CYBER-ENABLED MATERIALS, MANUFACTURING, AND SMART SYSTEMS (CEMMSS)

$219,100,000
-$52,420,000 / -19.3%

Overview

The Cyber-enabled Materials, Manufacturing, and Smart Systems (CEMMSS) framework integrates a number of science and engineering activities across NSF–breakthrough materials, advanced manufacturing, and smart systems, including robotic and cyber-physical systems. Through CEMMSS-funded research, materials with unique properties and functionality are being discovered and developed more reliably and efficiently through the integration of theory, simulation, data analytics, and experiments. Further, using advanced manufacturing strategies, new materials are being fashioned into objects, structures, and systems embedded with computational intelligence, thereby transforming static systems, processes, and edifices into adaptive, pervasive smart systems. Ultimately, CEMMSS is leading to fundamental scientific advances in intelligent, autonomous physical systems that can operate successfully and collaboratively in dynamic, uncertain, and unanticipated environments.

The smart systems of tomorrow and the materials from which they will be composed will vastly exceed those of today in terms of adaptability, autonomy, functionality, efficiency, reliability, safety, usability, recoverability, and recyclability. The systems will collaborate with humans and with one another. These advances have the potential to accelerate scientific discoveries to address key national and societal challenges critical to U.S. security and competitiveness.

CEMMSS is a six-year investment area, spanning FY 2013-FY 2018. While the NSF-wide CEMMSS investment will conclude at the end of FY 2018, collaborative research activities pursued under CEMMSS are expected to continue.

CEMMSS comprises a research portfolio and enables new multidisciplinary research communities in the following three grand challenge areas:
- *Breakthrough Materials* investments accelerate the discovery and development of materials required for meeting societal needs and finding paths for sustainable and scalable manufacturing technologies;
- *Advanced Manufacturing* investments advance knowledge for production of novel products through processes that depend upon the coordination of information, computation, automation, networking, or other emerging scientific capabilities; and
- *Smart Systems* investments drive next-generation robotics and cyber-physical systems, with enhanced adaptability, functionality, reliability, safety, and usability in dynamic and unanticipated environments.

By the end of CEMMSS, there will be evidence of an integrated and thriving ecosystem of cyber-enabled systems composed of advanced materials; improved interdisciplinary education; and research infrastructure used by CEMMSS scientists and engineers.

Goals

The following three goals have been established to realize significant advances in the aforementioned grand challenge areas:
- Goal 1: Science and Engineering
  CEMMSS is establishing a scientific basis, a codified knowledge base, and shared principles for leveraging advanced materials, and designing, manufacturing, and deploying cyber-enabled smart systems.
- Goal 2: Education, Workforce Development, and Community-Building
  CEMMSS investments are leading to the education of a cadre of high-caliber disciplinary and interdisciplinary researchers, and the development of a vibrant and capable workforce to ensure a pipeline of talent and a growing community in these critical areas.

- Goal 3: Research Infrastructure
  CEMMSS is developing the critical research infrastructure that can be used to discover, test, refine, and validate the advanced materials, along with the design, manufacturing, and development methods that enable the deployment of smart systems.

FY 2018 Investments
Goal 1: Science and Engineering
- Advanced Manufacturing: NSF will continue to invest in Scalable Nanomanufacturing and Cellular Biomanufacturing, leveraging tools from engineering and biology (including synthetic biology), as well as in cyber-manufacturing systems.
- Breakthrough Materials: NSF will focus on strengthening existing projects by supporting the development of intra- and inter-project connections. Supplements to existing awards will be used to identify synergies within the research community and to accelerate pathways for transitioning innovative materials to practice.
- Smart Systems: NSF will refine the Cyber-Physical Systems (CPS) and National Robotics Initiative (NRI) program solicitations to include emphases on autonomous, intelligent systems. Additionally, NSF will examine the social, behavioral, and economic research issues associated with the design, manufacturing, and deployment of Smart Systems.

Goal 2: Education, Workforce Development, and Community Building
NSF will continue to support and facilitate partnerships with other federal agencies, industry, professional societies, and other stakeholders to build a robust research portfolio, accelerate the transition of research to practice, and hone educational and workforce development opportunities. Partnerships have proven valuable in facilitating a diverse, use-inspired CEMMSS research portfolio, for example, the CPS program, which comprises five federal agencies in addition to NSF; industry partners facilitating the Transition to Practice award option; and a recent National Academies' study on the future of CPS education.

Goal 3: Research Infrastructure Development
NSF will support data, software, and physical infrastructure necessary for CEMMSS. Specifically, for Breakthrough Materials, NSF will continue investments in the two Materials Innovation Platforms focused on two-dimensional materials. For Smart Systems, NSF will emphasize engaging the relevant community to identify infrastructure requirements and incentives for community adoption and use of such infrastructure.

Cyber-Enabled Materials, Manufacturing, and Smart Systems
Funding by Directorate
(Dollars in Millions)

Dir/Office	FY 2016 Actual	FY 2017 (TBD)	FY 2018 Request
BIO	$5.48	-	$5.48
CISE	91.93	-	72.70
ENG	110.00	-	101.25
MPS	63.83	-	39.67
SBE	0.28	-	-
Total, CEMMSS	**$271.52**	**-**	**$219.10**