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Democratic Transhumanism

James J. Hughes, Ph.D.

This article was adapted from a lecture given by James Hughes at the 1st Annual Workshop on Geoethical Nanotechnology on July 20, 2005 at the Terasem Retreat in Lincoln, VT.

James J. Hughes, Ph.D. is Associate Director of the Institutional Research and Planning Department and a Visiting Lecturer of Public Policy for Trinity College of Hartford, CT. Hughes explains that the politics of the 21st century have transcended the two-dimensional paradigm because of the entrance of biopolitics. Biopolitics raises many questions about personhood and human rights and has created unlikely alliances between what would typically be opposing political groups. Hughes urges us to promote a democratic transhumanist view, one that embraces new technologies and does not limit human rights only to humans. The result will be a better world for many diverse groups of people and posthumans.

Introduction

How do we build a transhuman culture and polity in which humans of the 1.0 version (posthumans, A.I.'s and so on) can coexist peacefully and not end up in a civil war? How can we create a forward-looking set of public policies that have more complex

"We are on the forward edge of advocating a particular kind of social order and determining what that social order might be."

answers to the challenges that we face than an attitude of relinquishment? Such policies would take for granted that people will eventually want to adopt and make universally available these technologies because of all of the wonderful benefits that they provide. They would anticipate downsides and accommodate them with possible solutions.

What kind of politics need we be grappling with, at least up until 2043, when, due to the arrival of the Singularity, politics becomes irrelevant and we all start shooting out to the stars? What kinds of political engagement need we, as activists, begin thinking about in order to create this kind of a world? Just like the abolitionists or the advocates of the separation of church and state two hundred years ago, we are on the forward edge of advocating a particular kind of social order and determining what that social order might be.

Emerging Biopolitics

I call the politics around that social order "biopolitics". The recent struggle over Terry Schiavo showed some of the emerging dimensions of that politics.¹ In this situation, there was an enormously unpopular intervention in a very private family decision around whether Terry Schiavo was a person or not. The

Democrats seemed completely divided. Tom Harkin, Ralph Nader and Jesse Jackson were all on the side of saving Terry Schiavo against the wishes of her husband, Michael.

What was going on? Why were the disability rights activists, who usually side with the Democrats, siding with the "Save Schiavo" campaign? Just as the progressives and the seculars were divided, so were the Christian right and the libertarians. Why? I argue that it was because of this emerging "biopolitics."

Pope Benedict, formally known as Cardinal Ratzinger, will be a new player in emerging biopolitics as he has recently announced that bioethics and related topics will be at the top of his agenda.²

No Longer a Two-Dimensional Space

In the politics of the twentieth century, there were two dimensions - a cultural dimension and an economic dimension. Politically, different parties were aligned within this two-dimensional space. In Europe, you could find parties in each of the different corners and in between, and so people kind of figured out where they fell based on their religious views, their attitudes about regulation and egalitarianism, and so on.

Biopolitics enters this two-dimensional space, making it more complex. There are people who have one or another of those four kinds of politics who become transhumanists on one end of that biopolitics, and at the other end become what we call now "bioconservatives" or "bioluddites."

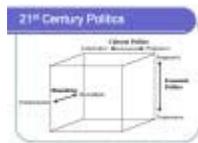


Image 1: 21st Century Politics

We do not yet have people in all eight of those corners, nor do we have movements or organizations that represent them all, but I am going to talk about a couple of the movements

that show that this space is coming into existence and how we need to respond to it.

Emerging Issues

What are some of the struggles and issues that will frame emerging biopolitics for the upcoming 20 or 30 years? The principal struggles are: Who is a citizen with a right to life? Is A.I. something that we are going to enslave, deny any rights to, and keep as a separate part of our society? Are posthumans who upload going to be considered a part of our society?

Recently, at John Hopkin's University, ethicists argued that we should never introduce human neurons into chimpanzees and great apes because it would create an ethical anomaly if they start to think and act like human beings. My answer is "So what?" We can create a society in which that is okay and possible, in which a chimp can go to grad school along with everybody else.

Another emerging issue is the struggle over the control of reproduction, including contraception and abortion, which we have witnessed. Struggles will soon multiply around genetic testing, germline genetic modification, cloning, sex selection, the intrauterine repair of disabilities, and so on.

This leads us to the next issue. Society generally assumes that there is a legitimate distinction between therapy and enhancement. This notion is enshrined in public policy and in what Medicaid and private insurance reimburses for. In the future, it will be very difficult to draw a line between these two kinds of things.

