Nanotechnology and the Body:
The Convergence of Technologies and Human Potential

I have been envisioning a world in which a functioning, radical nanotechnology exists for the past ten years in my Nanotech Quartet, which consists of Crescent City Rhapsody, Queen City Jazz, Mississippi Blues, and Light Music. As is sometimes the case in science fiction, reality seems to have caught up with me. In 1990, I could never have imagined that what seemed a strange little corner of speculative thought would be the subject of a Forbes Nanotech Report to which one could subscribe in order to keep track of the hottest new investments.

Nanotechnology is, in fact, the magic word of the moment. It is nebulous enough to mean many things to many people: an enabling technology, a method of streamlining manufacturing, a visualizing technology, and a buzzword signalling that the world and our lives might change in the next few decades in ways that we cannot now predict. We are moving faster than the terrain our headlights reveal.

We are living in a very important age in human history. Never before has so much information, and so much transformational power, been at our command. And never before have we had the luxury of being able to think about what we want, or what we ought to do with the technologies we are inventing. It is our responsibility to find out all that we can about what is happening in the world of science and how that might relate to future social change.

I am not a scientist. When asked about my science credentials, I often respond that they are the same as Greg Bear's, who is a well-known science fiction writer: a degree in English, and the ability to do research. I always have scientists vet my novels, and,

in fact, a lot of scientists seem to enjoy them, so I guess I'm doing a good job in translating the worlds revealed by science into believable fiction. I speak to you as a writer, someone who deals in creating visions, and as a teacher who spent thirteen years learning how children learn. Writing science fiction and teaching are both ways to envision the future, which is what I seem to do.

The word matter, in its Latin root, means mother. All matter is, in this sense, of us. We are of it. But it is only in the twentieth century that, because we have developed finer and finer ways to look at matter, we have been able to manipulate it to any great extent.

But how do we want to manipulate it? Who decides?

I assume that this audience is already conversant with not only the claims of nanotechnology, but with its history--beginning with Feynman's famous 1959 "there's plenty of room at the bottom" lecture and continuing through Drexler's Engines of Creation, which postulated both amazing possible social changes as well as the danger of "gray goo" -- the result of the creation of a universal replicator which could change all matter to just one thing. What I did not know until recently is that there exists a certain antagonism between Drexler and Richard Smalley, who received the Nobel Prize for Chemistry for his discovery of fullerenes. They ridicule one other's vision in print and on the internet. Who is right? Perhaps both of them. Drexler denies, for instance, that Smalley's characterization of his vision as one which requires "small, sticky fingers" is what he actually proposes or theorizes. When I saw him give a talk last spring, he said, "Where are these small, sticky fingers? They're not there." There is a schism in envisioning how the future of nanotechnology--and our future--will unfold. I find this fascinating, encouraging, and great stuff for the ongoing dialogue which takes place in science fiction. .

One problem with the various visions of nanotechnology is that they are so open-ended and speculative. Many doubt that Drexler's vision, which I call strong or radical

nanotechnology as outlined in The Engines of Creation, is possible. But open any technical or scientific journal today and you will see the prefix nano applied to information in every scientific sphere--biology, chemistry, and physics, to the extent that it may not be long before all of the disciplines develop at least a bit more commonality, a bit more linkage.

Here are some examples of the ways in which nanotech is referenced in recent issues of Science News:

“Dream Machines from Beans,” September 20 2003 Science News Vol 164: Carlo Montomegano of the University of California Los Angeles says, "The more we understand how living systems work, the more we're going to find that they are designed and structured in ways that we would like to use to fabricate and engineer nanomachines.”

This is one of the most promising avenues of what is called nanotechnology. By using or mimicking living cells and systems, we can vastly improve the efficiency of manufacturing, health care, and, I am hoping, education.

Here’s another one: “Gas Sensor uses Nanoteube Parts,” July 19, 2003, Vol 164 of Science News:

"The device includes an electrode made from an array of carbon nanotubes that produce a strong electric field. Gas molecules subject to this field become ionized. The specific voltage needed to ionize a particular gas is an identifying signature.” This device, developed by Nikhil Koratkar of Rensselaer Polytechnic Institute in Troy NY, is “small, easily powered, safe, and fast.”

Small, easily powered, and fast are hallmarks of what applied nanotechnology and nanoengineering promise to bring to the table in the very near future and, in fact, right now.

