elimination paradigms, from renewable biomass sources leading to the production of bio-based chemicals as competitive and sustainable alternatives to commercial chemicals derived from non-renewable sources; new or novel scalable green chemistry process technologies; processes that facilitate energy efficient chemical recycling and recovery for reuse from waste consumer and industrial products that would result in waste minimization, environmental pollution Â and reduced carbon footprint.

CT2. Separation Technologies
Separation technologies and materials that enable ease in phase separations, reduce or eliminate the amount of waste generated and energy required in industrial manufacturing and production processes, and promote a sustainable environment with substantial improvements in energy efficiency and separation efficiency with applications such as, but not limited to, separations for multi-component solid, liquid and gas streams, inorganic and organic chemicals, fuels, new processes for critical and strategic metals and minerals extraction, novel purification processes; recycle and recovery by separation of higher value materials from waste, air pollution mitigation to remove gaseous pollutants, particulates and pathogens; novel separation techniques and media as disruptive improvements to current established separation technologies, including but not limited to organic/inorganic membranes, porous media, Â and structured materials in applications including drinking water, wastewater treatment, food, medical and pharmaceutical applications, industrial chemicals, and microelectronics applications to name a few.

CT3. Renewable Polymers
Proposals could include technologies related to novel polymeric materials designed to replace current materials that are produced in a non-sustainable manner, have hazardous by-products and/or, are not biodegradable. Examples may involve, but are not limited to, novel polymeric materials and coatings from recycled materials, polymers, plastics, additives, sealants, elastomers, textiles and coatings from a bio-based or renewable feed stock source, bioengineered plastics and biochemically produced polymers and precursors that lead to biodegradable polymers.

CT4. Sustainable Chemical Process Technology
Chemically or biochemically (including catalytic/biocatalytic approaches) produce commodity, specialty chemicals and fine chemicals from renewable and abundant natural resources with substantially improved energy efficiency and reduced environmental impact compared to current approaches. New or novel green chemistry processes; processes that facilitate energy efficient

recycling and chemicals recovery for reuse from waste consumer and industrial products that would result in waste minimization and reduced environmental pollution. Systems with novel homogeneous and heterogeneous catalysts and biocatalysts, co-catalysts, promoters, and/or supports that are highly active, selective and long-lived compared to the state-of-the-art; sustainable catalysts that are based on environmentally friendly and non-toxic metals, non-metallics and earth-abundant elements; catalysts enabling simplification of complex multistep chemistries into fewer steps and ideally a single step, with byproduct elimination and substantial reductions in energy costs and capital equipment costs, that lead to superior process technology alternatives to existing technologies; cost effective catalytic (and bio-catalytic) technologies that lead to significant breakthrough improvements in process efficiency, productivity, energy and capital efficiency, waste minimization and environmental impact reduction in the production of commodity and specialty chemicals of current commercial importance or in emerging applications.

CT5. Novel Chemical Process Equipment and Technology
Innovative chemical process technology and equipment that lead to significant process simplification and enhanced energy efficiency leading to lower waste byproduct production and carbon footprint, systems that lead to substantially improved energy efficient interfacial transport of heat and mass enabling novel and superior technology improvements or new offerings to address a significant existing need; systems that facilitate the safe conduct of complex and hazardous chemistry through novel system designs that lead to capital efficient processes and possibly retrofittable designs into existing facilities; technology to greatly enhance process efficiency in the use of energy and raw materials compared to the current state of the art in the manufacture of industrial chemicals and materials; technologies that allow for new commercially attractive synthetic pathways that are currently uneconomical for the efficient and safer synthesis of hazardous commercially important and new emerging materials; systems that reduce complex multistep syntheses routes to significantly fewer steps resulting in process simplification, enhanced productivity, capital efficiency, safety and environmental impact; innovative industrial chemical production processes designed for zero waste generation.

CT6. Carbon dioxide and Methane to Industrial Chemicals
Proposals are solicited that seek to develop and commercialize processes for efficient carbon dioxide capture from concentrated industrial exhaust sources and pathways for its conversion to value added industrial chemicals and products resulting in net carbon sequestration on a life cycle analysis. Proposals of interest would also include those with catalytic process technologies for the conversion of methane (from natural gas, landfills, wastewater treatment etc) to industrial chemicals. Proposals of interest include those with novel catalytic process technologies to directly convert captured carbon dioxide to methanol through non syn-gas routes, as well as novel catalytic technologies to convert methane directly to methanol and hydrocarbons and value added chemicals (through non syn-gas routes). Approaches could include biochemical pathways.

CT7. Food Technology
Proposals of interest would involve the development of materials and methods and substitutes that meaningfully reduce dietary calories in processed foods; development of innovative food processing technologies, chemistry and formulations to influence energy intake to reduce and

prevent obesity; proposals could be multidisciplinary in combating the issue of obesity presenting disruptive and transformational approaches to addressing this societal need.

CT8. Rare Earths and Critical Materials Technologies
Proposals of interest would involve the development of technologies of commercial relevance enabling development of new sources for rare earths, metals and critical materials of strategic national importance; improving the economics of existing sources; accelerating material 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.

Biological Technologies

BT1. Sustainable Agricultural Biotechnology
New approaches for meeting the world's future nutritional needs. Target areas for improvement may include (but are not limited to) drought tolerance, improved nutritional value, enhanced disease resistance, and higher yield. Proposers should give consideration to technologies that enhance biodiversity, produce less carbon dioxide, and use less water and fertilizer. (Program Director: Ruth Shuman; rshuman@nsf.gov).