I argue that we should not draw any lines between these two. An extra fifty years of life is as valuable from 20 to 70 years old as it is from 70 to 120 years old. Most people do not believe this because they think that they do not want to live past the age of 70, but if we enhance life the

way we anticipate, extending life past seventy will be quite attractive and we will begin to see that living to 120 and beyond is an attractive possibility.

We see the outlines of this struggle with the conservatism in the social security debate, where people are saying, "What is going to happen if people live even longer than they currently live and use up even more resources?" We have to start thinking in a proactive public policy framework. We do want everyone to live longer; we do want to create an anti-aging Manhattan Project where everybody lives longer. What kind of policies are we going to need in place for when that does happen?

The final emerging issue is control over the brain. The cognitive liberty issues that Wrye Sententia addresses are central to emerging biopolitics.³

The convergence and acceleration of all of these different technologies are bringing these new biopolitical struggles to the fore.

Recently, the NSF (National Science Foundation) promoted a recent publication on "Neurovascular Central Nervous Recording Stimulating System Using Nanotechnology Probes." The NSF is embracing a particular model of how we can get nanowires up into the brain and begin to accelerate nano-neural interfaces, which started happening last year when Cyberkinetics began to put chips inside the brains of permanently paralyzed people.

The Biopolitical Spectrum

On one end of the biopolitical spectrum, the bioconservatives make up an incredibly diverse

coalition of people, one that is increasingly self-conscious of its own common interests. On the other end,

"There are extreme ecologists and romantic Luddites ... who believe ... [that] what we have now, in terms of all kinds of progress, is enough and we should not go any further."

you have its backbone and anchor, the religious right. The religious right's objection to these kinds of technologies can be taken back to their opposition to autopsies five hundred years ago. More recently, they source C.S. Lewis' book "The Abolition of Man", which makes Christian arguments against human genetic engineering. Then there are extreme ecologists and romantic Luddites and various others who believe, as Bill McKibben argues in his book, "Enough: Staying Human in an Engineered Age", that we should say, "Enough! What we have right now, in terms of all kinds of progress, is enough and we should not go any further."⁴

We also have leftist and feminist critics of biotech who think, because of concerns for equity of access and corporate control and the ways that the Nazis and fascists and other kinds of people have used these technologies, that we need to ban these technologies. Finally, we have the "pro-disability extremists" who are disability rights activists that believe they not only have to fight for the rights of those with disabilities, but must defend disability as an equal way of life by resisting anything that might overcome it. This is quite an extreme position, but one that is increasingly present within the disability rights movement.

2002, A Landmark Year

When we look back on the emergence of biopolitics, we will recognize 2002 as a landmark year. In 2002, Leon Kass was appointed to the President's Council on Bioethics; Fukuyama published "Our Posthuman Future"; Greg Stock published "Redesigning Humans"; the Christian Right published their "Manifesto on Biotechnology and Human Dignity"; the Vatican published the Ratzinger-supervised document, "Human Persons Created in the Image of God", which argues the Vatican's emerging position on human enhancement; and McKibben published "Enough" in 2003.

In addition, the President's Council on Bioethics (PCB) published, "Beyond Therapy", which is their attack on human enhancement technology.

The people who like that report claim it is a nuanced, poetic, academic treatise. In reality, it is a subtle attack on human enhancement technology. In the report, none of the beneficial arguments about why it is good to live an extra fifty years are taken seriously.

Emerging Critics of Biotech

Recently, the Women's Bioethics Project (WPB) added up all the money the Christian Right has poured into attacks on bioethics since 2002 (on human enhancement in particular, but also on abortion and stem cells) and it added up to tens of millions of dollars.⁵

The Center for Bioethics and Culture in California is a proliferating, metastasizing network of Christian bioethics institutions underwritten by the following institutions: Chuck Colson's Prison Ministries; the Trinity International University and their Center for Bioethics and Human Dignity, which has a list of hundreds of Christian Right bioethics speakers who can attack anything you want them to attack; the Discovery Institute, which is better known for advocating intelligent design, but is also the base for Wesley J. Smith, who argues that America is turning into a "culture of death"; the Ethics and Public Policy Center in Washington D.C., home of the New Atlantis journal and Eric Cohen, who works closely with the President's Council; the American Enterprise Institute, where Kass, Fukuyama, and PCB member James Wilson are ensconced; the National Catholic Bioethics Center; and even the Hudson Institute, where Michael Fumento, who is positive on some biotech, yet opposed to other technologies like stem cell research, works closely with the Christian right.⁶

There are many surprising, emerging conservative alliances. Nigel Cameron, a well known anti-abortion bioethicist is aligned with Lori Andrews, a well-known feminist. Andrews wrote a book in the 1970s

"Transhumanism ... means that human beings want to transcend the human condition."

about Huey Newton and the Black Panthers and was a staunch libertarian feminist in the 1980s. She is also known for her "Saul on the road to Damascus" experience, when she discovered that the commodification of the human body is going to lead to capitalism taking over everyone's bodies and that women will, as a result, be oppressed by patriarchal medicine. She bought into the biocon critique, and she and Nigel set up an institution in Chicago called The Institute on Biotechnology and the Human Future.

