Langdon Winner's testimony to the Committee on Science of the U.S. House of Representatives on The Societal Implications of Nanotechnology
Wednesday, April 9, 2003

I want to thank the Committee on Science for inviting me to testify this morning. I will do my best to respond directly to the specific issues you have asked me to consider.

"What factors influence the successful adoption of new technologies into society? What questions should be asked during the research and development phase to help minimize the potentially disruptive impact of transformational technology developments?"

Nanotechnology is an emerging technology with enormous potential to alter our way of life in decades ahead. It is by no means the first emerging technology to generate sweeping changes in society and the environment, nor will it be the last.

If one looks at previous episodes of technological transformation, it becomes clear how crucial it is to ask: Who gets to define what the transformation will involve? Typically, what happens is that the promoters of a new technology, those with the most to gain in the short run, are the ones who speak first and most loudly. The boosters predict a wide range of practical benefits - new products, services, efficiencies, improvements of all kinds. Indeed, they usually proclaim that there is a revolution just around the corner, one that will alter society for the better, making us wealthier, wiser, more democratic, and stronger in community bonds.

Often the promoters try a clever ploy, announcing that the changes on the horizon are "inevitable," beyond anyone's power to guide or significantly alter. In advertisements, World's Fairs exhibitions, and public relations campaigns, proclamations of inevitability have long been standard themes.

In contrast, those who have concerns about how the technology may develop and what its ultimate outcomes will be tend to speak later and more hesitantly. As people in society at large take notice, they ponder predictions of a world transformed and begin to raise questions about the benefits and drawbacks, the range of social, economic, political, and environmental consequences involved. Eventually, this broader constituency may ask for a voice in making decisions about where, how and to what extent the emerging technology will be applied.

It is fairly common for those who voice concerns about the social, economic, and environmental consequences of technological change to be denounced as irrational, unscientific and even anti-technology. Thus, Rachel Carson's modest report in The Silent Spring about the environmental destruction caused by the use of chemical pesticides brought heated denials from the chemical industry and attacks on Ms. Carson's scientific credentials (even though she was a noted scientist) and flagrant efforts to destroy her reputation. Of course, we now think of Rachel Carson as a hero, one able to focus our society's awareness of environmental problems and solutions. But as she raised her voice, calling our attention to the consequences of spreading poisons through the environment, she was derided as ill-informed, an enemy of progress.

Recurring episodes of this kind show why it is important to open the study and discussion about emerging technologies to the light of day, and to do this sooner, rather than later, in the process of planning, development and application.

The claim that a particular development is "inevitable" is particularly unhelpful in this

regard. It suggests that people who have recently become aware of potentially significant changes to their way of life have no legitimate role in the negotiations. After all, who would be so foolish as to make suggestions when faced with the "inevitable"? As the motto of the 1933 World's Fair in Chicago informed visitors, "Science Finds - Industry Applies - Man Conforms."

But, in fact, technological change is never foreordained, the future never foreclosed. Real choices need to be identified, studied, and acted upon despite recurring efforts to say, "Sorry, you're too late. Your participation won't be needed, thanks."

Indeed, it seems increasingly clear that open deliberations about technological choices are crucial to the eventual acceptance or rejection of emerging technologies. The boosters like to think that their technologies will enter the world rather smoothly. Emerson's famous dictum, "Build a better mousetrap and the world will beat a path to your door," is an idea many technologists still prefer. What actually happens, however, is far more messy and complicated. The acceptance of any technology requires the building of a broad social coalition that agrees to support its introduction and use. Often there are alternative devices and systems, new ones and older ones, jockeying for this support. The test of whether or not a technology is acceptable is ultimately whether enough people agree that "yes, the new methods make sense."

Alas, all too often those who try to shepherd new technologies into being adopt strategies that cripple the processes through which consensus, coalition, and balanced choices might arise. This strategy can backfire, producing unhappy surprises at the end of the development process. Instead of building a broad national and international base that supports one's innovation, one finds distrust and stiff resistance.