BT2. Biosensors
Biosensors are sensors that contain a biologically-based sensing element. Proposed projects might include but are not limited to real-time sensors, microbial component-based sensors, sensors for monitoring fluxes of metabolites, nanobiotechnology-based sensors, biomedical sensors, and micro- or nanofluidic-based sensors. Application areas of interest may include (but are not limited to) toxicity testing, food safety, drug evaluation, environmental monitoring, and bio-prospecting. Other types of sensors should refer to the EI topic.Â (Program Director: Ruth Shuman; rshuman@nsf.gov)

BT3. Life Sciences Research Tools
Developing novel technologies that will advance scientific research across the biological spectrum. This may include enabling technologies for drug discovery (high-throughput screening assays and platforms, and high-content screening assays and platforms; novel high-content screening technologies based on characterization of physical properties of cells are of high interest). Proposals should focus primarily on the development of innovative consumables, processes, and services where there is significant market opportunity. (Program Director: Ruth Shuman; rshuman@nsf.gov)

BT4. Bioinstrumentation
The development of technology for novel or improved instrumentation primarily for biological

research applications. (Program Directors: Ruth Shuman; (rshuman@nsf.gov) and Juan Figueroa; (jfiguero@nsf.gov)

BT5. Synthetic Biology and Metabolic Engineering
Using synthetic biology to engineer novel biologically-based (or inspired) functions that do not exist in nature. Proposed projects may include creating new manufacturing capability by designing microorganisms, plants, and cell-free systems for the production of novel chemicals and biomolecules. Applications may include (but is not limited to) health-care products, food ingredients, chemicals, and other biomaterials such as enzymes and bio-based polymers. (Program Director: Ruth Shuman; rshuman@nsf.gov)

BT6. Fermentation and Cell Culture Technologies
Proposed projects might include but are not limited to novel or improved microbial fermentation or mammalian and plant cell culture technologies, bioreactors, processes, scale-up, development of expression platforms, and purification. (Program Director: Ruth Shuman; rshuman@nsf.gov)

BT7. Computational Biology and Bioinformatics
Developing and applying computationally intensive techniques (e.g., pattern recognition data mining, machine learning algorithms, and visualization) and may include but are not limited to sequence alignment, gene finding, genome assembly, drug design, drug discovery, protein structure alignment, protein structure prediction, prediction of gene expression and protein-protein interactions, genome-wide association studies and the modeling of evolution. Proposed projects might include the creation and advancement of databases, algorithms, computational and statistical techniques and theory to solve problems arising from the management and analysis of biological data. (Program Director: Ruth Shuman; rshuman@nsf.gov)

Biomedical Technologies

BM1. Smart Healthcare
Proposed projects may include devices, components, systems, algorithms, networks, applications or services to enable the transformation of healthcare from indemnity-based, reactive and clinic-centered to preventive, proactive, evidence-based, person-centered and cost-efficient. Examples of projects include mobile health; telemedicine; methods and tools to evaluate the safety, effectiveness, efficiency and clinical outcomes of mobile health applications; enabling the use and the harmonization of electronic health records (EHRs) while empowering and protecting patients/consumers, citizen-centered health information technologies, novel tools for the planning, design, implementation and management of health information networks; the reduction of medical errors, operational inefficiencies and resulting adverse events; and connecting health care professionals for collaborative medicine networks. (Program Directors:Â Jesus Soriano; jsoriano@nsf.gov; and Murali Nair: mnair@nsf.gov)

BM2. Pharmaceutical Manufacturing
Proposed projects must include new processing or manufacturing devices, components and systems that will improve the efficiency, competitiveness and output of the nation's pharmaceutical manufacturing sector; that will reduce the cost, risk and time-to-market of new pre-clinical and clinical-stage drugs and biological products; or that address major market

opportunities in the developing world. Proposed projects may include transformative approaches and methods in manufacturing operations, project management, process development, process engineering, analytical development or quality control and assurance. Proposals are strongly encouraged to address the net preservation and extension of natural resources, a reduction in the use or release of toxic or harmful constituents, the use of less extreme temperatures or conditions, or a reduction in the production of waste. (Program Directors: Jesus Soriano; jsoriano@nsf.gov; and Rajesh Mehta; rmehta@nsf.gov)

BM3. Materials for Biomedical Applications
Proposed projects may include biological materials, biomimetic, bioinspired, bioenabled materials and synthetic materials, all intended for biological, medical, veterinary or healthcare applications. Examples of proposals may include, but are not limited to: the synthesis, purification, functionalization, characterization, development, validation, processing, scale up and manufacturing of biomaterials. novel polymeric materials, polymers, plastics, additives, sealants, elastomers, textiles, alloys, ceramic and composite biomaterials,, improved implants; coatings for therapeutic applications; or nanomaterials. Materials not intended for biological, medical, veterinary or healthcare applications must refer to the NM or CT topics. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM4. Diagnostic Assays and Platforms
Proposed projects should focus on transformational diagnostic technologies. Proposed projects may include but are not limited to non- or minimally-invasive disease diagnosis, detection and monitoring, software-based diagnostic methods, biomarker development, disease-specific assays, personalized medicine, flexible implantable devices and point-of-care testing for diseases. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM5. Drug Delivery
Proposed projects might include but are not limited to new platforms, chemical formulations, excipients, devices or methodology for the delivery of drugs or biological products. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM6. Tissue Engineering Regenerative Medicine
Proposed projects may include enabling engineering and manufacturing approaches, technologies and systems that will advance the research, development, quality control and production of artificial tissues and their derivatives in scientific, therapeutic or commercial applications. Proposed projects may also include novel methods or technologies to replace or regenerate damaged or diseased animal or human cells, tissues or organs to restore or establish their normal function (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM7. Biomedical Engineering
Using engineering approaches to develop transformative methods and technologies that will solve problems in medicine. Proposed projects may include devices and systems that provide new strategies for the prevention, diagnosis, and treatment of health conditions; advance end of life or palliative care; reduce drug counterfeiting; and enable new and more efficient risk-management methods to better address safety issues of drugs and medical devices; and sensors, actuators and intelligent systems for surgical robotics. Proposers are encouraged to form an

