The 2016 National Nanotechnology Initiative (NNI) Strategic Plan contains the objectives and provides the framework under which individual NNI agencies and departments (of which there are currently 20) conduct independent mission-specific nanotechnology programs and coordinate these activities and collaborations with other NNI entities. Under the 21st Century Nanotechnology Research and Development Act of 2003 (Public Law 108-153), NNI participating entities are required to develop an updated strategic plan every three years. The 2016 update “identifies high-impact research investments” to address the “challenges associated with designing and fabricating integrated nanosystems.” Four primary goals are highlighted, including:
1. Advance world-class nanotechnology research and development programs.

Nanotechnology is the new frontier, a new industrial revolution, which is breaking ground in multiple fields of physical science. As such, NNI agencies and departments have supported fundamental basic science research across multiple disciplines such as biology, chemistry, materials science, and physics. NNI agencies have invested more than $23 billion in support of world-class nanotechnology research, user facilities, technology transfer from lab to commercial enterprise. The goal is to continue expanding the limits of fundamental understanding of the phenomena that occur at the nanoscale and to use this knowledge to exploit those phenomena to create advanced materials and devices whose performance exceeds that of current technologies. NNI agencies will continue their commitment to excellence using a multiple pronged system, to include strengthening and support of multidisciplinary research and development, identifying breakthrough technologies through active engagements with stakeholders, assessing nanotechnology research and development programs, identifying signature nanotechnology initiatives that will be supported by multiple NNI entities, and challenging and engaging the broader nanotechnology community to solve problems of national and global significance through grand challenges [13].

2. Foster the transfer of new technologies into products for commercial and public benefit.

Innovation and entrepreneurship are the cornerstone of nanotechnology evolution from the lab to commercially available, disruptive technologies that have changed society in ways that were unimaginable several years ago. Additionally, intellectual property, standards development, and the potential environmental, health, and safety (EHS) implications of engineered nanomaterials (ENMs) and nanotechnology-enabled products (NEPs) are new areas of policy development arising from nanotechnology to better serve society. More work is needed to fully realize the benefits that nanotechnology can have for our national security, economic well-being, creation of jobs, and quality of life. The focus of this goal is to establish and expand the ecosystem and the resources to foster nanotechnology innovation and the responsible transfer of NEPs from lab to market. NNI agencies, together with the National Nanotechnology Coordination Office (NNCO [14]), will enhance outreach on the local, national, and global scale to industry, technical and professional societies, trade organizations, as well as and other nongovernmental organizations. Specific activities include: providing the business community with materials that explain the federal funding and regulatory environment, emphasizing commercialization through public-private partnerships, promoting resource availability to stakeholders, and engaging international partners to develop standards.

3. Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology.

Science, Technology, Engineering, and Mathematics (STEM) outreach programs have been a robust NNI legacy. For instance, the NSF sponsored Nanoscale Informal Science Education Network (NISE Net [15]), a network of museums and other institutions that had more than 30 million people participating in its programs, events, and exhibitions from 2008 to 2015. Contests, activities, challenges, and outreach engagements in nanotechnology-related topics for students, educators, and the general public have been
employed inspire the next generation of scientists and engineers, including those from underrepresented groups. Specific objectives associated with this goal include expanding outreach to inform the public about nanotechnology’s impacts, supporting programs that develop a skilled workforce, sharing physical and cyber research and development structures (notably user facilities and cooperative research centers), and encouraging the development and advancement of informatics literacy and data storage tools for nanotechnology research and development.

4. Support responsible development of nanotechnology.

In 2016, the NNI initiated a series of webinars focused on promoting best safety practices in nanotechnology research, product manufacturing, and product disposal and recycling. NNI agencies will continue these activities and pursue other opportunities to collaborate with the nanotechnology community to share information and best practices; the goal being to create a comprehensive knowledge base for evaluation of the potential risks and benefits of nanotechnology to the environment and to human health and safety. Objectives include being able to quickly disseminate such information, while also addressing the capacity to consider related ethical, legal, and societal implications, and encouraging sustainable development.

The Science

Science Synopsis

Nanotechnology is a combination of technology and nanoscience, which studies the fundamental nature of nanomaterials. Nanoscale objects are many thousands-of-times smaller than the unaided human eye can see. Nanoscience crosscuts all fields of the physical sciences, including chemistry, biology, physics, materials science, and engineering.

Computational modeling and simulation tools as well as data analytics and related software can support and enhance all aspects of nanotechnology research, development, and commercialization as they are becoming more efficient at predicting the nanoscale material behavior and performance. Such tools can reduce the time, work, and cost during research and development stages toward producing nanomaterials and nanomaterial-based products. Software tools can help process and analyze the large amounts of data generated from the testing and evaluation of nanoscale materials and nanotechnology-enabled devices as well as assist in identifying trends for optimizing their desirable properties and performance.

Environmentally responsible and sustainable development of nanotechnology includes the evaluation of existing nanomaterials across their life cycle; managing, policing, and recycling nanomaterials at the end of their lifecycles; the integration of sustainability concepts into the design of new nanotechnology-enabled materials, and even currently unknown avenues of sustainable development yet be imagined. NNI activities will continue to promote integration of sustainability into the research, development, design, and manufacture of engineered nanomaterials and nanotechnology-enabled products.

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