NSF SBIR / STTR SOLICITATION TOPICS AND SUBTOPICS

For proposals due:

June 10th, 2014 (SBIR)

June 11th, 2014 (STTR)

The National Science Foundation's SBIR/STTR program provides seed money for startup and small business private ventures. For more information, please visit http://www.nsf.gov/eng/iip/sbir.

EDUCATIONAL TECHNOLOGIES AND APPLICATIONS (EA)

Cognizant Program Director: Glenn Larsen, GLARSEN@NSF.GOV

Submitted proposals for the Educational Technologies and Applications (EA) topic should provide storyboards, sketches, or descriptions of how the proposed application will work and how users would interact with the application. Projects that propose technologies or products similar to those in the marketplace or those similar to existing products and processes must make the case for a strong innovative component of the project. Technologies that can be easily replicated by potential competitors tend to lack innovation and are not likely to be funded.

EA1. General Education Applications Topics can include 1) the technology transfer of innovative and sustainable products and services that leverage and commercialize education research investments made to educational institutions by the National Science Foundation and other government agencies; 2) solutions 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; 3) the innovative delivery, applications, and curricula on STEM (science, technology, engineering, and math) that aligns with voluntary national education standards, state standards, or standards recognized by national accreditation associations and that can compete with educational and open content programs offered for free or low cost; 4) 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; 5) personal learning environments that allow students to control their environment in relation to their personal learning style to acquire knowledge with consideration of their teacher's expectations; 6) applications that better enable informal and traditional learning or applications that help bridge formal and informal learning environments or effectively promote positive behavior changes; 7) open content and community based research activities that provide new or alternative forms of sharing and repurposing information, content, pedagogies, and experiences that are long-term and sustainable; and 8) learning technologies that motivate and enhance the self-esteem and learning performance of students.

EA2. Global, Distance, and Cyberlearning Education Applications Topics can include 1) innovative applications that use online learning, hybrid learning, collaborative models, and new tools that, when combined, will have the potential to deliver new and powerful educational opportunities in STEM

disciplines; 2) learning environments that allow students to control and experiment with educational situations in relation to their personal learning style to acquire knowledge anytime and anywhere; 3) technologies that enable new forms of educational collaboration across national boundaries; 4) learning applications that provide for better decision making and informed judgments about problems and situations affecting global issues related to theory, education technology, and data; 5) projects in which technology allows the tailoring of learning experiences to special needs and interests of groups or individuals and/or expanding formal education beyond classroom settings; 6) applications that support and promote cultural diversity, international awareness, and understanding; 7) interoperable mobile learning environments that enable students to access and connect to vast resources of knowledge wherever they may be located through smart phones, tablets, wearable devices, or tools that have yet to be developed; 8) virtual and remote laboratories that enhance the physical science laboratory for use in global and distance learning to leverage time and the availability of equipment that may otherwise be unavailable; 9) applications and systems accelerate the theory, education technology, and data cycle; and 10) authoring systems and content generators that easily allow educators to create, distribute, and share new resources across multiple platforms.

EA3. Simulations and Gaming Technology Applications Topics can include 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. Examples include 1) single-player, small-groups, or massively multiplayer online gaming applications that foster cooperation and can include card, board, or digital games; 2) 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; 3) games that target the assessment of student knowledge while providing intrinsic motivation for student participation; 4) games that better enable entrepreneurs to learn and effectively compete in a global economy; 5) games that support immersive and experimental learning; 6) simulations and role-playing games where students can participate in providing creative solutions to difficult or complex situations; and 7) laboratory simulations that accurately reflect similar that may otherwise be costly, use precious resources, or otherwise be unavailable for general student use.

EA4. Entrepreneurship Education Applications Topics can include 1) entrepreneurship education and training integrating diverse topics, such 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; 2) personal learning environments that allow students to control and experiment with entrepreneurial situations in relation to their personal learning style to acquire knowledge; and 3) innovative tools that enable entrepreneurs and educators to learn or judge the effectiveness and validity of external resources for research, product launch, and effective operations of technological and education related products and services.