The Institute on Biotechnology and the Human Future has an equal number of right-wing and left-wing fellows. They include people coming out of the anti-abortion movement, Paige Cunningham and Christopher Hook (one of the Christian Right activists who writes for *Christianity Today*); William Hurlbut, conservative theologian on the President's Council; and C. Ben Mitchell, who's at the Chicago Center for Bioethics and Human Dignity. The fellows also include various left-wingers: Lori Andrews, who is pro-choice; Brent Blackwelder, who is from the "Friends of the Earth"; Judy Norsigian, who was central to the "Our Bodies, Ourselves" Project, and staunchly pro-choice.

What causes these unlikely alliances? On one hand, there is the dominance of a pastoral version of left-wing thought, which says that all these technologies are leading in a bad direction. The Center for Genetics in Society in California is one of the leading articulators of that theory. They believe that we are heading towards techno-eugenics and that we need to stop that.⁷

There also exists the pastoral elements within the environmental movement, including Jeremy Rifkin, who is not so much focused on this any more, and his protégé, Andrew Kimball, and the ETC; the deep ecologists; anti-genetic-modification groups, which have begun to expand their scope into anti-GM for human beings as well; the disability rights extremists (people opposed to cochlear implants and the backlash against Christopher Reeve, arguing that Christopher Reeve was distracting people with

paralysis from the need to accept that they have paralysis and move on).⁸

Transhumanism Movement

On the other side, we have the transhumanism movement. Transhumanism is actually a pan-cultural and pan-historical tendency, which means that human beings want to transcend the human condition. In the past, they have attempted to do so through such avenues as drugs or spiritual disciplines of one kind or another. What defines transhumanism as a modern movement is when these aspirations come together with science, reason, humanism, and the other products of the Enlightenment, and people actually begin to use those modalities instead of these other spiritual modalities.

Some people who represent an early stab at this movement are political revolutionaries as well, including J.P. Condercet and William Godwin (the father of philosophical anarchism), both of whom foresaw the conquering of death as something that humanity would eventually achieve; H.G. Wells and Olaf Stapledon, socialists of one variety or another, who foresaw future revolution of the human race; and BS Haldane and Bernal, both Marxists, who argued for in-vitro fertilization and cybernetic implants. After World War II, things began to move away from the association with the Left of these techno-utopian ideas. For instance, Julian Huxley coined the term, "transhumanism", in 1957 and defined it as "the human species transcending itself." FM 2030, who was influenced more by the New Left and counterculture, begins to argue that we are in a transhuman stage of history.⁹ This is when the term transhumanism itself comes into fore.

Max More and Natasha Vita-More began work in the 1980s and 1990s and *"The term 'human rights' has been hijacked by the human racists and we need to liberate it from them."* establishing the Extropy Institute, and there began to be a real melding of these ideas with people in the libertarian movement. One libertarian is Ron

Bailey, a writer for *Reason Magazine*. Bailey will soon release his book, "Liberation Biology", which will join the panoply of transhumanist books that have come out this year. These ideas begin to associate transhumanism not with the political Left, as it had been before, but with a libertarian kind of politics.

Certain core elements of the transhumanist movement are distinguishable from other, more common types of politics. One of the key arguments in transhumanist or biopolitical politics is the argument over what a citizen is going to be. Is a citizen going to be defined by personhood, with interests over time and an objective experience of selfhood - or is it going to be defined by "human-racism," by being human, humanness of some kind? Or do we believe that all human beings are bad and we have to go back to some kind of natural order?

On one hand, there are people who believe that a polity is central and that the polity can be diverse. On the other hand, there are those who believe that only humans should be in that polity, or that we should not have a polity at all because human beings are bad.

Transhumanism is also defined by a classical struggle over reason and human liberty; progress versus sacred taboos, nature, and romanticism. This gives transhumanists a natural affinity with the politics of cultural progressives, people who are for gay and lesbian rights, people who are for a liberated role for women, and anti-racists.

The final defining characteristic of transhumanism is the argument about whether human beings can effectively create institutions that manage the risks that we face or whether we will always be punished for the hubris of attempting to understand and control our own condition. If we are always going to be punished, then we must have a static social and technological order. If we can understand those risks, then we can have a progressive social order.