interdisciplinary team that includes relevant engineering as well as biology/health related expertise. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM8. Biomechanics
Developing novel motion or structural biomechanic technologies for the improvement of human motion. Systems that incorporate sensory inputs and computational intelligence ranging from internal and external sensors, and cognitive orthotics are strongly encouraged. Proposers are encouraged to form interdisciplinary teams that include relevant engineering, computational as well as biology/health related expertise. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

BM9. Medical Imaging Technologies
Proposed projects might include but are not limited to novel or improved imaging technologies and/or imaging agents to advance the diagnosis and treatment of disease and improve prognosis. (Program Director: Jesus Soriano; jsoriano@nsf.gov)

Education Applications (EA)
SBIR Proposal Due Date: June 11th
STTR Proposal Due Date: June 13th

Program Director:
Glenn Larsen (glarsen@nsf.gov)

Administrative Information

Internal Review Board (IRB) approval or an exemption is needed for proposals that involve human subjects; only an IRB can provide a letter of exemption if humans are involved as test subjects or are being used to validate the research. Education Application (EA) projects that are not using human subjects must address how they plan to assure customer acceptance or accuracy. Project proposals must describe their plans as applicable as to how they will obtain IRB approval, the organization that is being planned to provide it, and how long it is expected to take once NSF notifies the potential awardees that IRB documentation is needed. Know that the EA program CANNOT make a positive award recommendation without documentation (approval or exemption) from an accredited IRB when human subjects are involved.

Innovative projects are essential for favorable funding recommendations. It may be helpful to know that the EA program does not fund projects that are incremental or evolutionary with respect to technology and applications. This would include projects that primarily port existing knowledge and processes to electronic media.

Proposals must address the potential for commercialization of the innovation and how it would lead ultimately to revenue generation. It is important that the proposed technology increase the competitive capability of industry, be responsive to societal needs, and is sensitive to solving "real" problems driven by critical market requirements. There is considerable overlap between the subtopics and proposers should pay attention to the areas indicated under each subtopic to assist the program in placing these proposals on review panels.

Education Applications

The Education Application (EA) topic addresses the challenges of advancing STEM (science, technology, engineering, and mathematics) education for all American students, to nurture innovation, and to ensure the long-term economic prosperity of the Nation. The urgency of this task is underscored by the need to ensure that the United States continues to excel in science, technology, and innovation in the 21st century. Proposed applications should provide storyboards, sketches, or descriptions of how the proposed application will work and provide examples of how users would interact with the application. Projects that propose technologies or products similar to those in the marketplace must make the case that their efforts are not incremental and that they will lead to sufficient revenues that justify an NSF SBIR investment. Projects that can be easily replicated by potential competitors are not responsive to the Educational Application (EA) topic.

Proposals must address one of the subtopics that are outlined below. When submitting a proposal to the EA Topic, you must indicate the corresponding subtopic under which you are submitting the proposal, e.g., **EA1** for proposals in the area of "Pre-college Education Applications" or **EA5** for proposals in the area of "Tools for Learning". **In addition, use the code as the first item in the key words/phrases portion of the Project Summary of your proposal**.

EA Topics

- EA1 - General Education Applications
- EA2 - Global, Distance, and Cyberlearning Applications
- EA3 - STEM Educational Gaming Applications
- EA4 - Entrepreneurial Education Applications
- EA5 - Tools for Learning and Assessment

EA1 - General Education Applications

- Solutions are encouraged that address the needs of a variety of learners including K-12 students, college students, families, particular types of community members, teachers, and the general public
- Innovative applications that better enable classroom management, recordkeeping, and standards-aligned planning that permits more effective use of educational resources.
- Curricula on STEM content (science, technology, engineering, and math) that aligns with voluntary national education standards, state standards, or standards recognized by

national accreditation associations and can compete with educational programs offered for free or low cost.
- Innovative applications that provide practical solutions to combined knowledge, critical thinking, and problem solving, or the development, administration, scoring, reporting of tests, and balanced assessment across the classroom, district, state, and national levels.
- Personal learning environments that allow students to control their environment in relationship to their personal learning style to acquire knowledge with consideration of their teacher's expectations.
- Applications that better enable informal and traditional learning or applications that help bridge formal and informal learning environments or effectively promote positive behavior changes.