Certainly, a lot of what is presently called nanotechnology is not, actually, nano in scope. It is very small, but it is still macro. Start-up companies with Nano in their title, if pressed, will admit this.

One of the developments touted as true nanotech are quantum dots, called q-dots. These are semiconducting nanocrystals the size of one organic molecule or as large as twenty nanometers. They fluoresce, and can be used to locate and image very small tumors and to perform cheap, fast medical tests, among other things. This technology is already in production for use in various medical applications. You can buy q-dots, many different kinds of them, on the internet. Q-dots are also being used at Laurence Livermore Lab to enable bottom-up creation of computer chips, which are, of course, rapidly becoming the core of our civilization.

Some of us have internalized technologies, such as pacemakers, artificial heart valves, and prosthetics which respond to intentionality. Nanotechnology promises, and soon, smaller, faster, infinitely more sophisticated devices. They will not just be used to correct vision or hearing abnormalities, but may take the form of implanted monitoring bio-nano devices which scour the bloodstream, alert us to potential problems such as tiny and easily treated cancers, prevent Alzheimer's Disease, or cure cystic fibrosis and other genetically transmitted diseases. On the table in the blue-sky realm are biocomputers embedded in the body (actually, it is often pointed out that we are biocomputers, that we are nanotechnology in action) which will perform the function of personal aides, organizing data and our lives, and lightening our load. Implanted GPS's will communicate with information in the environment and let us know where we can find a restaurant in an airport, or a product in a grocery store. Sensors will respond to externally placed orienting information. Not only will this be good for business, but it will also help those of us who are hard of seeing, directionally impaired, or confused--either congenitally or because of age. As a science fiction writer, I can think of a lot of hazards. Will we be seeing this information through the Bill Gates empire? Will hackers insert confusing viruses which take us to a competitor's

business? We'll see.

In the U.S., the National Science Foundation presently has a mandate to educate the public about nanotechnology. The book put out by the Nanotech Initiative last year, which is edited by Mihail Roco and William Bainbridge, is titled Converging Technologies For Improving Human Performance. Converging Technologies for Improving Human Performance sounds just a little bit Soviet-Union to me, but in essence, it is definitely my vision for the future. The subtitle is "Nanotechnology, Biotechnology, Information Technology and Cognitive Science."

That just about covers it all.

And that's one of the points.

Nanotechnology promises to be multidisciplinary in a way that science has not been since the eighteenth century. In fact, it demands and involves the knowledge of every branch of science and engineering that now exists. I have read that some universities are now offering degrees in "nanotechnology," which explains the television commercial. I am not sure what this really means. I suspect that this mythical nanotechnologist would be like the board certified emergency physician--someone who knows a lot about many different subjects, and coordinates that information.

Earlier this year I was invited to a conference called Imagining and Imagining Nanoscience and Engineering. Aside from its smallness, and the impossibility of seeing much of what is happening in this realm directly, another reason that nanotechnology must be imaged and imagined is because of its vastness, and because of its potential for both positive and negative outcomes. This is where the public dialogue comes in.

Nanotech has the potential to be invasive, to change the body, and even, most radically, the brain---mind and consciousness. The claims for nanotechnology are huge. It may

give us very long lives, very cheap and easily reproduced and modified material goods, and make us very smart, and even mentally very different, via the hypertexting of information and its melding into the biological sphere and through easy and precise access to any system in the human body. At this conference one of the remarks I thought important was that we ought to be speaking of nanotechnologies, rather than simply nanotechnology. The materials, potential, and scope extend into the realms of external and internal, and they extend farther than we can see or predict.

Part of the NSF initiative involves getting the scientists and engineers talking to one another. A few years ago I was talking to Gregory Benford, a noted astrophysicist and science fiction writer. I mentioned that my father is an electrical engineer and he said, Oh, an engineer, in rather disparaging tones. I thought, but he doesn't even know my dad and he's already prejudiced against him! But the sciences, among themselves, have the same problem.

In science--the root of which is "to know," we are all looking at the same thing--the natural world, and ourselves as part of the natural world--but from different vantage points. A biologist sees a different cell than a physicist sees. The sciences speak different languages. They are cultures unto themselves. So although by now we have a lot of information, it is not very well cross-referenced. Is there any way to combine our information into a kind of Grand Unified Theory of Everything? Maybe not in the near future. After all, it's hard enough to come up with a Grand Unified Theory in just the field of physics--never mind throwing in everything else. But a true theory of everything would explain the natural world from the core. Physics, chemistry, biology, biophysics, biochemistry--perhaps there is a way to unite these visions, just as I often hope there is a way to unite the two cultures of science and the humanities which CP Snow defined in his famous lecture and book of that title in the late nineteen-fifties.