The term "human rights" has been hijacked by the human racists and we need to liberate it from them. We must create a new engagement with the human rights movement and say, "We want rights, but they do not have to be defined by *humanness*." The Universal Declaration of the Human Genome stated that the human genome underlies the fundamental unity of all members of the human family and the recognition of their inherent dignity and diversity. If this is true, then we cannot have posthumans, as Fukuyama says, because we will not be able to recognize each other as members of the same polity.

My argument is that there is no genetic basis for human rights. Is *"... this struggle is an intrinsic part of the liberal democratic tradition."* hairlessness an element of our genetic rights? If you have too much hair on your body, should you not be a member of our polity? Great apes, for instance, meet many of the criteria for a basic entry into our society, as members of our polity who should have certain kinds of rights. Conversely, you could be human and not a person; you could be a fetus or brain dead, which is argued in abortion rights and in the case of Terry Schiavo.

Establishing a new code for legal personhood and for citizenship in general that is personhood-centered as opposed to humanness-centered is one of the central struggles. It is a struggle that goes back to John Locke, who defined a citizen as a person who is a thinking being, which means this struggle is an intrinsic part of the liberal democratic tradition.¹⁰

Another consequence of this focus on individual personhood as the core of our new politics is that we need to ground this progressive vision in the claim that individuals have a right to be supported in their fullest flowering of personal possibilities. We want a society where we can be all we can be as ordinary citizens. Part of being all you can be in this coming period will be having available to us, and having the rights to use, the full panoply of technological opportunities to control our reproduction, our brains, and our bodies. We will be able to

overcome the disabilities that we were born with, just because we were born human 1.0.

Bioethicists are moving in this direction with us. Arthur Caplan is considered the dean of American bioethics. He and most other American bioethicists were stunned when Leon Kass was appointed to the President's Council on Bioethics and have been in serious reaction against him ever since. As a consequence, Arthur Caplan uses every opportunity he gets to preach his gospel, saying things like, "Enhancing intelligence, changing personality, or modifying our memory should be available to everyone as a guarantee of equal opportunity." Caplan takes very seriously the notion that enhancement is not only possible, but that it is coming down the road. It is not intrinsically bad because of some kind of "yuck factor", and if people are concerned about equity, then we need to make it universally available.¹¹

Growing Transhumanism

Transhumanism is moving beyond some of the cultural, political, and gender constraints that it was under in the 1990s. It is becoming a much more diverse movement, one that could build and be the basis for the kind of coalition for which we are hoping. We currently have about 3,000 members in the WTA and thirty chapters around the world.

Ms. Abdhi is the Vice Chair of the Kenyan Transhumanist Association. She is a Muslim, Somali refugee and has been considering whether to return to Somalia (which does not even have a government), in order to spread the word about transhumanism. She stands out as an example of the mind-boggling diversity that the WTA currently encompasses in our global movement, under our chair, Nick Bostrom, at Oxford.

There are many constituencies to whom we need to reach out as we develop our arguments about why the human enhancement movement, the transhumanist movement, and the movement for the kinds of society that we want to see created, speaks to their concerns. These include:

- Disabled seeking assistive tech and cures
- Feminists supporting full reproductive rights including germinal choice
- Drug law reform advocates supporting deregulated access to neurotechnologies
- Human rights activists supporting a right to bodily autonomy
- Scientists and health workers alienated by growing religious right restrictions
- LGBT community seeking reproductive options
- Tech-friendly ecologists supporting tech-solutions to eco-threats
- Senior citizens looking for cures for age-related diseases
- Developing countries hoping to use emerging technologies to "leapfrog" to development
- Animal rights activists advocating a post-speciesist basis for rights

While all these movements have within them Luddite wings, they also have within them people who are open to the message of technological self-determination and technological empowerment. One example is the disabled Michael Chorost, who wrote a book embracing the notion that he is a cyborg, saying, "I was empowered, I was liberated as a human being, because I had a computer inside my body."

Feminists are beginning to look at India and China and say, "We have concerns about sex selection, but we do not think that all Indian and Chinese women should have their rights to control their own reproduction taken away because of concerns about sex selection. Maybe the right to germinal choice is more important," and so on and so forth.¹² Transgender activists have been some of the first and most courageous body modifiers in our country.