EA5. Tools for Learning and Assessment Topics can include 1) 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; 2) adaptive learning environments combined with assessments that provide alternative paths of instruction; 3) gesture-based computing applications, semantic analysis, and tools that enable collaborative work with multiple students interacting on content simultaneously; 4) 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; 5) devices that enable expanded dimensional learning such as 3D modeling, computer aided design (CAD), as well as new materials, technologies, and processes for learning and 3D printing suitable for educational settings; 6) Augmented Reality (AR) and tools that layer information over 2D and 3D spaces to provide new environments for learning; 7) wearable information centers, power sources, flexible displays, jewelry, glasses, output devices, and input tools that allow students to interface with computers and other devices in creative new ways that help overcome natural or physical barriers to learning; and 8) sensors and systems that detect student engagement, frustration, or boredom while providing real-time feedback to both students and teachers.

EA6. Information Management and Technology for Education Topics can include 1) innovative applications that better enable classroom management, recordkeeping, and standards-aligned planning that permit more effective use of educational resources; 2) collecting, analyzing, sharing, and managing data that promotes learning and/or leads to designed learning environments; 3) 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; 4) learning analytics, big data, searching, data mining, data analysis, intelligent agents, knowledge modeling, user models, mobile tools, and

decision support systems that improve the understanding of teaching and learning to improve student performance, retention, and transfer in various environments; 5) cloud-based services and applications that support collaboration, file storage, teacher and student productivity, data collection, data security, data privacy, and ubiquitous access to information in secure environments in an educational setting; and 6) innovations that provide for better learning and knowledge transfer in many-to-one, one-to-many, and many-to-many environments.

INFORMATION AND COMMUNICATION TECHNOLOGIES (IC)

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A recent report by the McKinsey Global Institute ("Disruptive technologies: Advances that will transform life, business, and the global economy"; May 2013) lists the 12 most disruptive emerging technologies. The top 4 (in terms of potential economic impact) fall clearly into the category of information and communication technologies, while the remaining 8 are enabled, at least in part, by advances in information technology.
Proposals should focus on technology innovations that have major impact, a clear and compelling value proposition, and substantial commercial potential. It should be stressed that the lists of examples in the subtopics below are non-limiting - they are included only to indicate the types of technical area that fall within the scope of the sub-topics.

IC1. Components and Infrastructure Innovations that will substantially improve the underlying technical performance, or extend the functionality, of information and communication systems. Examples of relevant technical areas include (but are not limited to) communication signal sources and detectors - optical (lasers, LEDs, photodetectors), RF, or microwave; specialized optical fibers and optoelectronic devices (e.g., for optical amplification, dispersion compensation, or multiplexing); short range and long distance transmission technologies - optical, RF, and microwave; data storage and retrieval technologies; data transmission technologies; data processing devices - electronic ICs, quantum devices; server technologies; energy conservation technologies for servers and server farms.

IC2. Information Technology Applications Applications that will benefit society, with particular emphasis on internet-based applications. Examples of relevant technical areas include (but are not limited to) mobile technology; the "Internet of Things"; cyber-physical systems; automation of knowledge work; cloud computing; cloud-based data management; cloud-based IT services; IT enabled commerce; big data and advanced analytics; data mining and information services; data visualization; predictive systems; social networking applications; neural networks; smart grid applications; smart building management; traffic flow optimization; and remote medical services.

IC3. Security and Privacy Innovations that will protect networks against attack or failure and/or network users and user data against compromise. Examples of relevant technical areas include (but are not limited to) cyber security; cloud computing security; data loss prevention; information assurance; privacy and data integrity; encryption; key generation and management, key distribution, quantum key distribution; wireless LAN security; access authorization; identity management; and personal authentication (biometrics, multi-factor authentication, etc.).

IC4. Human-System Interaction Innovations that will enable humans to interact more effectively and efficiently with information systems. Examples of relevant technical areas include (but are not limited to) human-computer/network interfaces; human-machine interfaces; wearable devices - smart watches, smart glasses, intelligent textiles; augmented reality and reality virtualization; voice, language, and gesture recognition; eye tracking; tactile displays; and human identification (biometrics).

SEMICONDUCTORS (S) AND PHOTONIC (PH) DEVICES AND MATERIALS

Cognizant Program Director: Steven Konsek, SKONSEK@NSF.GOV

Photonics (PH) The Photonics topic addresses the research and development of new materials, devices, components, and systems that have the potential for revolutionary change in the optics and photonics industries. Proposals should be motivated by market opportunity, a compelling value proposition, clearly identified end users and customers of the proposed technology, and a viable pathway to commercialization.