One very important aspect of nanotechnology, as far as I am concerned, lies in its potential for improving and enhancing the learning process. This excites me

tremendously. Some of the claims for what I call in my books nanobiology are fanciful and outrageous, and most of them raise important ethical issues which require deep and informed discussion, but they elicit a visionary approach to the future of humanity which I find as moving as any rhapsody.

It might be too late for those of us in this room to become as mentally enhanced as I envision, although I fervently hope not. But the possibility of this vision does rely on education--first, the sensible education of preschoolers, and, for the rest of us, the development of what I call brain plasticity enhancers. Or maybe sensitive period replicators might be a better term. I'm eagerly looking forward to them, and I'll define them a little more clearly later on.

As a former Montessori teacher, I will forever remain fascinated by the way that we as a species unfold in response to our environment, cued by an almost unfathomably complex series of biochemical events. By understanding and using these events, which evolved in order that we could survive and take full advantage of our environment, I believe that we can powerfully enhance the capability of every child to learn, to become a part of the community in which they live, and to contribute to that community at an optimal level.

First I want to offer some examples of how children learn. It is the common perception that although reading is key, it can be difficult to learn how to read.

It is not. It is simply not presented at the right time to most normal children, nor in the optimal way for them to absorb and then link all of the physical processes necessary to reading--left to right movement, in English; and top to bottom. Enough of English is phonetic so that learning the phonetic sounds of the letters, rather than the useless names and order of the alphabet, is one of the most important aids. Incorporation of physical motion is vital to mapping the brain. I taught for thirteen years, ten of those years in my own 100 student school, and with very few exceptions all of my four year olds were reading and writing three and four letter phonetic words, and this was a

baseline. Most were doing more, and not because of any pressure. Writing, actually, occurs first, in normal children, about six months before they spontaneously begin to read. By my calculations, I taught about a thousand children to read. I did not use expensive, fancy equipment, although it is available. I had a year's training--rather expensive, but in retrospect, excellent, during which I learned about the learning sensitivities children experience, which Dr. Montessori called sensitive periods. This method of education was developed almost a century ago. The point is this: with all that we have learned about humans since then, particularly with the type of imaging and other scientific tools and methods now at our disposal, one would think that we would be doing much, much better in educating all of our children. Because I am speaking to professors, teachers, and students, I am sure that all of you can appreciate the need for improvement in this area. None of us likes to waste our time, or to have our time wasted, and particularly in our public schools, despite the terrific dedication of teachers--I come from a family teachers, so I know how dedicated they are--there is room for a lot of improvement.

The cognitive sciences need to focus on the biological underpinnings of learning in a big way. We need to learn how to best teach children how to think, rather than how to follow directions. We need to learn more about neurological conditions during the classical "sensitive periods" for language, spatial understanding, and, in fact, for everything that the growing child incorporates so quickly. We need ways to look at each child as an individual, to give them the baseline information they need at the appropriate age--reading information when the sensitive period for language is active, not when it is over--and then move quickly to prolong in each of them the joy of learning and the ability to actually think, to pose and solve their own problems, to have some measure of independence in a system in which teachers are mentors and guides.

Though the ability to think in certain ways and in certain extremes now seems limited to a few individuals labeled as "gifted," might it not be possible to isolate the elements which cause this state and make them as easily manufactured and transferable as books, or as antibiotics? Would it be possible to re-create this ability to learn in adults

who are interested in learning certain subjects, or in older children in need of a remedial sensitive period?

One science fiction staple is the "teaching machine." They are usually not described in great detail. But visions of the future do seem to include the possibility of enhancing the learning process, and probably some of the ways in which we can do this fall under the aegis of what is called nanotechnology.

Nanotechnology can help, not only with external aids such as the frequently envisioned wearable computers and personal aides, but perhaps with somewhat more scary, more invasive processes which, as I mentioned before, might allow my own aging brain to learn a language with the facility of a toddler, or understand a particular branch of mathematics. We know that during the course of brain maturation we lose billions of neuronal connections; it is an editing process. With the advent of a new understanding of neurons and of how the brain works, might it not be possible to mimic those developmental stages in which learning is occurring at a very deep level?

