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Nanotechnology Stakeholders Meeting  
Senate Committee on Environment and Public Works  
Washington, DC 6 April 2006

Key Points

1. Productive nanosystems will be programmable, molecular-scale systems that make other useful nanostructured materials and devices. They will be qualitatively different from nanomaterials, particularly regarding regulatory issues.
2. Such molecular machine systems are in their infancy today; only a handful of primitive devices exist in the lab. A Technology Roadmap for development will be completed in about a year (Battelle/Foresight).
3. Nanosystems will bring powerful new capabilities, from highly advanced medical applications to equally advanced weapon systems which could be abused. While in principle nanosystems could be designed to self-replicate, as do biological systems, this would be both very difficult and is unnecessary to provide manufacturing capabilities.
4. The ability to make goods to atomic precision implies that we would have pollution-free manufacturing: byproducts could be recyclable molecules and waste heat. Land saturated with toxic waste could be converted to clean soil on-site. Why, then, do we have such deep concern about responsible development? Because this is a dual use technology, and the implications for weapons development are equally dramatic. We seek to prevent abuses by those who would threaten our security.
5. Safeguards need to be created as integral parts of these systems. Responsible development dictates that we create safe and reliable systems using a methodology that instills public confidence. This needs to be a thoughtful process, not a series of knee-jerk reactions to fictional stories of machines run amok.
6. We recommend developing voluntary consensus standards which could be incorporated into regulations and enforced by an appropriate agency. The successful NIH Biosafety Guidelines and the ASME Boiler and Pressure Vessel Code serve as excellent models for the voluntary guidelines and the standards enforcement approaches respectively. The ASME Code has been incorporated into federal and state regulations, and the public safety is enhanced by this additional legal authority. Since 1999, the Foresight Nanotech Institute and the Institute for Molecular Manufacturing have produced the Foresight Guidelines on Molecular Nanotechnology that provide initial guidelines for the responsible development of productive nanosystems by practitioners, industry, and government. These Guidelines are now in their sixth revision.
7. Like computing, the field of nanotechnology is very broad, and thus its regulation spans human health and safety (NIH), environmental protection (EPA), and eventually weapon systems (DoD, DHS, CIA). It is important that we make appropriate distinctions between different classes of nanotechnology and that we effectively coordinate between agencies on issues of jurisdiction, monitoring, and enforcement of regulations.
8. This is a perfect opportunity for the U.S. to provide leadership and do things differently: instead of developing legislation in reaction to technology gone wrong, we have a rare and unique opportunity to be proactive and craft legislation that builds on legislation already in place, and to shepherd an emerging technology as it matures.



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9. It will be critical to do this in a way that minimizes the impact on the pace of development—from both economic and security perspectives, the U.S. and its allies cannot afford to be second out of the gate with productive nanosystems.

## Recommendations

1. Initiate federally-funded standards research and component design for productive nanosystems:
  - a. Establish a standard set of terms to describe the different technologies
  - b. Direct funding explicitly toward the development of productive nanosystem components
  - c. Study safeguard designs and support development of consensus standards
  - d. Promote the adoption of ethical guidelines for practitioners in the field
  - e. Provide for international collaboration and monitoring
2. Re-craft existing legislation to include productive nanosystems as a dual-use manufacturing technology: nanosystems are a highly desirable engine for economic growth and environmental rejuvenation, but with the potential for abuse similar to chemical and biological weapons.
3. Establish a division within a regulatory entity or a new agency with sufficient resources to ensure standards enforcement across the government, including the Dept. of Homeland Security, DoD, DOE, NIST, EPA, HHS, and other relevant agencies.