PH1. Lighting and Displays Subtopic includes (but is not limited to) solid state lighting and smart lighting systems and controls, energy efficient display technologies, light emitting diodes (inorganic or organic), display backplane technology, and transparent conductors.

PH2. Communications, Information, and Data Storage Subtopic includes (but is not limited to) optical communication and networking infrastructure and components, photonic integrated circuits, new materials and systems for data storage, novel components for network applications, and multifunctional and other novel optical fibers implementations.

PH3. Energy Subtopic includes (but is not limited to) photovoltaic materials and devices, systems for smart glass applications, breakthrough thermophotovoltaics, metamaterials, and materials and systems for solar thermal applications.

PH4. Advanced Metrology and Sensors Subtopic includes (but is not limited to) sources and detectors for advanced IR systems, advanced remote sensing systems, sources and detectors for advanced microscopy, novel camera systems for 3D metrology, and advanced imaging systems.

PH5. Advanced Optical Components and Systems Subtopic includes (but is not limited to) the building blocks for next generation optical components and systems, such as new photonic materials, breakthrough process technologies, nanophotonics, biophotonics, plasmonics, photonic integrated circuits, and manufacturing techniques to enable low-cost breakthroughs for advanced photonic components.

Proposals in this area should take special care to clearly highlight real market opportunity and a compelling value proposition for the technology.

Semiconductors (S) The Semiconductors topic addresses the research and development of new designs, materials, devices, and manufacturing systems that have the potential for impactful change in the semiconductor industry. Proposals should be motivated by market opportunity, a compelling value proposition, clearly identified end users and customers of the proposed technology, and a viable pathway to commercialization. The program encourages cooperation with the semiconductor industry to address current challenges as well as new frontiers.

S1. Electronic Materials Subtopic includes (but is not limited to) novel semiconductor materials, magnetic materials, advanced thermal management materials for device integration, materials for advanced lithography, and materials for high-temperature, high-power, or high-frequency applications.

S2. Electronic Devices Subtopic includes (but is not limited to) advanced semiconductor devices, bioelectronics and biomagnetics, quantum devices, magnetic and multiferrous and spintronics devices, memory devices, power electronics, flexible electronics, and nanoelectronic devices.

S3. Processing and Metrology Technology Subtopic includes (but is not limited to) processing and metrology technologies that enable low cost, high performance or novel, advanced semiconductor devices.

S4. Integrated Circuit Design Subtopic includes (but is not limited to) low power circuits and architecture, novel chip architectures, and the integration of nano- to micro-scale devices on circuits.

ELECTRONIC HARDWARE, ROBOTICS AND WIRELESS TECHNOLOGIES (EW)

Cognizant Program Director: Murali Nair, MNAIR@NSF.GOV)

Sensors (SE) 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.

Wireless Technologies (WT) Wireless has become the platform for many applications with direct impact on virtually every aspect of life, evolving well beyond mobile phones and PDAs to other devices, services, channels, and content. Microwave circuits afford wider frequency spectrum and very short antennae. With GaAs and SiGe, entire microwave transceivers can be inexpensively put on a single chip. 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. RFID chips are providing improvements in warehousing, materials handling, and shipping operations, replacing bar-code labels in many areas.

WT1. Systems and Devices 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 are sought.

WT2. Spectrum Usage Proposals in the areas of spectrum-related research and development activities that improve the efficiency by which the radio spectrum is used, and the ability of all Americans to access spectrum-related services.

Energy and Power Management (EP) In the power electronics realm, as CMOS chips go to finer lithography with each new generation, their multiplying transistors require lower voltages and higher currents. These trends have driven up power demands on printed

circuit boards and placed constant pressure on power-supply and power-system developers to increase the efficiency and power or current density. At the same time, the trends toward lower voltages and higher currents have encouraged migration from centralized to distributed and portable power architectures.

EP1. Electronic Devices, Boards and Interfaces Newer chips with lower supply-voltage requirements has greatly complicated power-system and power-supply design. Innovations in the areas of low-power device design and manufacturing as well as printed circuit and other boards that will operate at lower power and longer lifetimes are welcome.