The senses are being mapped. Oliver Sacks has done pioneering work in this area, and this is just the beginning. There is a lot of research being done on synethesia, which is when one sense is confused with another--for instance, musical notes give a sensation of color. Once the senses are mapped, it is conceivable that they could be re-mapped.

A few years ago, I had cataract surgery on both eyes, and had one lens replaced for distant vision and one for close, because, being a science fiction writer, I had a fear of a future in which I might not be able to get glasses, and therefore might not be able to read, which seemed like a horrific possibility to me. What I have, with my plastic implanted lenses which I was told will last for thousands of years, is called “monovision.” I was assured that soon my brain would choose which eye to use depending on the situation. It sounded great.

The reality is that although my brain might have the ability to choose which eye to use, it has not yet decided to do so. I have brief flashes of how “monovision” might optimally work, but so far my brain is very stubborn. I have decided that there is probably some very, very slow remapping work going on. It might never be completed. Although I might be seeing all the information, I’m still not integrating it. Perhaps it takes a long time to remap the brain in such a way that it can use this information. The plasticity nanodrug (it may be that soon things won’t seem quite real unless prefaced by “nano”) is definitely needed here.

Children learn by doing. You don’t learn mathematical concepts by seeing them written on a white board or even by memorizing the times table or making computations on a computer. You can learn multiplication and what it really means--and again, all my four year olds could multiply, because multiplication is just adding the same number over and over again--by manipulating materials, by setting out beads or stones or checkers one by one in a grid and counting them, by counting bead chains consisting of groups of beads, by as many other manipulative situations as the teacher has the imagination to invent. You can see for yourself that four times eight can be represented as a rectangle or as a rectangular prism. With q-dot monitoring devices, perhaps the connections set up in the brain while the hand and the eye are doing this work can be visualized, so that we can see exactly where children who are having a difficult time learning a particular concept have a problem. Using similar technologies, perhaps we can cure the many forms of dyslexia at an early age.

I think that we, collectively, don't know much about the sciences, and that is one of the problems. Many children don't even learn how to read, so I suppose that it is optimistic of me to call for a lot more than that. I have spent years trying to catch up with science. Even though I have spent years absorbing the history of physics, the present state of physics, and using perhaps the more fringy aspects of physics in my novels, especially in The Bones of Time and Light Music, I still don’t know much about it. The abstractness of these ideas is what attracts me. The more I read about them, the more I observe the realities of physics filtered through the English language, the more I

realize that I am still not touching, as it were, what is really there, even though whatever it is comprises my very cells and surrounds me. I wish that I had become fascinated with these things at a much younger age. I think that learning about the history of science and technology and the philosophy of science and technology could serve to excite children about the possibilities of science. The idea of competent scientists teaching children their subjects is unlikely to be executed soon--those specialists are reserved for graduate students. And the convergence of teaching ability with a gifted understanding of a subject is rare. But it is a hope.

However, another way that we can examine the possibilities of the sciences is through literature. We can look at the myths deconstructed in science fiction, and in the various futures portrayed therein. Reading science fiction is to fan out a deck of cards. Infinite games, infinite possibilities, are contained therein. Just as in any genre, including the genre of literary fiction, there are good and bad examples. It might serve us well, though, if the general stigma against reading science fiction--and there is a stigma; just observe Margaret Atwood's frantic distancing of her new novel from being labeled as such--were to abate, to have this literature as widely read and discussed by reading circles as are the most popular works of fiction, many of which come complete with a list of questions in the back. One of the questions in any sf book might be: is this possible? Why or why not? Is this possibility good or bad? Why?

Science fiction is uniquely situated to think about the issues posed by a presently developing nanotechnology from a human point of view rather than that of pure information. There are mental and emotional barriers against change. We have spent, literally, ages, trying to come to terms with our own mortality. We have developed elaborate visions of an afterlife, of which cyberspace is but a thinly veiled copy, where we might be immortal and limitless in terms of what we might conceive and what we might do. This long investment could account for negative attitudes toward bodily improvement and enhancements. The known -- death and a possible heaven--is much more attractive to some people than the unknown, for instance, where are all

these old people whose lives might soon be extended going to live, and who will pay for them, and what will they do? Continue to meddle in the lives of their children? Obviously, new models of family and of society would evolve if the longevity aspects of nanotechnology came to pass, and that is scary for some people, and it ought to be at least thought-provoking to those of us who are not afraid. As has always been the case in technological leaps, a lot of work on nanotechnology is being done by those involved in defense, particularly in the fields of averting bioterrorism, and in enhancing the capabilities of the military and of soldiers in the field.

