

NATIONAL NANOTECHNOLOGY INITIATIVE – LEADING TO THE NEXT INDUSTRIAL REVOLUTION

President Clinton's FY 2001 budget request includes a \$225 million (83%) increase in the government's investment in nanotechnology research and development. The Administration is making this major new initiative, called the National Nanotechnology Initiative (NNI), a top priority. The emerging fields of nanoscience and nanoengineering – the ability to manipulate and move matter - are leading to unprecedented understanding and control over the fundamental building blocks of all physical things. These developments are likely to change the way almost everything – from vaccines to computers to automobile tires to objects not yet imagined – is designed and made.

The initiative, which nearly doubles the investment over FY 2000 will strengthen scientific disciplines and create critical interdisciplinary opportunities. Agencies participating in NNI include the National Science Foundation (NSF), the Department of Defense (DOD), the Department of Energy (DOE), National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), and Department of Commerce's National Institute of Standards and Technology (NIST). Roughly 70% of the new funding proposed under the NNI will go to university-based research, which will help meet the growing demand for workers with nanoscale science and engineering skills. Many of these research goals may take 20 or more years to achieve, but that is precisely why there is an important role for the Federal government.

Funding by Agency:

	FY 2000 (\$M)	FY 2001 (\$M)	Percent Increase
National Science Foundation	\$97M	\$217M	124%
Department of Defense	\$70M	\$110M	57%
Department of Energy	\$58M	\$ 94 M	62 %
NASA	\$5M	\$20M	300 %
Department of Commerce	\$8M	\$18M	125%
National Institutes of Health	\$32M	\$36M	13%
TOTAL	\$270M	\$ 495 M	83 %

Nanotechnology is the builder's new frontier and its potential impact is compelling: This initiative establishes Grand Challenges to fund interdisciplinary research and education teams, including centers and networks, that work for major, long-term objectives. Some of the potential breakthroughs that may be possible include:

- Shrinking the entire contents of the Library of Congress in a device the size of a sugar cube through the expansion of mass storage electronics to multi-terabit memory capacity that will increase the memory storage per unit surface a thousand fold;
- Making materials and products from the bottom-up, that is, by building them up from atoms and molecules. Bottom-up manufacturing should require less material and pollute less;
- Developing materials that are 10 times stronger than steel, but a fraction of the weight for making all kinds of land, sea, air and space vehicles lighter and more fuel efficient;
- Improving the computer speed and efficiency of minuscule transistors and memory chips by factors of millions making today's Pentium IIIs seem slow;
- Using gene and drug delivery to detect cancerous cells by nanoengineered MRI contrast agents or target organs in the human body;

- Removing the finest contaminants from water and air to promote a cleaner environment and potable water;
- Doubling the energy efficiency of solar cells.

The NNI Investment Strategy:

This initiative builds upon previous and current nanotechnology programs, including some early investment from some of the participating agencies. The research strategy listed below is balanced across the following funding mechanisms: fundamental research, grand challenges, centers and networks of excellence, research infrastructure, as well as ethical, legal and social implications and workforce programs. This initiative will initially support five kinds of activities:

- **Long-term fundamental nanoscience and engineering research** that will build upon a fundamental understanding and synthesis of nanometer-size building blocks with potential breakthroughs in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, environment and energy, chemical and pharmaceutical industries, biotechnology and agriculture, computation and information technology, and national security. This investment will provide sustained support to individual investigators and small groups doing fundamental, innovative research and will promote university-industry-federal laboratory and interagency partnerships.
- **Grand Challenges that are listed above.**
- **Centers and Networks of Excellence** that will encourage research networking and shared academic users’ facilities. These nanotechnology research centers will play an important role in development and utilization of specific tools and in promoting partnerships in the coming years.
- **Research Infrastructures** will be funded for metrology, instrumentation, modeling and simulation, and user facilities. The goal is to develop a flexible enabling infrastructure so that new discoveries and innovations can be rapidly commercialized by the U.S. industry.
- **Ethical, Legal, Societal Implications and Workforce Education and Training** efforts will be undertaken to promote a new generation of skilled workers in the multidisciplinary perspectives necessary for rapid progress in nanotechnology. The impact nanotechnology has on society from legal, ethical, social, economic, and workforce preparation perspectives will be studied. The research will help us identify potential problems and teach us how to intervene efficiently in the future on measures that may need to be taken.

Funding by NNI Research Portfolio:

	Fundamental Research	Grand Challenges	Centers And Networks of Excellence	Research Infrastructure	Ethical, Legal, and Social Implications and Workforce	Total
FY 2000	\$87M	\$71M	\$47M	\$50M	\$15M	\$270M
FY 2001	\$170M	\$140M	\$77M	\$80M	\$28M	\$495M