EP2. Sustainable Energy Harvesting, Storage and Management - Device and System Level Proposals are solicited in the areas of electronic systems for portable energy sources for mobile technologies and off-grid type applications, including new energy sources. Proposals in the areas of power management systems for energy scavenging/harvesting and compact energy conversion systems, conversion from renewable resources, interface devices between batteries and super-capacitors as well as smart power demand-response management systems are welcome. Proposals with ideas on nature-inspired processes for sustainable energy solutions and carbon storage, reducing the carbon and resource intensity of hydrocarbon extraction, energy conversion, and its uses are sought. Innovative projects may include new critical devices, components, and systems for energy harvesting and conversion from renewable resources (excluding solar technologies). Refer to PH topic for solar technologies.

EP3. Smart Grids and Infrastructure Proposals that address innovations in 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 are sought.

EP4. Power Management Innovations in the areas of (but not limited to) novel voltage conversion, micro-inverters and DC-DC voltage converters, and compact hi-voltage, hi-power systems are welcome. Proposals covering new energy sources for portable and mobile devices, smart power demand-response management systems (e.g. smart grids, buildings, and circuits), inverters, motors, and generators for higher efficiency, smaller size and power factor corrections are encouraged.

Robotics and Human Assistive Technologies (RH) Considerable progress will be made if robots possessed the high intelligence needed to cope with uncertainty, learn from experience, and work as a team. Robot designers are borrowing features from insect nervous systems, and engineers and computer scientists collaborate 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. 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.

RH1. Learning, Intelligence and Motion Proposals addressing robot intelligence and experiential learning, particularly those in the areas of high-performance processors/hardware to provide situational awareness, and improved artificial intelligence, are welcome. Innovations in voice, obstacle and image recognition, emotional response, and eye-hand coordination are encouraged. Proposals describing projects that borrow features from other animal nervous systems and include biologists, neuroscientists, and/or psychologists in their team in order to exploit new knowledge in the study of the brain and behavior, are encouraged.

RH2. Robotic Applications Proposals involving robotics and intelligent machines having complex, human-like behavior for applications such as the protection of critical infrastructure or the monitoring of the environment while using mobile technologies and sensors networks are sought. Innovations in areas such as improved time imaging, visualization, dexterity and manipulation, anthropomorphic (human-shaped) robots, naturally inspired, biomimetic, neuromechanical robotics, haptic, real-time and bio-inspired feedback are also welcome. Other applications, including (but not limited to) precision agriculture, are also appropriate.

RH3. Robotics in Agile Manufacturing Proposals that address next-generation automation, the flexible and rapid reconfiguration of assembly lines allowing mass customization, the use of advanced control, scheduling, modularization, and decentralization with agile, mobile robotic systems that can enable the cost-effective manufacture of small, lot-size products are sought.

RH4. Co-Robots Innovations in the development of co-robots, robots that work symbiotically (beside, in direct support, or cooperatively) with people, to extend or augment human capacities are welcome. Proposals describing the 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; 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, construction, exploration, and assistive applications are encouraged.

RH5. Control and Architecture Proposals involving novel and advanced approaches to sensing, perception, and actuation in embedded and highly distributed systems; intelligent control architecture for robotic systems; the development of human-robot interfaces; communication and task sharing between humans and machines, and among machines; and self-diagnosing, self-repairing robots, are sought.

RH6. Human Assistive Technologies and Bio-related Robotics Proposals to support the physical and educational needs of individuals with disabilities - e.g. vision, hearing, cognitive, motor related - are sought. Robotic applications in healthcare (tele-robotics, robotic prosthesis, robot-assisted rehab, miniature robotics, high-throughput technologies - imaging, screening of drugs, surgical procedures) are appropriate. Medical devices that provide new capabilities to doctors including surgery; robotic exoskeletons to enhance human strength; personal robots with an emphasis on human-centered end use and interaction, increased autonomy; robots of augmentation are welcome. Proposals that address concepts for protecting human hands (in various extreme environmental conditions), and haptic, real-time and bio-inspired feedback concepts and mechanisms are also sought.

Micro-electronics Packaging, Thermal Management & Systems Integration (MT) 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. Innovations include (but not limited to) improved techniques for interconnect and packaging at the board level, packaging approaches for the board components, the passive components, techniques for board assembly, and applications of techniques to packaging and systems integration for optoelectronics and wireless systems.

ADVANCED MANUFACTURING & NANOTECHNOLOGY (MN)

Cognizant Program Director: Rajesh Mehta, RMEHTA@NSF.GOV

Advanced Manufacturing (M) The Advanced Manufacturing (MN) 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 both the end users of the proposed technology and the proposed pathway to commercialization. It is also important that the proposals are responsive to strong societal needs in terms of job growth and global trends.