This was certainly the case in the development of nuclear power in the United States. For many years plans were made by talented but inward-looking elites in government, business and the military who thought they knew best what the public would want. They regaled the populace with lovely propaganda about "the friendly atom" and "electricity too cheap to meter," but avoided going public about serious problems that the insiders knew about - the real costs of the plant, safety issues involved in their design, and the problem of nuclear waste disposal.

When these deeper problems finally did surface powerfully in the 1970s and 1980s, the social coalition that proponents of nuclear power hoped would support them suddenly collapsed. The building of nuclear power plants in the U.S. was halted, possibly forever.

Another episode of technological backfire, one perhaps more relevant to the rise of nanotechnology, is evident in the crisis that now surrounds biotechnology. Once again, the social coalition of support, neglected or even scorned as biotech development moved ahead, has now evaporated in key areas of application. For reasons they find entirely sensible, nations in the European Union now refuse to buy genetically modified foods from the U.S. In a similar way, faced with severe famine, Zambia has refused to accept GMO corn, even as a charitable gift.

What this suggests is that the failure to provide open, thorough and honest attention to the broader social, political and cultural contexts that influence the acceptance or rejection of emerging technologies can lead to disaster. Late in the process, it does little good to tell those who are unwilling that they're being irrational or that there is something woefully defective in their culture (not ours). To paraphrase the great American philosopher, Yogi Berra: If people don't want to adopt your better mousetrap, nobody's going to stop them.

I hope that the legislation you are considering, especially its provisions that support research on social and ethical implications of nanotechnology, will help create new practices and institutions in which all the important questions will be rigorously explored. I cannot predict whether or not broadly based, effective social coalitions will form around nanotech projects. I do know that it is increasingly risky to ignore or exclude the great multiplicity of groups and interests that would like to have a voice in defining what these technologies are and what they mean. In fact, wise policy would try to stimulate understanding of the implications of the technology on a broad scale, fostering widespread study and discussion open to everyone.

The Committee has asked, "What are the current concerns about existing and potential applications of nanotechnology science and engineering?"

Nearly two decades after the publication of Eric Drexler's Engines of Creation, a number of concerns about nanotechnology are finally attracting wide attention.

Some observers predict that particular materials produced by molecular nanotechnology (MNT) will turn out to be environmentally destructive.

Some worry that products of MNT could, in some configuration of events, prove hazardous to human health.

A recurring nightmare is that promised inventions in self-replicating systems might escape the boundaries originally established for them and begin to wreak havoc. As novelist Michael Crichton recently commented, "Imagine a mass of tiny computers, each smaller than a speck of dust, programmed to fly in a cloud over a country like Iraq and send back pictures. Imagine the computers begin to evolve and the aggregate cloud becomes a death dealing swarm that threatens mankind - a mechanical plague."

Others hear about ambitious proposals to employ nanotechnology and other "convergent" technologies to create (decades from now) a race of posthumans. Those not yet persuaded that this is "inevitable" wonder whether it's a good idea to seek to divide the human species in this manner and whether public funds should be spent on such ghoulish research.

Another persistent concern is that the rise of this field will not, as promised, be of general social benefit, but will simply amplify trends long under way -- the concentration of wealth and power in the hands of the few and a widening gap between haves and have-nots in the U.S. and around the globe. Historically speaking, predictions the latest and greatest technology will equalize wealth and opportunity have usually proven false, a fact that never deters boosters of the "next big thing" from promising that this time (!) the economic and social developments will be universally shared.

Faced with the various possibilities described in writings about this new field of research, I must admit that I know too little to judge the likelihood of various scenarios, both optimistic and pessimistic. Indeed, I doubt that anyone has this knowledge at present. Rather than play Cassandra (or Norman Vincent Peale), I would simply note three overriding questions that ought to be considered as our society decides which proposals for nanotechnology research are worth sponsoring.

(1) Should we continue long-standing efforts to conquer and dominate nature rather than seek harmony with natural structures and processes?