EA2 - Global, Distance, and Cyberlearning Education Applications

- Innovative applications are encouraged that use online learning, hybrid learning, collaborative models, and new tools which when combined, will have the potential to deliver new and powerful educational opportunities in STEM disciplines.
- Educational applications that build upon information, communication technologies, immersive interfaces, and open educational resources.
- Content-specific projects that can effectively compete with free and open content offered by universities and institutions.
- Learning environments that allow students to control and experiment with educational situations in relationship to their personal learning style to acquire knowledge anytime, anywhere.
- Collecting, analyzing, sharing, and managing data that promotes learning or leads to designed learning environments.
- Technologies that enable new forms of educational collaboration across national boundaries.Â
- Learning applications that provide for better decision making and informed judgments about problems and situations affecting global issues related to education, science, and technology.
- Projects in which technology allows the tailoring of learning experiences to special needs and interests of groups or individuals or allows expanding formal education beyond classroom settings.
- Applications that support and promote cultural diversity, awareness, and understanding.
- IMPORTANT NOTE:Â All NSF funding must be used within the United States.

EA3 - STEM and Entrepreneurial Gaming Applications

- Science, Technology, Engineering, and Mathematics (STEM) related innovative educational gaming applications that enable engaging learning experiences, digital literacy, collaboration, problem solving, communications, critical thinking, and skill improvement.
- Proposed projects that include single-player, small-groups, or massively multiplayer online gaming applications that foster cooperation and can include card, board, or digital games.

- Serious games, simulation based games, and entrepreneurial type games with substantial innovations that go beyond porting current knowledge, processes, and applications towards existing technologies and delivery platforms.
- Games that target the assessment of student knowledge while providing intrinsic motivation for student participation.

EA4 - Entrepreneurship Education Applications

- Entrepreneurship education and training should integrate diverse topics as strategic planning, business model development, opportunity recognition, product entry, intellectual property, project management, legal requirements, and business constraints in innovative ways for success in the contemporary global economy.
- Personal learning environments that allow students to control and experiment with entrepreneurial situations in relationship to their personal learning style to acquire knowledge.
- Applications that transcend simple porting of existing knowledge using current delivery platforms such as seminars, lectures, and individual consulting that are considered non-responsive to this subtopic.
- Games that better enable entrepreneurs to effectively compete in a global economy.

EA5 - Tools for Learning and Assessment

- Tools and kits that empower students to become scientists, engineers, and educators; tools that allow them to design and build things, and increase participation or demonstration in hands-on learning related to science, technology, engineering, math, and entrepreneurship of technical products and services.
- Adaptive learning environments combined with assessments.
- Learning analytics that improve the understanding of teaching and learning to improve student performance.
- Tools that build real-time information from data-mining on complexity, diversity, and similar types of information to generate knowledge that can be used to revise curricula, teaching, and assessment such as in learning analytics.
- Gesture-based computing applications that enable collaborative work with multiple students interacting on content simultaneously.
- Education tools that benefit from objects having their own IP address or location based services for new types of communications, assistive technologies, and new applications of benefit primarily to education.

Electronics, Information and Communication Technologies (EI)

SBIR Proposal Due Date: June 11th
STTR Proposal Due Date: June 13th

Primary Program Directors:
Juan Figueroa (jfiguero@nsf.gov)
Murali Nair (mnair@nsf.gov)

Electronics, Information and Communication Technology (EI) Topic

The National Science Foundation (NSF) Small Business Innovation Research (SBIR) program seeks innovative state-of-the-art, high-risk, high-potential research proposals in wireless, electrical, photonic, microelectronic, nano-electronic, and information technologies. Applications of these technologies can range widely in photonics, sensing systems, electro-optics, telecommunications, computation, integrated circuit design, quantum information processing, scientific and industrial instrumentation, robotics and control systems, advanced electronic materials, magnetics, micro- and nano-electro-mechanical systems, energy and power management, micro- and nano-electronics manufacturing, and information sciences. The EI topic is grouped under nine **(9)** alphabetically designated subtopics. You must select a subtopic appropriate for the proposed research and enter its letter and number designation (e.g. A.3) in the subtopic box on the proposal cover page. Innovative EI proposal areas that are not suggested explicitly in the subtopics below may still be of interest if they fall generally within one of the subtopics.

NOTES:
1. Proposals that focus on topics such as software coding, protocols, computing architectures, etc. and if the final product is a software package or licensable software IP, should be submitted under sub-topic I.
2. Proposals that address processes associated with the manufacture of non-electronic materials, components, or systems should be submitted under the Advanced Materials (AM) topic.

Sensors

Recent technological advancements in materials science and bioengineered systems have made inexpensive, powerful, and ubiquitous sensing a reality. Examples range from truly smart airframes and self-evaluating buildings and infrastructure for natural hazard mitigation to large-scale weather forecasting, self-organizing energy systems and smart devices that self-assemble into networks leading to the first electronic nervous system that connects the Internet back to the physical world. New detection technologies that overcome barriers of time, scale, materials and environment, and emphasize self-calibration, selectivity and sensitivity are solicited. Items of interest include but are not limited to the following subtopics. (Program Director: Murali Nair; mnair@nsf.gov)

A.1 Environmental sensing
A.2 Electrical/magnetic/optical/physical sensors
A.3 Acoustic emission monitoring
A.4 Body-area sensors/actuators for real-time, closed-loop health monitoring
A.5 Wireless sensors and wireless detection of sensor I/O
A.6 Sensors for smart transportation and infrastructure
A.7 Micro-power wireless/ autonomous sensing and networking
A.8 Actuators to enhance sensor performance
A.9 Sensors for life sciences, medical applications and systems

A.10 Gas phase and liquid phase sensing
A.11 Integrating performance standards for calibration (e.g. resistance, time, voltage)
A.12 Process control
A.13 Non-Destructive Testing and Evaluation systems
A.14 Remote sensing and search technologies