M1. Personalized Manufacturing Innovative, new-to-the-world manufacturing methods and machines leading to mass customization. The applications may include (but are not limited to) clothing, footwear, furniture, ear buds, dental restorations, and person-specific medical devices such as headbands, hearing aids etc. The resultant products may need to be cost competitive with the relevant mass manufactured products. Proposals may also include development of software-as-a-service or workflow-as-a-service tools to assist young personalized manufacturing businesses.

M2. 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 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.

M3. 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.

M4. Industrial Ecology and Sustainable Manufacturing Technology Proposals may cover technologies that take a system approach to green engineering for industrial, residential, and commercial infrastructure, industrial manufacturing infrastructure design innovations; technologies that present new process and system design paradigms enhancing environmental sustainability with reductions in carbon footprint and ways of enhancing the sourcing, use, and recycle of materials and energy streams; 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, and dynamic

optimization of complex industrial manufacturing processes; new technologies (involving materials, sensors, devices, and control systems) that support smart infrastructures to ensure efficient and sustainable energy transmission, distribution, monitoring, and management.

M5. 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.

M6. 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 SOx, NOx, 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.

M7. 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.

M8. Machines and Equipment Innovative machines and equipment in a range of operations for making 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.

M9. Modeling & Simulation Innovations in the 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.

M10. 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.

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 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 Innovations for manufacturing at the nanoscale, including self-assembly, nanolithography, nanopatterning, nanotexturing, etc. Proposals that seek to develop processes, techniques, and equipment for the low-cost, large-scale production of nano-structured materials are encouraged.

ADVANCED MATERIALS AND INSTRUMENTATION (MI)

Cognizant Program Director: Ben Schrag, BSCHRAG@NSF.GOV

The Advanced Materials and Instrumentation (MI) topic addresses the development of new and improved materials and instruments for a wide variety of commercial and industrial applications. Proposals in Advanced Materials may focus on the creation of innovative material systems and/or on critical fabrication, processing, or manufacturing challenges involved in the successful commercialization of materials. Proposals in Instrumentation may focus on new instruments for use in scientific, industrial, engineering, or manufacturing environments, among others. Types of instruments that will be considered include systems and tools designed for the purposes of detection, characterization, measurement, processing, control, and/or monitoring. A wide variety of applications areas will be considered as part of this topic.

MI1. Metals and Ceramics Material innovations to improve the performance of and/or allow new functions in metallic and ceramic materials. 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). This subtopic also includes composites of metallic and ceramic materials (metal-matrix and ceramic-matrix composites).

MI2. Structural and Infrastructural 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. Structural materials that are metallic or ceramic should be submitted under topic MI1.

MI3. Coatings and Surface Modifications Material and process innovations in surface modifications and coatings. Includes (but is not limited to) 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 MI1 topic for proposals related to inorganic coatings.

MI4. 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, functional thin films, and novel materials for sensing or instrumentation.

MI5. Materials for Sustainability Material innovations designed for improved sustainability, mitigating adverse environmental impacts, and/or improved public health. Includes (but is not limited to) 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 that reduce overall energy consumption or waste, or that increase recyclability or reusability at end-of-life.

MI6. Other Materials New innovations in materials that do not fit into any of the above five materials topics but that nevertheless meet the intellectual merit and broader/commercial impact criteria of the NSF SBIR/STTR program.

MI7. Instrumentation for Characterization and Imaging New innovations in instrumentation whose primary purpose is measurement, characterization, or imaging. Includes (but is not limited to) optical and electron microscopy, scanning probe methods, magnetic imaging (NMR, MRI, etc.), spectroscopic and chemical methods, and other scientific instrumentation.

MI8. Instrumentation for Detection, Actuation, Control, and Manipulation New innovations in instrumentation whose primary function is detection, control, or manipulation. Includes (but is not limited to) new instruments for use in industrial processes, manufacturing, research, engineering, military, and/or consumer applications.

MI9. Other Instrumentation New innovations in instrumentation that do not fit into either of the above two instrumentation topics but that nevertheless meet the intellectual merit and broader/commercial impact criteria of the NSF SBIR/STTR program. Refer to the BT topic for bioinstrumentation.