During the past two centuries, the desire to conquer nature has often seemed synonymous with progress. Dam the rivers, drain the swamps, harvest the forests, and bring all plants and

animals under human control - such counsel seemed eminently sensible. More recently, however, as some unhappy consequences of this ham-fisted approach have surfaced, many scientists, engineers, designers, and entrepreneurs have affirmed that seeking harmony with nature is a more promising technological and economic approach.

Unfortunately, this recognition seems to have escaped the enthusiasts of nanotechnology for whom the prospect of conquering nature right down to the last molecule and atom seems positively invigorating. It appears that God's creation is, alas, not all that it should be. Fortunately, it can now be refashioned by a new generation of godlike spirits who live in Cambridge, Palo Alto, the Research Triangle, and other concentrations of high tech brilliance. Thus, the peculiar values of the American middle class, so exquisitely realized in Happy Meals, SUV's, $200 Nike sneakers, and botox wrinkle treatments, will now be read into the smallest crevasses of the material universe. This is something to look forward to.

All of it occurs at a time in which it should be clear that strategies for dominating nature through brute force have failed repeatedly. For example, the creation of larger, technically more sophisticated fishing boats with better and better ways to track and catch fish has brought astonishing returns. Although it was a difficult battle and took many years to complete, we have finally conquered the Atlantic cod. The poor creature has not raised the white flag. It is simply disappearing from the nets and from the nation's supply of healthy protein.

I understand the obsession with dominating nature and the desire for power and wealth it reflects. These tendencies are a dreary, but recurring presence in modern life. Neverthess, it is still worth inquiring: Why should American taxpayers be asked to subsidize ever more systematic assaults on natural realm? If they knew the kinds of projects sometimes proposed in this domain, how would they feel about them?

At present we see a wide range of scientific and technological strategies that try to work closely with nature rather than impose imperial dominance. It is interesting that these programs -- ones that stress "natural capitalism," "green design" "biomimicry," and "sustainable economy" - point to a new industrial revolution, but one quite different from the revolution described by proponents of nanotechnology. Is it possible that the rush to nanotech will come into conflict effort to create a socially harmonious, ecological sustainable future? That prospect seems entirely likely.

(2) Should we actively promote a path development in which technical means become the driving force that shapes social ends?

The unfolding of nanotechnology may become yet another instance of a familiar phenomenon in which powerful techniques emerge from the lab and then go looking for uses. This pattern defies common sense understandings of the proper relationship between human ends and technical means.

In the common sense sequence, one begins by asking: What are our needs? What fundamental purposes define our inquiries? After the basic social ends have been clarified, compared, debated, and evaluated, we then move on to make choices among existing means, including newly developed technical devices.

As one reads reports coming from scientists and policy makers interested in nanotechnology and converging technologies in several areas of scientific and technological development, one does not see the common sense ends/means thinking at work. In writings on nanotechnology, there seems little willingness to ask: What are society's basic needs at present? What basic goals define our sense of well-being going forward?

What we find instead is a kind of opportunistic means-to-ends logic. Researchers and institutions interested in doing molecular and atomic scale engineering scan the horizon to see what opportunities might be identified as justifications for public funding and private investment.

Thus, enterprising nanotechnologists notice applications that might deliver medical doses tailored to specific cells.

Looking at the sheer size of the Department of Defense budget, nanotech promoters begin imagining ways in which the technology might provide new weapons and other devices to the military. Yes, there's always a lot of money in that.

Others catch on to this lucrative game and say, well, perhaps research on a range of nanotech applications could help the elderly or people with disabilities.

In sum, what we see here are tools that evolve quickly in response to a variety of internal research priorities and then go opportunistically looking for things to do. And, of course, one can always find something.

I am pleased that Congress is prepared to offer support for study of the societal and ethical dimensions of an important new field of scientific and technical research. But I fear that the manner in which the work is done will reproduce the kind of backwards logic that has shaped far too much of American technological development in recent decades. It is a logic that justifies the creation of a wide range of flashy new gadgets but cannot be bothered to examine the most urgent facts about the human condition in our time.

(3) Is it wise to experiment with technological applications likely to produce irreversible effects?

