

# Vision for Converging Technologies and Future Society

PHILLIP J. BOND

*Under Secretary of Commerce for Technology, U.S. Department of Commerce, Technology Administration, Washington, D.C. 20230, USA*

**ABSTRACT:** This brief presentation places the challenges of nanotechnology in a political, social, and economic context.

**KEYWORDS:** NBIC convergence; public policy; future technology; social and ethical implications; nanotechnology

It is a privilege to be here on behalf of President Bush and Secretary of Commerce Don Evans, but I am a little uncomfortable being in a room with *real* technical experts. Mike Roco did me the great favor of not going through my background, which would betray a political animal with an interest in technology and an affinity for it, but not anywhere near the technical expertise of the folks here, so bear with me because I do want to talk about some serious matters.

This is a low-tech presentation, a chance to talk informally about the philosophy and “big picture” as we try to move the NBIC agenda forward in America and around the globe. We’ve come together at this conference at a special time for the scientific community writ large, and a very poignant time on the heels of the Columbia tragedy. I’d like to recount an anecdote that brought that point to life: my Assistant Secretary, a Princeton graduate, gave me his alumni newsletter this week. On the front page was the story of a Princeton nanoresearch initiative done in conjunction with NASA, and it was all about self-healing skin for shuttles. It was ironic to have that show up in your mailbox on the heels of the tragedy, but it makes the point that the exciting

Address for correspondence: Philip Bond, Under Secretary of Commerce for Technology, U.S. Department of Commerce, Technology Administration, 1401 Constitution Avenue, N.W., Washington, D.C. 20230. Voice: 202-482-1575; fax: 202-501-2594.

phillip.bond@technology.gov  
www.technology.gov/UnderSec.htm

**Ann. N.Y. Acad. Sci. 1013: 17–24 (2004). © 2004 New York Academy of Sciences.  
doi: 10.1196/annals.1305.002**

things that you're working on cannot possibly come soon enough. President Bush at the memorial service said "each of them knew that great endeavors are inseparable from great risks, and that each of them accepted those risks willingly—even joyfully—in the cause of discovery. This cause of discovery and exploration is not an option we choose. It's a desire written in the human heart. We are that part of creation which seeks to understand all creation."

And out of respect for the crew of the Columbia and my colleagues at NASA—all of whom were bonded by that spirit of discovery—I'd like to ask us all to take a moment to reflect on that sentiment. But we will press on, we will persevere, for it is written in our hearts, and that is very much what this conference and your work is all about.

The ideas, the theories, the convergence of NBIC and the possibilities you're contemplating, the businesses you're contemplating are mind-boggling, awesome, incredible, uplifting, fill-in-the-your-own-adjective endeavors. But as awesome as they are, we also need to recognize that technology, always and everywhere, has been a two-edged sword.

This pursuit of technological gain has always been double-edged in three areas: societal, financial, and political.

With respect to the political: the body politic is susceptible to the virus of fear. Fortunately history shows that we've done pretty well dealing with that virus, and when I reflect back on the 20th century and the advances we've made, I tend to do so in a very personal way: my grandparents, Ralph and Helen Baird, made a life out here in Compton, California. He was a science teacher in high school. He died last year at 101, preceded just slightly by his wife, who died at age 99. Before they died we made a videotape of them looking back on all the things they'd seen in their life. They'd literally personally moved from Conestoga wagons to watching a man land on the moon. What they saw spanned the advent of the horseless carriage, the massive deployment of electricity, to the atomic age. They told great stories about the early days of the automobile. When they lived in Kansas they called the party line to alert the neighbor on the next farm to "Quick! Run down the road, because one of those things is coming!" They went on to see instantaneous global communications. They didn't really understand, but did appreciate the fact that you could have live coverage of events from around the globe. They also lived to see the sequencing of the genome and cloning.

Again, each of these accomplishments had downsides, and, as the truism has it, some things, the more they change, the more they stay the same. During the Industrial Revolution Dutch workers feared that machines would replace human beings, and so they took their wooden shoes—*sabots*—and threw them into the machines to clog them—the first case of *sabotage*.