CHEMICAL AND ENVIRONMENTAL TECHNOLOGIES (CT)

Cognizant Program Director: Prakash Balan, PBALAN@NSF.GOV

The Chemical and Environmental Technologies (CT) topic covers a wide range of technology areas of current and emerging commercial significance in the broad and multifaceted chemical process industry. Proposals of relevance would seek to develop and commercialize novel technology with a core focus on sustainability in one or more arenas such as design, synthesis, processing, use, disposal, and reuse/recycle/recovery of chemical and biochemical substances and products. Phase I proposals would typically be at the proof of concept/technical feasibility stage on new or novel technology concepts involving chemical engineering principles when submitting to this overall topic area. A proposal should present a clear value proposition, a strategy for commercialization of the innovation, and an explanation of how the project could rapidly lead to revenue generation for the small business. It is important that the proposed project involve novel, discontinuous, disruptive innovations; be responsive to strong industrial and societal needs; and focus on addressing real problems driven by critical market requirements while catalyzing the acceleration of U.S. job creation through strong business growth. Even if there is not a clear subtopic listed for the chemical and environmental technology research that you are seeking funding for, you are welcome to discuss it with the program director as a first step.

CT1. Bio-Based Chemical Technology Relevant projects would involve novel biochemical process technologies using engineered organisms and biocatalysts for the conversion of renewable raw material to cost-competitive products that represent sustainable alternatives to commercial industrial commodity, specialty and fine chemicals and products derived from non-renewable sources. Projects proposed should also be built on sustainable, energy efficient, and waste minimization or elimination paradigms leading to process Technologies for the production of biobased chemicals. Technologies that facilitate the separation and purification of products made through biochemical pathways should submit to the Separations Technology (CT2) topic. Process intensification approaches should consider the CT12 topic.

CT2. Separation Technology Relevant projects could involve any separation technology that enables and/or enhances the efficiency of separations in existing or new process technologies with a focus on enhanced energy efficiency and reduced capital requirements. Application areas include (but are not limited to) separations for multi-component and multiphase solid, liquid, and gas streams; separation technologies in both inorganic and organic chemical applications; novel purification processes; materials that permit effective sensor designs based on separations; recycle and recovery of higher value materials from waste; Novel separation techniques and media as disruptive improvements to current established separation technologies are encouraged, including (but not limited to) organic/inorganic membranes,porous media, structured materials and synthetic materials for drinking water and wastewater treatment; food, medical, pharmaceutical, chemicals and biochemical processes.

CT3. Polymers and Plastics Technology Proposals pursuing new and novel chemical and biochemical routes to making novel polymers, plastics and polymeric materials with unique and novel properties and functionality for commercial applications would be relevant to this topic. Proposals could include technologies related to production of novel sustainable polymeric materials and plastics. Projects may focus on novel approaches to produce biobased polymers that are cost competitive with petroleum based products; that possess superior engineering performance characteristics compared to existing commercial products; show enhanced biodegradability; result in reduced toxicity, superior recyclability. Projects may involve (but are not limited to) the development of products such as novel polymeric materials; bioplastics; biosurfactants; sustainable packaging materials for food and non-food applications; self-healing polymers; products from recycled materials or from a bio-based or renewable feed stock source; bioengineered plastics and biochemically produced polymers and precursors that lead to more sustainable, greener replacements to current polymers and polymeric products. Projects of interest may seek to develop technologies that facilitate recycle, and conversion of post-consumer and industrial waste, waste polymeric materials, plastics, etc, into products for broad commercial reuse.

CT4. Novel Chemical Process and Catalytic Technology Processes that chemically or biochemically (including catalytic/biocatalytic approaches) produce chemical products 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; technologies involving the development of 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-metallic, and earth-abundant elements; catalysts enabling the 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, which lead to superior or new process technology alternatives to existing technologies.

CT5. Carbon Dioxide and Methane Conversion to Industrial Chemicals Proposals of interest would 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 chemical process technologies for the conversion of methane (from natural gas, landfills, wastewater treatment, etc.) to industrial chemicals; novel catalytic process technologies to directly convert captured carbon dioxide to methanol through non syngas routes, as well as novel catalytic technologies to convert methane directly to methanol and hydrocarbons and value-added chemicals (through non syngas routes). Approaches could include novel biochemical pathways.

CT6. Food Technology Proposals of interest may include developing novel food processing technologies for better quality and nutritional value; improving process monitoring, control, and sensing technologies for food quality and safety; sustainable food packaging materials; novel food storage technologies; innovations that conserve the food supply and lead to lower wastage in the supply chain from farm to consumer; real-time microbial contamination sensing and control, the removal of toxic compounds from processed food, animal, and dairy products, eliminating health hazards.