As a general matter, technologies should be judged superior if the consequences of their use are reversible. Some common projections about the outcomes of nanotechnology point to effects that could never be recalled from the environment or from the species with which nano-systems interact. As we scope out the possibilities here, we need to ask: Would particular paths of research and development risk opening Pandora's box? If so, how can present policies help eliminate that menace?

The final question the Committee has asked me to address is probably the one most important for the specifics of the legislation. "How can research on the societal and ethical concerns relating to nanotechnology be integrated into the research and development process?"

A growing number of scientists, scholars, university administrators, and social activists express a vital interest in this topic. Clearly, there is need to initiate systematic studies of the social and ethical dimensions of nanotechnology. We need broad-ranging, detailed, intellectually rigorous inquiries conducted by persons who have no financial or institutional stake that might skew the questions raised or constrain the answers proposed.

Studies of this kind could be launched in a number of ways, including funding truly cross-disciplinary programs in universities to scope out key issues and policy alternatives.
But I would not advise you to pass a Nanoethicist Full Employment Act, sponsoring the creation of a new profession. Although the new academic research in this area would be of some value, there is also a tendency for those who conduct research about the ethical dimensions of emerging technology to gravitate toward the more comfortable, even trivial

questions involved, avoiding issues that might become a focus of conflict. The professional field of bioethics, for example, (which might become, alas, a model for nanoethics) has a great deal to say about many fascinating things, but people in this profession rarely say "no."

Indeed, there is a tendency for career-conscious social scientists and humanists to become a little too cozy with researchers in science and engineering, telling them exactly what they want to hear (or what scholars think the scientists want to hear). Evidence of this trait appears in what are often trivial excercises in which potentially momentous social upheavals are greeted with arcane, highly scholastic rationalizations. How many theorists of "intellectual property" can dance on the head of a pin?

One way to avoid the drift toward moral and political triviality is to encourage social scientists and philosophers to present their findings in forums in which people from business, the laboratories, environmental organizations, churches, and other groups can join the discussion. It is time to reject the idea there are only a few designated stakeholders that are qualified to evaluate possibilities, manage the risks, and guide technology toward beneficial outcomes.

Examples of technology policy steered by narrowly interested technical elites can be found in America's systems of medicine. For several decades, research and development have produced ever more exotic, high tech treatments that help propel costs of health care to dizzying levels. Following this path, according to the Word Health Organization, the U.S. ranks only 24th the quality of medical care actually delivered to its populace.

For many decades, there has been a tendency in government funded research and development to exclude the participation of those who are the ultimate stakeholders -- the general public. Citizens pay the bills for the work unfolding; they and their children and grandchildren will be the ones to experience the ultimate outcomes, good or bad.

Why not include the public in deliberations about nanotechnology early on in the process rather than after the products reach the market?

In that light, I believe Congress should seek to create ways in which small panels of ordinary, disinterested citizens, selected in much the way that we now choose juries in cases of law, be assembled to examine important societal issues about nanotechnology. The panels would study relevant documents, hear expert testimony from those doing the research, listen to arguments about technical applications and consequences presented by various sides, deliberate on their findings, and write reports offering policy advice.

It is possible that the news media would find these citizens panels a fascinating topic to cover. The active engagement of everyday folks in the shaping of public understanding of emerging issues and controversies in this area could make extremely valuable contributions to the articulation of issues, problems and possible solutions.

To begin, one might ask citizens panels to explore two highly relevant questions.

Will proposed paths for the military application of nanotechnology make us safer or not?

Would projected uses of nanotechnology in industry tend to create jobs or eliminate them?

There is now a lively research program within the National Science Foundation -- Social Dimensions of Engineering, Science, & Technology -- that funds experimental citizens panels of the sort I am describing. I would suggest that Congress build upon these fruitful

experiments and specify (perhaps in the present legislation) citizens panels as one way to inform public debate about the societal and ethical dimensions of nanotechnology.

These days we often hear how important it is to be innovative in emerging technical fields. Here is a way that Congress could be truly innovative - creating ways for citizen stakeholders to join in the study and evaluation of new technologies.

Thank you for considering these ideas and suggestions.