Wireless Technologies
Wireless will become massive in its pervasiveness, and impact virtually every aspect of life evolving well beyond mobile phones and PDAs to other devices, services, channels and content. Microwave circuits afford more frequency spectrum and very short antennas. With GaAs and SiGe, entire microwave transceivers can be inexpensively put on a single chip. New modulation methods, like spread-spectrum and orthogonal frequency-division multiplexing, bring greater spectral efficiency and more bits/Hz of bandwidth, and lead to less susceptibility to noise, interference, and multi-path distortion. On-chip DSPs allow new signal-processing functions. New RFID chips are revolutionizing warehousing, materials handling, and shipping operations, replacing bar-code labels in many areas. Proposals that involve next generation wireless communication technologies requiring systems with high data rates, low cost, and that support a wide variety of applications and services, while maintaining full mobility, minimum latency, and long battery life, but not limited to the following areas are sought. (Program Director: Juan Figueroa; jfiguero@nsf.gov)

B.1 Medical device applications
B.2 Wireless surveillance
B.3 RFID
B.4 Wireless sensor networks
B.5 Personal area networks
B.6 Bandwidth efficient techniques
B.7 UWB systems
B.8 SDR architecture and hardware
B.9 Smart antenna systems
B.10 RF component and device design
B.11 Spectral efficiency
B.12 Reconfigurable wireless platforms
B.13 Security of wireless systems
B.14 Legacy: Backwards and forwards interoperability and compatibility
B.15 Special-purpose wireless systems
B.16 Wireless system tests, measurements, and validation
B.17 Economic models for spectrum resource sharing

Electronic and Optoelectronic Devices
The Electronic and Optoelectronic Devices subtopic addresses the device building blocks for micro- and nano-electronics, photonics, magnetic and optoelectronics and electro-mechanics.Â The program encourages cooperation with the semiconductor and photonics industries to address current industry challenges as well as new frontiers.Â Areas include the following subtopics. (Program Director: Steven Konsek; skonsek@nsf.gov)

C.1 Electronic Devices

- Bioelectronics and biomagnetics
- Quantum devices
- Magnetic, multiferrous and spintronics
- Sensor devices and materials
- Memory devices
- Power electronics
- Flexible electronics
- Nanoelectronic devices
- Other electronic devices

C.2 Integrated Circuit Design

- Low power circuits and architecture
- Novel chip architectures
- Integration of nano to micro-scale devices on circuits

C.3 Photonic Devices

- Nanophotonics and plasmonics
- Advanced sources and detectors
- Optical devices
- Optical imaging
- Light emitting diodes (organic/inorganic)
- Lasers
- Photovoltaics
- Nonlinear and ultrafast photonic devices
- Photonic integrated circuits
- Other electronic devices

Micro-/Nano-Electro-Mechanical Devices and Systems (MEMS/NEMS)
(Program Director: Juan Figueroa; jfiguero@nsf.gov)

D.1 Sensors: Accelerometers, fluid flow measurement devices, combustion sensors, gyroscopic guidance systems, bio-analytic sensors, etc.
D.2 Actuators: Devices that respond to changes in their environment causing another device to turn on, turn off, adjusted or moved
D.3 Optical: Switches, lens arrays, beam splitters, corrective optics, etc.
D.4 Micro- and Nano-Machines
D.5 Integrated Systems:Â Materials, devices, and issues for integration of MEMs (e.g., sensors, actuators, micro-fluidics) with electronic and photonic circuits (e.g., CMOS, waveguides).Â Includes innovations in packaging and thermal management
D.6 MEMS design, processing, packaging, materials:
D.7 Innovative Technologies: Innovative ways of using and generating light not otherwise encompassed within the categories outlined above

Energy and Power Management

In the power electronics realm, as CMOS chips go to finer lithography with each new generation, their multiplying transistors require lower and lower voltages and higher and higher currents. These trends have driven up power demands on pc boards and placed constant pressure on power-supply and power-system developers to increase the efficiency and power or current density of their supplies. At the same time, the trends toward lower voltages and higher currents have encouraged migration from centralized to distributed and portable power architectures. Newer chips with lower supply-voltage requirements has greatly complicated power-system and power-supply design. At the system level, new energy storage technologies such as new battery chemistries, fuel cells, and flywheels could make a tremendous impact on system reliability and energy usage. Ongoing challenges at all scale levels in national and global energy needs are placing increasing demands for innovative alternative energy strategies that require a broad vision in a variety of areas including distributed controls and adaptive dynamic power flow for managing intelligent power grids of the future from the device to the system level. In the area of sustainable energy, proposed projects may include new critical devices, components, systems and materials for sustainable energy. Proposals are solicited on the following subtopics. (Program Director: Murali Nair; mnair@nsf.gov)