CT7. Sustainable Technologies for Energy Efficiency, Capture, Storage and Use Proposed projects might include novel technology and approaches for the direct capture, conversion, storage, and use of any renewable energy sources; and waste heat recovery. Projects may include novel technology that leads to substantial enhancement in energy storage capacity, energy use efficiency, energy management, and energy recovery from waste streams compared to currently available technologies in any applications, including (but not limited to) residential, commercial, and industrial applications. Technologies may include combinations of mechanical, electrical, electrochemical, chemical/material, and biochemical approaches. Innovations for existing or novel energy storage techniques (such as batteries, capacitors, supercapacitors) are also relevant; nature-inspired processes for sustainable energy generation or capture; innovations in lubrication/tribology leading to reduced energy intensity in the chemical process industry; portable energy generation technologies that completely rely on renewable sources to allow supporting industrial energy needs in remote off-grid and underdeveloped economic regions.

CT8. Bioenergy and Renewable Fuels Technology Proposed projects might include new and novel methods to generate energy from marine, plant, algal, and microbial bio-energy sources; hydrogen production; innovations in high-yielding biomass crops for energy and chemicals production that do not compete with food supply. Proposed projects might involve the development of new, commercially viable renewable fuel options with reduced environmental impact relative to existing fuels, including (but not limited to) drop-in replacements to petroleum-based transportation fuels.

CT9. Water, Waste Treatment, and Environmental Sustainability Proposed projects may 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 the reuse of water and waste streams. Technologies proposed should be significant breakthroughs or enhancements relative to the current state of the art and seek to address current and emerging industrial/municipal and agricultural needs, 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, off-grid, and fixed installations for municipal, industrial, and agricultural waste, water and wastewater treatment, and recycle and reuse. Projects of interest

may seek to develop technologies that facilitate recycle, and conversion of post-consumer and industrial waste, waste chemical, polymeric materials, plastics, etc,into products of commercial use and value

CT10. Environmental Pollution Monitoring and Mitigation Proposed projects may include methods to reduce human ecological and environmental impacts; microbial contamination sensing and control; the 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; and pathogen and toxin diagnostics technologies. Projects could involve real-time sensing, the monitoring and tracking technology of pollutants that are currently regulated as well as newer, emerging, non-regulated contaminants that could have potentially broad and deleterious environmental, health, and safety impact.

CT11. Sustainable Agriculture and Forestry Technology Technologies that allow for the more effective use of renewable forestry as a biomass feedstock through biochemical or green chemistry pathways for the production of wood-based fuels and industrial chemicals, such as cellulosic fibers, lignin-based materials, plastics from cellulose, food packaging and building materials, coatings, sealants, elastomers, adhesives, etc. Technologies that allow the more efficient processing of wood for industrial use and technologies that enhance the renewal and management of forests for sustainable industrial and commercial use would be relevant. Technologies that increase the efficiency of nutrient assimilation; sustainable and commercially viable precision agricultural and forestry technologies; high productivity harvesting technology; soil, environmental sensing, and monitoring technologies that improve forest and agricultural crop management and productivity, reduce carbon foot print, and enhance the sustainability of silviculture/agricultural practices.

CT12. Process Intensification Technology Innovative chemical process equipment and technology across all chemical engineering unit operations that lead to significant process simplification, enhanced energy efficiency, waste minimization or waste elimination, lower carbon footprint and greener, more sustainable processes; systems that lead to substantially improved energy efficiency and transport characteristics in challenging heat and mass transfer applications; novel unit operations and process design innovations in the production of commercially chemicals and materials; micro reactors; process miniaturization, lab on a chip approaches; systems that facilitate the safe conduct of complex and hazardous chemistry through novel system designs that include (but not limited to) process simplification, capital efficiency, retrofittability leading to greener and more sustainable process technology in new and existing manufacturing/production facilities.

BIOLOGICAL TECHNOLOGIES (BT)

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BT1. Agricultural and Food Security 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.

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.

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.

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

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 are not limited to) health-care products, food ingredients, chemicals, and other biomaterials such as enzymes and bio-based polymers.

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.

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.