Our everpresent enemies, though, are starvation, disease, disability, pain, impairment of human function, and ourselves--the territorialism which makes us go to war rather than negotiate, and to feel rather glorious about the decision.

Biotechnology, and its new definition as nanotechnology, advances against an enemy which threatens to take our loved ones from us with an inevitability stronger than any pernicious political system.

The big question of early work in molecular biology was: Can humans be modified? We now know the answer. The answer is yes. We are already modified, with drugs, birth control pills, the possibility of in vitro fertilization, extremely specialized surgeries. The questions now are, how much, how fast, and most importantly, why. New brains for old? As is probably clear by now, I would like an approximation of my nineteen-year old brain--its speed of calculation, the way it made connections, its sheer optimism and sense of being unlimited and able to solve or create anything of its choosing. I am sure that at some point, Einstein wanted his younger brain back again. I would like enhancement of senses, a deeper appreciation of art, music, and literature. I would like a mathematical mind. I would like a pain-free, healthy body. I would like choices. I would like a permanent sense of appreciation of life which would not wane or be damaged. I am sure that this priority list would vary with every individual, who would have to know, as we now know about the drugs we are prescribed, what the benefits are, and the hazards of each of these possibilities as presented by enabling

technologies.

When we study our fellow travelers on earth, we find astounding things. For instance, research on rainbow trout revealed, a few years ago, the process by which birds, fish, whales and turtles migrate via cells sensitive to magnetic stimuli. What if we could experience this deep orientation? I use this idea, magnified and changed in various ways, in Light Music.

Our very consciousness is based upon the fact that we are composed of biological programs which combined eons ago because of some benefit or some way in which one could be exploited by another and the exploitee would still exist. It is hard to get around this fact. Spirit and consciousness and all that we have so passionately ascribed to a realm other than bodily are, in fact, of the body. To me this is not depressing. It is exhilarating.

In Light Music, I foreground the fact that we live in the midst of a vibrational field, and that our senses have evolved to collect and interpret these frequencies. Much of the human brain is dedicated to the visual, our ears register sound, our other senses contribute data, and somehow our brain coordinates this information and gives us a sense of harmony, of time. What, I postulate, might happen to our identity, our sense of time, and the nature of our consciousness if we became capable of sensing other frequencies--for instance, bees see different wavelengths than we do. I try to put a very positive spin on this, and it is a process which takes a hundred years and then--much like what happens when children begin to talk--suddenly, the process has been integrated, and we grow and change. This is only one thread of a complex narrative, but it is integral, and it is the kind of vision that only science fiction is capable of examining. There is no other form of literature which looks not just at who we are but at what we might become. It is a way of thinking about our future and, at this particular juncture, it seems an important thing to do. Not didactically, and not in fear, but in a spirit of promoting understanding about what science and its practical handchild technology can do for us and against us.

We now have better and better tools with which to see that which actually surrounds us, and to see what we are made of and how we function. We are purely products of what works. There is no reason why we cannot improve on this, to think about what our goals might be regarding science and technology. We have the power to decide what to do according to what we deem is right and good through thoughtful consideration, dialogue, and what might be the most important characteristics of our species--intelligence, generosity, altruism, humor, love, and hope.

Happily, we live in an age in which there is a certain transparency. Any of us can read source articles and papers in scientific journals and if we cannot interpret them at first, we can learn the language and make more sense of them. We can talk to those who do understand. We can bring about a dialogue.

Science fiction is well-equipped to do this.

Science fiction is the literature of change. Paradoxically, it is the only literature that sees the world as it is now, not as it used to be. The potential for billing disputes aside, what present-day teenager would not welcome the implantation of a cellphone-like device within their body, perhaps even with quasi-telepathic properties much like E.O. Wilson's DNA based mode of communication in his scientific treatise Consilience, which he calls mindscript. We are all about communication right now. We are certainly not all about the joys of solitude and the fruits thereof. Even the most dedicated writer has succumbed to the invasiveness of email.