E.1 Electronic systems for energy efficiency and conservation, smart grids, smart meters, and smart buildings
E.2 Electronic systems for portable energy sources for mobile technologies and off-grid type applications
E.3 Power management systems for energy scavenging/harvesting and compact energy conversion systems
E.4 Interface devices between batteries and super-capacitors
E.5 Novel voltage conversion, micro-inverters and DC-DC voltage converters
E.6 Compact hi-voltage, hi-power systems
E.7 New energy sources for portable and mobile devices
E.8 Smart power demand-response management systems, e.g. smart grids, buildings, circuits
E.9 Inverters, motors and generators for higher efficiency, smaller size and power factor corrections
E.10 Energy harvesting and conversion from renewable resources, (including, for example, biological pathways but excluding solar technologies)
E.11 Sustainable energy storage solutions
E.12 Nature-inspired processes for sustainable energy solutions and carbon storage
E.13 Reducing carbon and resource intensity of hydrocarbon extraction, energy conversion and use
E.14 New technologies that support smart infrastructures (such as materials, sensors, devices and control systems) to ensure efficient and sustainable energy transmission, distribution, monitoring and management
E.15 Sustainable Energy. Proposed projects may include new critical devices, components, systems and materials for sustainable energy in any of the following areas: energy harvesting and conversion from renewable resources, (including, for example, biological pathways but excluding solar technologies); sustainable energy storage solutions; nature-inspired processes for sustainable energy solutions and carbon storage; reducing carbon and resource intensity of hydrocarbon extraction, energy conversion and use; and new technologies that support smart

infrastructures (such as materials, sensors, devices and control systems) to ensure efficient and sustainable energy transmission, distribution, monitoring and management.

Scientific Instrumentation
(Program Director: Juan Figueroa; jfiguero@nsf.gov)

Geosciences

NSF/SBIR seeks proposals to design, develop, and prototype innovative sensors, devices and instruments for the scientific understanding of the integrated Earth systems, and that lead to an improved understanding of the factors that define and influence the Earth's environment and planetary processes. Ozone levels, coal mine safety, radiation levels, seismic sensing, and oil exploration. Items of interest include but are not limited to:

F.1 Instruments addressing environmental monitoring in geophysical, atmospheric, and oceanographic phenomena
F.2 Devices for physical measurements at the Earth's surface and in boreholes beneath the surface
F.3 Instruments for measurement of atmospheric parameters, such as temperature, pressure, water vapor, and radiation
F.4 Instrumentation for research in the world's oceans, lakes and seas, polar icecaps and remotely operated geosciences instruments

Astronomical

Proposals that lead to new instruments and devices are solicited for astronomical observations in the radio, sub-millimeter, infrared, and optical wavelengths. Items of interest include but are not limited to:

F.5 Adaptive optics, wave front sensors, innovative focal plane technology, and lasers for artificial guide stars
F.6 Holographic gratings for dispersing elements and imaging Fourier transform spectrometers
F.7 Large diameter, broadband filters having low focal ratio number and uniform antireflection coatings
F.8 Heterodyne imaging spectrometers, with channel-independent auto-correlation, high resolution and large spectral coverage
F.9 Low-cost analog/digital converter chips for radio astronomy with high sampling rates and precision
F.10 Other Scientific Instrumentation

Robotics and Human Assistive Technologies
Challenges such as voice, obstacle and image recognition, emotional response, and eye-hand coordination still remain. High-performance processors, hardware to provide situational awareness, and improved artificial intelligence (AI) are enabling researchers to create lifelike robots with an entire gamut of facial expressions. Considerable progress will be made if robots possessed high intelligence needed to cope with uncertainty, learn from experience and work as a

team. Robot designers are borrowing features from insect nervous systems, engineers and computer scientists cooperate with biologists, neuroscientists and psychologists to exploit new knowledge in the study of the brain and behavior. Some robots will help people do what they can't or would rather not do. Other robots will tackle complex projects by working as teams. Robots will help protect critical infrastructure and monitor the environment as mobile, intelligent sensors. Proposals involving robotics and intelligent machines having complex, human-like behavior are sought but not limited to the following subtopics. (Program Director: Murali Nair; mnair@nsf.gov)

G.1 To support the physical and educational needs of individuals with disabilities â€“ e.g. vision, hearing, cognitive, motor related
G.2 Improved time imaging, visualization, dexterity and manipulation
G.3 Haptic, real-time and bio-inspired feedback
G.4 Semi-autonomous tele-robotics
G.5 Naturally inspired, biomimetic, neuromechanical robotics
G.6 Precision agriculture robotics
G.7 Robotics in healthcare (robotic prosthesis, robot-assisted rehab, miniature robotics, high throughput technologies â€“ imaging, screening of drugs, surgical procedures)
G.8 Concepts for protecting human hands (in various extreme environmental conditions)
G.9 Robotics in agile manufacturing
G.10 Robotics in education
G.11 Anthropomorphic (human-shaped) robots
G.11 Co-robots - robots that work symbiotically (beside, in direct support, or cooperatively) with people to extend or augment human capacities; next generation of robotic systems able to safely co-exist in close proximity to humans in the pursuit of mundane, dangerous, precise or expensive tasks; proposals for sensors and perception, actuators and control, intelligence, machine learning techniques, architectures, systems, human/robot interfaces, and other developments that either realize or help to realize co-robots in manufacturing, service, exploration and assistive applications
G.12 Novel and advanced approaches to sensing, perception, and actuation including embedded and highly distributed systems
G.13 Intelligent control architecture for robotic systems; development of human-robot interfaces; communication and task sharing between humans and machines, and among machines; self-diagnosing, self-repairing robots

Micro-electronics Packaging, Thermal Management & Systems Integration
Proposals are solicited on more efficient means of integrating semiconductor components and devices into systems. The growth in chip density, coupled with the demand for high performance, small size, light weight, and affordable reliability has placed enormous pressure on interconnect technology and packaging at all levels. Proposals are solicited in improved techniques for interconnect and packaging at the board level, packaging approaches for the board components, the passive components, techniques for board assembly and finally, applications of techniques to packaging and systems integration for optoelectronics and wireless systems. (Program Director: Murali Nair; mnair@nsf.gov)