With respect to financial concerns: at the dawn of the electrical age it was Westinghouse vs. Edison, AC vs. DC. Edison was invested in DC. He wanted to show that AC was dangerous and that we should fear it, and so he electrocuted animals, cats, horses, even an elephant, to make his point.

I just read Stephen Ambrose's lively history of the transcontinental railroad, which shows parallels to the building out of the IT network: the financing schemes behind building the railroad sound like they came out of today's headlines about the finances behind the Internet.

Social-ethical questions can be seen in fearfulness and skepticism of the Wright Brothers' activities: "If man were meant to fly . . ." and with regard to automobiles, some may be unaware that when they first became available, they were sometimes banned from cities. San Francisco had a law that you had to park your car at the edge of the city and ride a horse or carriage into town.

Look now at the twenty-first century—we see that almost anything can be done, when you think about building from the bottom up, but it can only be done if we address the other edge of the sword.

The same technologies that have brought scientists together, particular the information technologies, have made our world smaller, and have brought more people into the public square. In effect, IT has brought more people looking over your shoulders into your labs, as they have at least some information about what you're contemplating. And more and more often, these are people who think science is too important to leave to the scientists. So scientists have a big challenge, recognizing the imperative to go forward, while being aware of their societal obligations.

We are talking about convergence ideas, bringing the wet and dry labs together and tying in cognitive and other research to do really miraculous things. It's not fantasy to talk about being able in the future to help the blind to see and the deaf to hear, to solve world hunger, to beat cancer and AIDS, and to create new types of knowledge at this convergence. And yet others will find this downright scary: the race to the apocalypse.

Let me sound a realistic note as we tackle these issues as a culture and as a country. I'm not trying to be negative. I would subscribe to the notion put forth by Churchill after London was bombed: "This is not the beginning of the end, it's the end of the beginning." I think that's where we are. But people are going to be fearful. Accelerating technological change means accelerating moral and ethical changes as well; it means that the margin for error is much smaller for all of you. It means that your job—as scientists, engineers, and those commercializing these discoveries—is tougher than that of those who have gone before you, because we do have more people involved in the public square.

And when I look ahead at this future, I ask myself some of these ethical and moral questions as a father of two young daughters. I read in *Wired* magazine about the emerging new race called *robo-sapiens*. Or I read Bill Joy's infamous piece about how the future doesn't really need us. Looked at through the prism of being a father, I realize that collectively we have to pay attention to the kind of world that we are creating. We must do this because it is the right thing to do and it is the necessary thing to do, balancing the

needs of society with the advancement of discovery. If we don't know that after 9/11, we'll never know it. Positive things are being contemplated, being accomplished, that should have huge and beneficial global impacts in terms of health care, the environment, and clean water. At the same time we must contemplate malevolent applications as well. What might the fruits of some of these technological advancements do in the hands of terrorists? What are the consequences of the embedded information technology surrounding us? As a parent, I'd like to know where my daughter is every second. But for an American society that values privacy there is also a downside. For other advances, it's even more ambiguous: I'm 46, and I'm having trouble pulling up names. I'd like to be able to plug in a little additional memory back here sometimes. And as I put in my contact lenses, I think that maybe it's not so bad to trade in the old 20–20 for some infrared, telescopic, or microscopic enhancements. But then you begin to think about customizing DNA and you're starting to talk about a departure from human development, which gives rise to some real and legitimate fears. We talk a lot about the gap between the haves and the have-nots. Think about a world of nano haves and have-nots: people who may have cognitive and physical abilities enhanced, who may be nourished by foods designed to knock out diseases that the rest of the world is dying from. This makes the playing field even more uneven and the *gap* becomes a *gulch*.

So we cannot afford to wait to deal with these issues. We have to wrestle honestly with them right now. And I submit that as scientists, *you* are in a position to help the culture and public policy makers more than many others. We can't afford to wait, because the public policy apparatus does not move quickly. And it is not designed to move quickly. I'm not second-guessing the wisdom of the Founding Fathers, who designed the system to move slowly and to require a super-majority in different cases. But the bottom line for you in a fast-changing world is that you're going to come up against a world that is designed to move slowly. You will have to think in advance about how to engage the public in the political arena—a political arena that is designed to be responsible to the general public and a general public that is susceptible to the virus of fear.

