

The Nanotech Schism

High-Tech Pants or Molecular Revolution?

The field of nanotechnology is divided between those who think it will simply improve our lives and those who think it will completely transform them. The former group thinks of nanotechnology as essentially a new branch of materials science. The latter group, inspired by nanotechnologist Eric Drexler, hews to a more ambitious vision in which molecular manufacturing, nanomedicine, and even nanoweapons will radically reshape the world. Many people in the former category think that Drexler's version of nanotechnology is bunk.

In recent months, the divide between the two groups has become more pronounced and bitter—and it couldn't have come at a worse time, as environmentalists, reporters, novelists, moviemakers, legislators, and regulators are beginning to pay attention to the potential risks of nanotechnology.

The first sign of the new trouble came late last year with the passage and signing into law of the Nanotechnology Research and Development Act, which boosts federal nanotech spending over the next few years. Assuming the schedule isn't altered, federal spending on nanotechnology is

going to increase each year until it crosses the \$1 billion yearly mark for the first time in fiscal year 2008.

This is a remarkable sum of money for a technology that is not just unproven, but almost nonexistent. Today, simple forms of nanotechnology are used in a few consumer products—like some new semiconductors, sunscreens, and stain-resistant trousers—but it isn't clear that such products are worth billions of taxpayer dollars. The real reason the government is willing to shell out for nanotech is because our leaders in Washington believe in the more revolutionary version of nanotech espoused by Drexler, with all its great promise and grave perils. "The possibilities are limitless" as we move "from an age of miniaturization to an age of self-replication," says Rep. Michael Burgess, Republican of Texas. Developing nanotechnology to maturity will require "long-term, sometimes high-risk" research, says Rep. Mike Honda, Democrat of California. The White House website describes the possibility of "nanomanufacturing of parts and materials 'from the bottom up'—by assembling them on an atom-by-atom basis."

One crucial provision of the nanotechnology bill might have gone far to determine whether Drexler's vision of nanotechnology is truly worth pursuing. This provision called for a study to evaluate the technical merits of "molecular manufacturing" and, if possible, prepare a timeline and a research agenda. Such a study could settle whether Drexler's ideas should be taken for real or ignored. But the final version of the bill only called for a study of the feasibility of "molecular self-assembly." This change in wording, made at a very late stage in the legislative process, may seem insignificant—but its actual effect was to gut the intended feasibility study of all usefulness: molecular self-assembly is not merely feasible, it has actually already been achieved.

The deletion of the molecular manufacturing study came as a major blow to those who hoped the Drexler version of nanotech was on the verge of getting a fair hearing. Several of them took to the Internet to blame the study's deletion on the NanoBusiness Alliance, the industry organization that represents the companies now engaged in mainstream nanotechnology. In response to the online criticism, F. Mark Modzelewski, the president of the Alliance, wrote an article mocking the "bloggers, Drexlerians, pseudo-pundits, panderers and other denizens of their mom's basements" who had developed "an elaborate fantasy about how molecular manufacturing research work was pulled from the bill by some devious cabal." In fact, another NanoBusiness Alliance official had already admitted to a reporter that the Alliance had approached the staff of Senator John McCain, Republican of Arizona, to have the study removed from the legislation.

Modzelewski and the NanoBusiness

Alliance clearly do not want to be associated in the public mind with the Drexler version of nanotechnology, but it was still surprising to see the lengths they would go to distance themselves. In January and February of this year, Modzelewski stooped to name-calling, writing vituperative e-mails to Glenn Harlan Reynolds, the University of Tennessee law professor and Drexler ally who has written thoughtful and serious articles on questions of nanotechnology policy. In one e-mail, Modzelewski said Reynolds was writing "nutty diatribes" based on "delusional fantasies," which he likened to "a wino's claims on skid row that bugs are crawling under his skin." The nanotech ideas of Eric Drexler and his supporters are just "comic relief," Modzelewski said.

This is unkind, unfair, and untrue. Were it not for Eric Drexler and his ambitious vision of molecular manufacturing, no one would have heard of nanotechnology today—and the federal government would certainly not be investing billions of dollars in nanotech research if they knew only of Modzelewski's modest mainstream aims. When lawmakers in Washington discuss the industrial potential of nanotechnology, they aren't thinking about stain-free nano-pants, but about molecular manufacturing, as envisioned by Drexler. It is *that* vision in which the politicians think they are investing.

For all Modzelewski's criticism of Drexler's "fantasies," no one has been able to sustain a scientific case against Drexler's version of nanotechnology since he first laid out a rigorous explanation of his ideas a dozen years ago. The most vocal of Drexler's scientific critics, Nobel laureate Richard Smalley of Rice University, agreed to debate Drexler in print last year. Their exchange, which appeared in the

December 1, 2003 issue of *Chemical and Engineering News*, did not settle the matter; in fact, Drexler and Smalley seemed to be talking past each other. In the end, Smalley stopped trying to win the debate with scientific reasoning and resorted to an emotional appeal, accusing Drexler of conjuring up a nanotech “monster” that has “scared our children.”

There is a kernel of truth in Smalley’s claim: Drexler *has* been warning for years about the potential risks of nanotechnology. But until someone demonstrates Drexler’s version of nanotechnology to be scientifically unsound, it cannot just be dismissed because it “scares our children.”

And children aren’t the only ones with fears. Last year’s bill, in addition to increasing funding for research, has also committed to studies of the ethical, societal, educational, legal, and workforce issues related to nanotechnology. Soon, universities will have professional nanoethicists making a living by pointing out the dangers of nanotech. Several

health and safety studies related to nanotechnology are underway. Environmental activists (including Prince Charles) have already begun to fret, and some critics have called for a complete moratorium on nanotech research.

Very few technologies have been as feared in advance as nanotechnology has been. If Mark Modzelewski and Richard Smalley really think Drexler’s ideas are just frightening fantasies, then they should quit the name-calling and welcome the chance to disprove those ideas. The government’s feasibility study of molecular manufacturing should be reinstated, and the matter should be put to rest once and for all. If Drexler’s ideas can be proven definitively wrong, then we can relax in our comfortable nano-pants. But if Drexler is correct, there is much work to be done. If the stakes are as high as Drexler and his allies suggest, the world needs to get this right the first time, for there is very little room for mistakes.