H.1 Printed Wiring Board Manufacturing - Board materials; Board preparation; Hole drilling, punching and plating; Circuit lithography (CAD tools); Solder masks; Multiplayer board fabrication
H.2 Single Chip Packages for improved performance and reliability in single and Multiple-chip packaging particularly thermal performance, of the following types: Throughâ€“hole; Surface mount; Area arrays (Ball Grid Array, Quad Flat Pack, etc.); Multichip modules
H.3 Passive Components - Methods for improving the performance of reliability of passives (capacitors, inductors, resistors) on the Printed Wiring Board with respect to: Discrete components; Integrated components; Embedded and on chip passive components
H.4 Board Assembly - Improved methods for board assembly in: Surface Mount Assembly including lead free soldering; Thick Film processing for ceramic components/ Hybrid systems; Thin Film processing using PVD and CVD techniques; Testing, Inspection and Measurement; Environmentally Benign Designs
H.5 Optoelectronic Systems - Improvement in manufacturing and systems integration of optoelectronic systems in the following areas: Optical Sources - lasers, VCSELs; Optical Detectors; Optical Channels/Fibers; Optical Interconnects
H.6 Wireless Systems - Manufacturing and systems integration of RF systems in the following areas: Transceivers â€“ Antennas; Microwave Discrete Circuits; Microwave Monolithic Integrated Circuits; Microwave Integrated Circuits

Information Technologies
(Program Director: Juan Figueroa; jfiguero@nsf.gov)

I.1 Security, Privacy, Encryption, and Information Assurance in browsers, geolocation, web/cloud storage, transactions, mobile, network and other applications
I.2 Knowledge Discovery, Search, Data Mining, "Big Data" Management, and Visualization within a wide range of data intensive applications that may include financial services, medical records, traffic, weather, construction, police, personalized user and other service related environments.
I.3 Digital Arts including graphic arts, photography, digitalization of traditional art media, radio, television, theater, image capture, archiving, conservation, and restoration,
I.4 Virtualization, Cyber-Physical Systems, and Engineered Systems that are built from and depend upon the synergy of computational and physical components such as a smart electric grid, smart transportation and traffic management, smart buildings, energy management, drones, and autonomous systems that augment human capabilities, or provide ubiquitous healthcare monitoring and delivery that are offered as a service.
I.5 Human Computer Interfaces

- Applications employing speech, touch, vision or biometric technologies
- Spoken language systems - conversational dialog management, semantic language analysis or interpretation
- Automatic translation

I.6 Predictive Information Systems. Creating devices, components, systems, algorithms, networks, applications or services that can be used to make reliable global, regional and local predictions of decadal climate variability and change; to support human intervention and to

prevent unintended consequences in plant, animal, human, and physical systems. Applications may include the protection of human-built infrastructure and the restoration of ecosystem services that further sustain human well-being in terrestrial and coastal areas.

Nanotechnology, Advanced Materials and Manufacturing (NM)

SBIR Proposal Due Date: June 11th
STTR Proposal Due Date: June 13th

Primary Program Directors:
Steven Konsek (skonsek@nsf.gov**)**
Rajesh Mehta (rmehta@nsf.gov)
Ben Schrag (bschrag@nsf.gov)

Nanotechnology, Advanced Materials and Advanced Manufacturing (NM) Topic
The NM topic seeks to support high-risk, high-payoff innovative technologies with the potential for significant impact on industry, consumers, and society, thereby catalyzing new business opportunities for small businesses in today's global marketplace. Novel technologies aimed at achieving increased performance, reduced cost, and/or new functions or applications are of great interest. NSF is committed to supporting the further development of scientific discoveries to benefit society and to emphasize private sector commercialization. We seek to fund small businesses which are committed to the creation of a sustainable and scalable business driven by revenues and support from customers and private-sector partners.

Proposals should address one of the subtopics that are outlined below. When submitting a proposal to the NM Topic, code the proposal to the corresponding subtopic under which you are submitting the proposal, e.g., N1 for proposals in the area of "Nanomaterials", AM5 for proposals in the area of "Structural Materials", and M1 for proposals in the area of "Manufacturing Processes". **In addition, use the same code as the first item in the key words/phrases portion of the Project Summary of your proposal.**

If your project or innovation does not seem to fit with one of the below topical areas, but still meets the technical and commercial/broader impact criteria of the NSF SBIR program, please contact one of the Program Directors listed above to discuss.

NANOTECHNOLOGY

The Nanotechnology subtopic addresses the creation, manipulation, and characterization 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 the end users of the proposed technology, and also the proposed pathway to commercialization.

N1. Nanomaterials
Material innovations in scalable synthesis, purification, and processing techniques for

nanolayered structures (e.g. graphene), nanowires, nanotubes, quantum dots, nanoparticles, nanofibers, and other nano-materials. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

N2. Nanomanufacturing
Innovations for manufacturing at the nanoscale, including self-assembly, nanolithography, nanopatterning, nanotexturing, etc. Proposals which seek to develop processes, techniques, and equipment for low-cost, large-scale production of nano-structured materials are encouraged. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

N3. Instrumentation for Nanotechnology
Innovations for new and improved methods and instruments for fabrication, characterization, or manipulation, which will assist in the development and deployment of nanotechnology and its commercial applications. Includes imaging and visualization methods (e.g. scanned probe microscopy and electron microscopy) as well as manipulation techniques (e.g. high-precision positioners and actuators), and chemical and spectroscopic methods. (Program Director: Ben Schrag; bschrag@nsf.gov)

ADVANCED MATERIALS

The Advanced Materials subtopic addresses the research and development of new materials and systems that have the potential for revolutionary changes and paradigm shifts in U.S. industry. Proposals should be driven by market needs and demand, and should identify the end users of the proposed technology, and also the proposed pathway to commercialization.

