

Remarks of David R. Forrest, Sc.D., P.E. at the Nanotechnology Stakeholders Meeting, Senate Committee on Environment and Public Works, Washington, DC 6 April 2006.

Good afternoon! On behalf of the Foresight Nanotech Institute I'd like to thank the committee for the opportunity to share our views and perspectives. Foresight has been involved in nanotechnology policy issues since its inception in 1986, and we are keenly interested in applications for the environment and public works so we very much appreciate the chance to participate today. As you may have already seen, if you've browsed through the two pages of graphics handouts, we have a rather different perspective than many of the others that you've heard about today.

Clearly, there's a huge technological difference between nanoparticles [holds up grayscale photo in right hand] like these silver nanoparticles, and productive nanosystems [holds up color graphic in left hand] like this concept drawing of a future manufacturing operation. Nanoparticles are of immediate interest and importance, and Foresight has publicly advocated for substantially increased funding for testing of nanomaterials.

But I'm focusing on nanosystems because the future benefits of nanomachines that can build and repair dwarf the expected benefits of nanomaterial technology. Productive nanosystems will be programmable factories that will be able to make atomically exact objects of any size by manipulating individual molecules—billions at a time. This means that the products of this technology will be of very high quality, low cost, and their manufacture will have a positive impact on the environment. This will be a VERY CLEAN technology. The regulatory issues for nanosystems are considerably different from those of nanomaterials.

Molecular machine systems are in their infancy today; only a handful of primitive devices exist in the lab. There are some examples in our handout. And a Technology Roadmap for development will be completed in about a year (Battelle/Foresight).

Productive nanosystems will bring powerful new capabilities, from highly advanced medical applications to equally advanced weapon systems which could be abused. Because this issue sometimes comes up, I want to mention that, while in principle nanosystems could be designed to self-replicate, as do biological systems, this would be both very difficult and unnecessary to provide manufacturing capabilities.

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, since this sounds so clean and safe, do we have such deep concern about responsible development? Because this is a dual use technology, and the implications for weapons development are as equally dramatic as those for the environment and medicine. We seek both technological and sociopolitical means to prevent abuses by those who would threaten our security.

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.

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. We've come a long way since the days that pressure vessels exploded randomly, killing people. The ASME Code has been incorporated into federal and state regulations, and the public safety is greatly enhanced by this additional legal authority. The Biosafety Guidelines are more akin to the kind of technology relevant to productive nanosystems.

Well, since 1999, the Foresight Nanotech Institute and the Institute for Molecular Manufacturing have produced the Foresight Guidelines on Molecular Nanotechnology that provide ideas and guidance for the responsible development of productive nanosystems by practitioners, industry, and government. These Guidelines are now in their sixth revision.

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 (like between nanomaterials and nanosystems) and that we effectively coordinate between agencies on issues of jurisdiction, monitoring, and enforcement of regulations.

Because nanosystems are just emerging, this is a perfect opportunity for the U.S. to provide leadership and do things a little 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 what's already in place, and to shepherd this promising, young technology as it grows and matures.

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

So, what does Foresight recommend that we do? [hold fingers up]

1. Initiate federally-funded standards research and component design for productive nanosystems:

- Establish a standard set of terms to describe the different technologies

- Direct funding explicitly toward the development of productive nanosystem components

- Study safeguard designs and support development of consensus standards

- Promote the adoption of ethical guidelines for practitioners in the field

- 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.

Mr. Chairman, that completes my comments and once again I'd like to thank the Committee for the opportunity to provide Foresight's perspectives and recommendations on nanotechnology regulation.