The system is designed to move slowly, as I said, but the rules of our Federal system are such that one senator who has serious concerns can stop a bill, one chairman who has a concern—whether legitimate or real or not—can stop a funding bill, even the funding bill for the NSF, indeed *any* funding bill. So we have to join forces.

Now, there's a lot of hype on the nano-front, and that's both good and bad. My fundamental job is to make sure we get the policies enacted in the federal government that are going to maximize technology's contribution to the U.S. economy, job creation, and standard of living. That means policy and it shouldn't be hyped. We'll try to filter out some of the hype, but there's also a lot of hope—a great virtue. But how does it interact with policy? The truth is

you don't get policies without some social passion. And guess what? The alchemy of hype and hope gives rise to exactly the social passion you need to move the political body. Without some passion in the public square—well-informed passion that deals with the fears—we will not achieve the potential that nanotechnology has to offer and we will not maintain America's current leadership in this critical arena of science and technology.

Let me comment briefly on the financial aspect I've alluded to as a possible hurdle. I have some concerns: I've talked with people at such places as the NanoBusiness Alliance about how, on the heels of the dot-com bubble, the technology community writ large cannot afford to have a nano bubble, to have people rush in and invest because it's a nano-whatever, to think that that's where venture capital needs to invest its money. We don't want to get burned because the technology and commercialization horizons really are longer. We don't want investors to think that anything the U.S. tech industry comes up with is just a mirage. My favorite shorthand for that: "Don't let *nano* become a four-letter word." Let's keep things in perspective and be honest with people in the funding world and elsewhere. Again, it really is a case of being more about my daughter's future than about mine. In the near term, it's largely about incremental, evolutionary improvements in existing products like the applications of Burlington Industry's NanoTex nano-fibers. I had dinner a month ago with a CEO who was bragging about his nano tie. Changes are going to be more incremental than fundamental, and more about our children's future than about ours.

If that's going to happen, we need to return to the issue of the socio-political challenges to which we're going to have to rise. We're seeing them already: genetically modified organisms, GMOs, are already being called "Frankenfoods." We have people starving in Africa even as we speak because the public is concerned about GMOs, which are still blocked in the EU. Advancements in IT, public privacy issues... human cloning.

We've seen a foretaste, I think, of the convergent world in the public distaste for performance-enhancing drugs among athletes. We talk about NBIC convergence and what it could mean for enhancing human performance, a combination of words that causes the knees of some Americans to tremble. It might even be a separate project to look at some time under the National Nanotechnology Initiative (NNI), to think about the language that can best be used to advance our common cause. There are some issues we can't just dismiss: for every Alar over-reaction, there are the DDT and thalidomide cases that remind us of the environmental and human consequences of technological misjudgments. They will be covered by the mass media—as they should be. They will cause people to hesitate. The good news in all this is that the NNI had the foresight to know that this was a concern and has a mechanism for addressing it written right into their very founding documents—the idea of building a program component to consider the social, ethical, legal, and cultural implications of nanotechnology. Now I understand that naturally and

necessarily, your minds race to all the positives, and I don't want to stop you. But I want to encourage you to use a little bit of your time and intellectual capital to help us in the policy arena to understand the potential negatives. When should you engage? Do you wait until there is an application that causes controversy? Or do you try to find an answer earlier?

I'm not going to pretend to be enough of a technician to know the answer to those questions, but I hope it can be earlier than the applications. Because at that point the body politic can get very excited, nervous, and indeed sick, causing great delay in an advance that can be wonderfully positive. So I want to encourage you to help us to think about how to handle this type of challenge, because you are in the best position to know what they might be. We are going to need scientists and engineers right there on the front lines to engage Washington, D.C. so that we can understand the upside as well.

What I'm really talking about is building support for the nano-future from the bottom up, and we're going to have to do that together with business people, scientists and engineers, and policymakers just to make sure that we don't get hung up by fear, and to do it in a way that ensures American jobs and protects American values.