SMART HEALTH (SH) AND BIOMEDICAL (BM) TECHNOLOGIES

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Smart Health (SH) The need for a significant healthcare transformation has been recognized by numerous organizations, including the President's Council of Advisors on Science and Technology (PCAST), National Research Council (NRC), Institute of Medicine (IOM), Computing Community Consortium (CCC), and the National Academy of Engineering.
The Smart Health subtopics aim to support devices, components, systems, algorithms, networks, applications, or services that will enable the much needed transformation of healthcare from reactive, hospital-centered, and indemnity-based to proactive, person-centered, preventive, and cost-efficient.

SH1. Business Models for User-Centered Healthcare Proposed projects should include transformative business models that are enabled by novel technologies and are designed for the benefit of healthcare providers, consumers, patients and/or their caregivers. Such technology-driven business models will: reduce the cost of health care; facilitate the shift of public and private incentives toward patient-centric goals; empower patients and healthy individuals to participate in their own health and treatment, such as educating customers, accessing, and visualizing health data and knowledge; reduce the impact of socio-economic status, gender, and ethnicity in the participation of people in their own health treatment. Overall, these new business models are expected to improve health-related behaviors; improve patient-physician communication, patient engagement, and care coordination. Proposed projects must a) focus on the development of technology that enables such novel business model(s); and b) demonstrate the expected economic benefit of the novel business model in user-centered healthcare.

SH2. Digital Health Information Infrastructure Proposed projects may include technologies that will enable: interoperable, distributed, federated, and scalable digital infrastructure; languages and tools for effective sharing and use of electronic health record data, data representation for such including semantic metadata, and networked applications that access such data; continuously extensible universal exchange language for current and future health and wellness data originating from diverse sources in multiple formats; data methods for controlling and maintaining data integrity, provenance, security, privacy, and reliability of original as well as aggregated data, providing trustworthy

patient identification and authentication and access control protocols, and maintaining sensitivity to the legal, cultural, and ethical issues associated with universally accessible digital health data in the U.S.; or systems methods for measuring and optimizing operations to improve quality and productivity of healthcare delivery systems.

SH3. From Data to Decisions Proposed projects may include methods and algorithms that: aggregate multi-scale clinical, biomedical, contextual, and environmental data about each patient (e.g., in EHRs, personal health records - PHR, etc.); enable unified and extensible metadata standards; serve as decision support tools to facilitate optimized patient-centered, evidence-based decisions; evaluate the safety, effectiveness, efficiency, and clinical outcomes of mobile health applications; integrate patient information with delivery systems performance and economic models to support operations management decisions; support inferences based on individual or population health data, multiple sources of potentially conflicting information, while complying with applicable policies and preferences; enable the secondary use of health data to support the assisted and automated discovery of reliable knowledge from aggregated population health records and the predictive modeling and simulation of health and disease. Proposals are encouraged to integrate technological, behavioral, socio-economic, value-driven actions, ethical, and systemic factors that interfere with patients' collaboration in care teams, adherence to treatment, and wellness regimens.

SH4. Interoperability of Medical Sensors, Devices and Robotics Proposed projects may include protocols and interface standards to enable interoperable, temporally synchronized, medical prosthetic and embedded devices and devices for the continuous capture, storage, and transmission of physiological state and environmental data; assistive technology systems and devices for improved health and healthcare that incorporate sensory inputs and computational intelligence ranging from internal and external sensors, wearable prosthetics, and cognitive orthotics to surgical-assist robots and social robots; sensors, analysis tools, and activators needed to assess and limit adverse environmental effects on health and wellbeing; simulation and modeling methods and software tools that aid in the design and evaluation of sophisticated medical devices and how they communicate to medical information systems in the clinic, home, and in and around the person.

Biomedical Technologies (BM) The Biomedical Technologies subtopics aim to support products, processes, or services that will enable the delivery of high-quality, economically-efficient healthcare in the U.S. as well as globally.

BM1. 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.

BM2. 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.

BM3. Tissue Engineering and 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.

BM4. Biomedical Engineering Proposed project should focus on 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; motion or structural biomechanic technologies for the improvement of human motion, 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.

BM5. Medical Imaging Technologies Proposed projects may 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.

BM6. 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, lab-on-a-chip technologies, and low-cost point-of-care testing for diseases.

BM7. Drug Delivery Proposed projects may include novel and transformative platforms, chemical formulations, excipients, devices, or methodology for the delivery of drugs or biological products.