AM1. Electronic and Magnetic Materials
Material innovations for new functionalities and/or improved performance in electronic and magnetic applications. Includes, but is not limited to, novel semiconductor materials, sensor materials, materials for advanced lithography, materials for high-temperature, high-power, or high-frequency applications, superconductors, and materials for organic and/or flexible electronics. Proposals related to semiconductor processing or manufacturing (such as the integration of advanced materials with silicon, or materials related to advanced lithography) are also included in the AM1 topic. (Program Director: Steven Konsek; skonsek@nsf.gov)

AM2. Optical and Optoelectronic Materials
Material innovations for improved performance in optical, photonic, and optoelectronic applications. Includes materials for improved optical or radiation sensors, optical materials for electronics (flexible or traditional), materials for lasers or light-emitting diodes, novel materials for displays, and active optical materials. Materials related to photovoltaics or photovoltaic processing or manufacturing also fit in the AM2 subtopic. Proposals focusing on the processing or manufacturing of photonic or optical materials are also appropriate for the AM2 subtopic. (Program Director: Steven Konsek; skonsek@nsf.gov)

AM3. Materials for Energy Storage Applications
Material and device innovations for existing or novel energy storage techniques. Includes materials for batteries, capacitors, and supercapacitors. Proposals are encouraged which involve novel materials or processes with significant potential to reduce cost, improve safety and/or

improve manufacturability. For proposals related to photovoltaics or other solar energy harvesting technologies, see the AM2 topic. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

AM4. Metals and Ceramics
Material innovations to improve the performance and/or allow new functions in metallic and ceramic materials. Â This topic includes bulk materials (e.g. superalloys, ceramics, and composites) and coatings (e.g. thermal and environmental barrier coatings, and tribological coatings), as well as other morphologies (e.g. foams).Â This subtopic also includes composites of metallic and ceramic materials (metal-matrix and ceramic-matrix composites). (Program Director: Ben Schrag; bschrag@nsf.gov)

AM5. Structural Materials
Material and process innovations to improve the performance of materials in structural applications. Includes, but is not limited to, materials for civil infrastructure (e.g. cement, concrete, structural panels, etc.), and polymer composites for various applications. Refer to the BC topic for synthesis and process development of polymer materials. (Program Director: Ben Schrag; bschrag@nsf.gov)

AM6. Coatings and Surface Modifications
Material and process innovations in surface modifications and coatings. Includes coatings for improved corrosion and wear resistance, anti-microbial and anti-fouling coatings, surface modifications for specialized applications such as superhydrophobic or biologically/chemically active surfaces, and techniques to improve manufacturability and reduce cost. Refer to the AM4 topic for proposals related to inorganic coatings. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

AM7. Multiferroics and Specialized Functional Materials
Innovations related to multiferroics or other functional materials for specialized applications. Includes, but is not limited to, piezoelectrics, ferroelectrics, thermoelectrics, magnetostrictives, or electrochromics, shape memory alloys, ferrofluids, materials for high or low thermal conductivity applications, novel materials for active device or energy harvesting applications, and novel materials for sensor or actuator applications. (Program Director: Ben Schrag; bschrag@nsf.gov)

AM8. Materials for Sustainability
Material innovations designed for improved sustainability, mitigating adverse environmental impacts, and/or improved public health. Proposals are encouraged which involve new processes and techniques that allow for new or increased use of recycled, renewable, non-toxic and/or environmentally-benign materials. Proposals are also encouraged for new innovations which reduce overall energy consumption or waste. (Program Director: Ben Schrag; bschrag@nsf.gov)

ADVANCED MANUFACTURING

The Advanced Manufacturing subtopic aims to support all 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 market needs and

demand, and should identify the end users of the proposed technology, and also the proposed pathway to commercialization.

M1. Manufacturing Processes
Innovations in technologies such as molding, forging, casting, machining, and joining, for processing of variety of materials including metals, ceramics, polymers, and composites. Proposals are encouraged which lead to significantly improved efficiency (in terms of materials, energy, time, or money) and sustainability. The topic also includes on-line detection and/or control of defects in those processes. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

M2. Machines and Equipment
Innovative machines and equipment for applications in a range of advanced manufacturing operations for nano-, micro-, and macro-scale products, in all industries including manufacturing, construction, and recycling. Innovative equipment modification or retrofitting to enable manufacturing of completely new products is encouraged. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

M3. Modeling & Simulation
Innovations in modeling and simulation of enterprise operations, manufacturing processes for intermediate or finished products, machines and equipment, including 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. Technologies enabling real-time prediction or optimization are also encouraged. (Program Director: Rajesh Mehta; rmehta@nsf.gov)

M4. 3-D Additive Manufacturing

Innovations in processes or machines which permit manufacturing through a layering process to achieve intricate net-shape products. Proposals are encouraged which permit the manufacturing of complex multi-scale and/or multi-functional products for superior performance and productivity. (Program Director: Rajesh Mehta; rmehta@nsf.gov)