The reason for that consideration is, of course, that there *is* a global context and, it's one of great competition. The government of Japan says that nano is key to the "restoration of the Japanese economy." They anticipate nano spending of about a billion dollars next year. The Peoples Republic of China says about \$240 million will be spent by the central government, and a like amount—maybe a little more—from local governments. Taiwan, \$112 million; Singapore, \$37 million, Korea \$145 million; in Israel universities are banding together for a total of about \$100 million and there is now an Israeli nano-business alliance. Recently Prime Minister Shimon Peres suggested \$670 million for a national initiative.

Europe has published the Sixth Framework, their policy paper for governmental investment there. In conjunction with the Sixth Framework, the European NanoBusiness Alliance put out a report entitled, "Ours to Lose," declaring that they are the world leader in nano research, but that the future is theirs to lose. By their accounting, they're saying they're going to exceed the U.S. in funding by a factor of two or more in the coming year. Now, I'm understandably skeptical of this because what Europe has really come up with is a fairly crafty marketing approach, thinking people are more likely to invest if they think you're number one than if you're number three or four. So this is a very competitive field and it behooves very clear focus on the part of U.S. policymakers. John Sargent and others on our staff at the U.S. Department of Commerce have been given the task of assessing U.S. competence with respect to where the global competition is, and I'm betting on America. If you look at the number of patents or publications, the U.S. is far ahead. The NNI is being replicated in other countries, and national plans are all almost verbatim copies of the NNI written here in America.

The other reason to bet on America is that we seem to have something in our national genetic code that makes us serial entrepreneurs. There are countries that can compete with us in per-capita patents, but they cannot compete with us in getting the products to market. Those of you who are involved in the technology transfer processes in this country understand that you are a great advantage to the United States. The current budget for nanotechnology research is almost \$850 million, which represents an increase of 7–15% over last year. The President has proposed a record \$123 billion dollars in basic research, a 9.5% increase over last year's record request. We proposed \$112 billion dollars in basic R&D for 2003. Congress has not passed the 2003 budget. And unless they pass it soon, the Congress will move on to the 2004 budget, a case in point of slow-moving public processes.

You know the priorities of NNI better than I do. I encourage you to pursue those, in the labs, in businesses, in transfer efforts. I want to assure you we're trying to do our part. In another part of my bureau is the National Institute of Standards and Technology (NIST), which carries out so much of the quantum metrology that you build upon, and we want to increase their budget as well.

Let me also assure you that in President Bush's proposed budget for the coming fiscal year there is a specific reference to NBIC convergence: "The convergence of nanotechnology with information technology, modern biology and social sciences will reinvigorate discoveries and innovation in many areas of the economy." So we recognize NBIC convergence, and we recognize that it is key to long-term economic growth and job creation.

The states are also moving out for competitive purposes to build clusters within their states, and universities are active as well. At the next level, you've got companies, venture capitalists, and enabling organizations. In Texas, there are about 40 nano-enabling groups already. As you can see, we have to engage at every single level if we're going to reap the benefits and address the real concerns.

The nano challenge inspires the next generation. Like the race to the moon, nanotechnology, in building human-condition solutions from the bottom up, is something young people can wrap their mind around. My 11-year-old's favorite subject is science, but by the time she's 15 the odds are overwhelming that it will not be her favorite subject, and we need to understand why. One step in keeping her and her peers interested is recognizing that the NBIC convergence is as exciting as the space race.

Let me close with this: I'm not a scientist or an engineer. I'm supposed to know how to move the levers of government in a way that will help you. I bring passion to that mission because I believe that we can make life better not only in America, but in the whole world. We can diminish the desperation around the globe, increase the hope, decrease the breeding ground for terrorism, and increase the breeding ground for opportunity and advancement.

In my position as Under Secretary of Commerce for Technology, I can guarantee that the opportunities and challenges of nanotechnology are

brought to the attention of Commerce Secretary Don Evans and other senior Administration officials in the White House and other federal agencies.

My final note is about the reality of politics—the necessary evil. To accomplish your objectives in Washington you have to understand the corporate culture of this town and know how to work within it to achieve your objectives. We need you to be engaged. We need your passion, your vision, and your knowledge to inoculate the body politic against the virus of fear.

I am a steward of the public trust and I pledge to be a passionate one. Together we can realize the hope...harness the hype...wrestle with the ethical...and maintain American leadership in the 21st century.