PRESIDENT'S COMMITTEE OF ADVISORS
ON SCIENCE AND TECHNOLOGY
PANEL ON NANOTECHNOLOGY
REVIEW OF PROPOSED NATIONAL NANOTECHNOLOGY INITIATIVE
NOVEMBER 1999

Summary

PCAST believes that the benefits to the United States of the National Nanotechnology Initiative (NNI) are compelling, and we endorse the funding level, balance, and mechanism recommended by Interagency Working Group on NanoScience, Engineering and Technology (IWGN).

Our Review

A PCAST Nanotechnology Panel, composed of industry and university experts and chaired by Dr. Charles Vest, carefully reviewed the report entitled National Nanotechnology Initiative – Leading to the Next Industrial Revolution, written by the National Science and Technical Council (NSTC) Committee on Technology's Interagency Working Group on NanoScience, Engineering and Technology (IWGN). This report frames a new interagency R&D initiative, the NNI, starting in Fiscal Year 2001, and proposes a 5-year funding plan, appropriately distributed across both agencies and funding mechanisms. The NNI has an essential exploratory and scientific component and focuses on fundamental aspects of nanoscale science and engineering that collectively have high potential to eventually lead to important applications, processes, and products. These outcomes will strengthen both scientific disciplines and create critical interdisciplinary opportunities. Our Panel reviewed the technical merits and the funding profiles in the NNI proposal and supports the IWGN recommendation for a substantial budget increase in Fiscal Year 2001 with sustained funding in this area.

The NNI research portfolio is balanced well across fundamental research, grand challenges, centers and networks of excellence, research infrastructure, and education and training. The NNI also provides mechanisms for building workforce skills necessary for future industrial and academic positions, proposes cross-disciplinary networks and partnerships, includes a mechanism for disseminating information, and suggests tools for encouraging small businesses to exploit nanotechnology opportunities. If it is implemented, we recommend that the NNI be annually reviewed by a non-government advisory committee, such as the National Research Council, to monitor and assess progress toward its goals.

Nanotechnology is the future.

Nanotechnology is the builder's new frontier – one where properties and phenomena are very different than those utilized in traditional technologies. Nature builds things with atomic precision. Every living cell is filled with natural nanomachines of DNA, RNA, proteins, etc., which interact to produce tissues and organs. Humans are now learning to build non-biological materials and machines on the nanometer scale, imitating the

elegance and economy of nature. This embryonic capability may portend a new industrial revolution. In

the coming decades, nanotechnology will enable us to manufacture devices that conduct electricity efficiently, compute, move, sense their environment, and repair themselves.

Nanostructures will revolutionize materials and devices of all sorts, particularly in nanoelectronics and computer technology, medicine and health, biotechnology and agriculture, as well as national security. For example, we anticipate computers with a thousand-fold increase in power but which draw a millionth the amount of electricity, materials far stronger than steel but with ten percent the weight, and devices that can detect tumors when they are only clusters of a few cells.

It may eventually be possible to develop technologies for renewable, clean energy; to replace metals with lightweight, recyclable polymeric nanocomposites; to provide low-cost access to space; and to develop new classes of pharmaceuticals. Investments in nanotechnology have the potential to spawn the growth of future industrial productivity. When allied with the biosciences, nanotechnology will accelerate the development of early detection instruments for physicians, as well as the development of noninvasive diagnosis and medical treatment. It will also lower the cost of pure water and healthy food for the world's population.

The United States cannot afford to be in second place in this endeavor. The country that leads in discovery and implementation of nanotechnology will have great advantage in the economic and military scene for many decades to come.

A bold, Federally funded national program is needed now.
Nanotechnology, which is based on phenomena first observed and characterized in the 1980s, is now emerging as an important new frontier. Direct, strategic investments made now in fundamental science and engineering will position the U.S. science and technology (S&T) community to discover and apply nanoscale phenomena, and transfer them to industry. Nanoscale S&T today is roughly where the fundamental R&D on which transistors are based was in the late 1940s or early 1950s. Most foreseeable applications are still 10 or 20 years away from a commercially significant market; however, industry generally invests only in developing cost-competitive products in the 3 to 5 year timeframe. It is difficult for industry management to justify to their shareholders the large investments in long-term, fundamental research needed to make nanotechnology-based products possible. Furthermore, the highly interdisciplinary nature of some of the needed research is incompatible with many current corporate structures.

There is a clear need for Federal support at this time. Appropriately, Federal and academic investments in nanotechnology R&D to date have evolved in open competition with other research topics, resulting in some fragmentation and duplication of efforts, which is natural at this stage. Going forward, however, nanotechnology will require a somewhat more coherent, sustained investment in long-term research. The NNI would

support critical segments of this research and increase the national infrastructure necessary to conduct it.

International Activity in Nanotechnology

The United States does not dominate nanotechnology research. Yet we strongly believe that the United States must lead in this area to ensure economic and national security leadership.

Compared to our nation, other countries are investing much more in relevant areas of ongoing research. Many other countries have launched major initiatives in this area, because their scientists and national leaders have determined that nanotechnology has the potential to be a major economic factor during the next several decades. Japan and Europe are supporting scientific work of the same quality and breadth of that done in the United States. Unlike in the other post-war technological revolutions, the United States does not enjoy an early lead in nanotechnology.

We must act now to put in place an infrastructure for nanoscale research that is equal to that which exists anywhere in the world. A suitable U.S. infrastructure will enable us to collaborate appropriately, as well as compete, with other nations. Without the NNI, there is a real danger that our nation could fall behind other countries. To ensure leadership in the future, the United States must make a large and sustained investment in this area.

Nanotechnology will inspire the public and the next generation workforce.

Our future workforce in S&T is decreasing, in part because far too many young people perceive that action is no longer in the physical sciences and engineering, and do not see how S&T connects to the world as they know it. Yet chemistry, physics, biology, engineering, and materials research are at the core of nanotechnology, which likely will play a dominant role in future decades. The NNI should parallel investments in R&D with a creative and entrepreneurial program that offers young people a truly interdisciplinary education, and that prepares the next generation of researchers and industrial leaders.

As nanotechnology develops, the core areas of the physical sciences, engineering and biomedicine in our nation's universities will become much more intimately coupled to each other. Future research efforts in these fields need a far better integration among each other and to industry and society as a whole. The relevance and inherent excitement of nanoscale R&D should attract young men and women to science as never before and also create exciting and important career options for them.

Nanotechnology and Global Challenges

In the next century, the world population will likely grow to over ten billion. Without revolutionary advances in environmentally sustainable technologies, global society will struggle with the implications of this growth. Nanotechnology, as broadly supported by the NNI, has the potential to develop lightweight, recyclable materials and energy efficient devices that will contribute to such sustainability. Therefore, the United States should move to develop this area quickly, not only for economic benefit, but also for its potential contribution to a more sustainable future.

In closing, we note that when radically new technologies are developed, social and ethical issues can arise. Accordingly, we recommend that a modest amount be set aside for the study of such implications of nanotechnology.

PCAST Letter to the President Endorsing a National Nanotechnology Initiative

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