The texts of the real and of the possible are the stuff of present science fiction concerned with nanotechnology. But there is a divide here. Apparently the Nanotechnology Initiative at the National Science Foundation was dismayed that the movie of Prey is soon coming out. It is, like all of Crighton’s books, a science horror story. A distributed consciousness, nanotech run amok, tries to "take over the world." The implication and the fear is that our product will be radically different than ourselves

and will not share our values or our goals. But must that be so?

My future history is different.

First of all, broadcasting has been interrupted. That's a big one to swallow, especially for physicists, and because of that I submerged the causes until I wrote the book which is chronologically the first book in the nanotech quartet, Crescent City Rhapsody. But that was the third book that I wrote. The first one was Queen City Jazz, and it begins in the middle of things.

A new method of communication has been invented which is based on biology.

Information is carried by the DNA of specially engineered e.coli bacteria, which lives within vertical interstices which run from the top to the bottom of all the buildings in Flower Cities. It is translated into what I call metapheromones, an artificial alphabet which operate much like our pheromones do, and connect directly to the user's brain via touch. The user touches the interstice with her hand, and information penetrates the membrane of the interstice, flows upwards, is collected at the top of the building by large bee-like creatures, and is transported to the appropriate building. This information can include any business or scientific information which we today communicate through print and visuals.

Though this may seem rather outlandish, I can assure you that it works. At least, when this book first came out in 1994, one of the questions interviewers asked was, is this going to happen, so readers thought that it might. My first answer was, I hope not; my second answer was that if there was any possibility of it happening I should be applying for patents.

In Queen City Jazz, what happens to Cincinnati, by that time a post-nanotech (and, in Vingean terms, a post-singlularity) Flower City, is indeed disturbing. One person's vision of the American arts envelops an entire population, which relives the lives of jazz

musicians, novelists, characters from American literature, and visual art endlessly and without volition. I took my dream and made it their nightmare. The problem, again, is that of free will. And it comes about because of the ease with which, possibly, a radical functioning nanotechnology will be able to manipulate the stuff of mind. Mississippi Blues, which follows Queen City Jazz, is a book about our relationship with that which has been created. It is about identity, free will, choice, and about deep Americana in the form of Mark Twain and his own problems with identity, truth, and vision, and about the divide between the ideals and the realities of the history of the United States.

In Crescent City Rhapsody, I envisioned how this future might have come about, through the believable bunglings of governments devoted to secrecy and to exploiting science not for the prosperity and evolution of humans and of the planet at large, but for profit and for defense. In this near-future world, events move quickly toward the singularity, and the work of one individual, Marie Laveau, is instrumental in establishing a refuge, a place of scientific transparency, a floating apolitical Crescent City. And in Light Music, the concluding volume of the quartet, a form of human transcendence occurs, with the help of thoughts from science writers such as Brian Green and his beautiful explication of superstring theory, The Elegant Universe.

My sources are books about science written by scientists, and journals such as Nature, Science, and Science News. I assemble a possible vision of the present and of the future by taking into account things that are happening right now. Like most sf writers, I am an optimistic person. Writers such as Neal Stevenson in The Diamond Age, Wil McCarthy in Bloom, and Linda Nagata in The Bohr Maker create futures in which humans are transformed, but in which individuality and free will, though it may be submerged, do not utterly vanish. Instead, they are transformed and rejuvenated through nanotechnology.

Because nanotechnology is a fuzzy term, and because it encompasses many disciplines, it will continue to be a fruitful mode of science fictional inquiry into where our sciences and our technologies may take us both in the near and the far future. Despite

the necessity of darkness for the sake of drama, science fiction is essentially a hopeful literature which, by examining both the positive and negative potential in our world and in the information we are revealing and beginning to learn how to use, contains strong, socially useful narratives which can help us navigate the rapids we have already entered. I told Eric Drexler a few years ago that when finished with my nanotech quartet, I wanted to turn my mind to a different future. My problem was that I could no longer envision a future in which nanotechnology is not an important and powerful facet. He said, "I know what you mean."

I'd like to end with a quote from Alan Kaye: "The best way to predict the future is to create it."

By understanding the body through newly developed techniques which fall into the vast field of knowledge labeled as nanotechnology, and by using this information to educate all of us, perhaps in very new ways, I hope that we will be able to create the kind of future we would all wish to live in. The literature of science fiction has the potential to play a very large role in this endeavor.