The WTA recently conducted a survey of its members, asking them about their politics and religion. The results illustrate the diversity of the organization. Members include libertarians, conservatives, upwingers, Democrats, U.S. liberals, left anarchists, communists, and non-politicals. It can be difficult at times in our organization to have so much diversity; it is very frothy and we have lots of good arguments. The WTA is not as diverse religiously. It is mostly an atheist movement at this point, but there are Buddhists, Catholics, Eastern Orthodox, and Muslims.

Democratic Transhumanism

My book, "Citizen Cyborg", is not only an argument for transhumanism, but also for a particular social democratic stance within transhumanism. The values that we need to embrace are not just the values of liberty, but also the values of solidarity. We must see ourselves as a movement that is trying to create a new polity. We are trying to create a new kind of citizenship, a new way that human beings can relate to each other. It is not just about each person's individual right to go off and become their own personal god, but it is about creating a new society. It is also about trying to assure that we all have equal access to these technologies as soon as possible so that when the Singularity comes and all the cards are thrown up in the air, we have the best possible opportunity for not ending up with an inegalitarian outcome.¹³

We need to embrace the fact that there is a legitimate role for regulation. On the one hand, we do need to be aware that the states and regulators may be on their way out as a way of governing politics. On the other hand, we need to recognize that states, regulation, and egalitarian distribution through collective action still play a necessary role in our society. If we create better means of accomplishing these things in the future, however, I am all for it.

Image 2 shows the current outline of the coalition that we are building within the WTA.



Image 2: Building H+ Coalitions

Other groups may soon be involved and we will cross that bridge when we come to it. For a brief time, I was negotiating with conservative Baptist Republicans in Alabama, who thought that they were transhumanists and wanted to join the WTA. Eventually they decided otherwise and left, but they did consider it, so other diverse groups might someday follow in their footsteps.

In this struggle for the kind of polity that we want to create, we must remember that the problems in the world are not caused by technology. Technology can be inscribed by the kind of politics from which it emerges, but it can also be turned into emancipatory, liberatory uses. An example of the kind of thing that we want to see happening is the WorldChanging blog, where a number of environmentalists are gathering to argue, "Look, we've been too Luddite in the past about different kinds of appropriate technology, and we need to start embracing all the different technologies and see how they can build a sustainable technological path to the future."¹⁴

We need to avoid both an anti- and pro-approach to technology, and understand that the problems in our world are really greed, racism, inequality, and superstition. I give the example of the cross bow, which was invented as a way for knights to shoot peasants from their horses, but turned out to be an even better way for peasants to shoot knights off their horses. Up until that point, if you tried as a peasant to get close to a knight, he would just whack you down easily with his sword, but you could pick him off from about a hundred yards away with a crossbow. Thus, crossbows are one example of many different kinds of technology that may be created under a particular kind of power context and may initially have an inegalitarian intention, but may have a very different result down the road.

Finally, to even those extreme libertarians, I argue that we need to devise policies that will make sure that people in places like Somalia have access to the same life-extension medicine, pills, vitamins and cybernetic implants that we richer countries will some day have. Even the most anti-regulatory folks must agree that shaping a polity that accommodates the haves and the have-nots equally with regard to these emerging technologies is a direction we must undertake.



James Hughes teaches Health Policy at Trinity College in Hartford Connecticut, and serves as Trinity's Associate Director of Institutional Research and Planning. Dr. Hughes also serves as the Executive Director of the Institute for Ethics and Emerging Technologies and its affiliated World Transhumanist Association. Dr. Hughes produces the weekly syndicated public affairs talk show Changesurfer Radio, writes the Change Surfing column for Betterhumans.com, and contributes to the democratic transhumanist Cyborg Democracy blog. Dr. Hughes is the author of Citizen Cyborg: Why Democratic Societies Must Respond to the Redesigned Human of the Future.

References

¹ Theresa Marie "Terri" Schiavo (December 3, 1963 – March 31, 2005) was a woman from St. Petersburg, Florida whose medical and family circumstances and attendant legal battles fueled intense media attention and led to several high-profile court decisions and involvement by politicians and interest groups. Schiavo experienced cardiac arrest and collapsed in her home in 1990, incurring massive brain damage. She remained in a coma for ten weeks. Within three years, she was diagnosed as being in a persistent vegetative state (PVS) with little chance of recovery. Her husband won the right to remove her life support in 2005. <http://en.wikipedia.org/wiki/Image:TerriSchiavo2.jpg> March 23, 2006 11:19AM EST

² Pope Benedict XVI (Latin: *Benedictus PP. XVI*), born Joseph Alois Ratzinger (April 16, 1927) is the 265th and reigning pope, the head of the Roman Catholic Church, and sovereign of Vatican City State. He was elected on April 19, 2005 in a papal conclave, celebrated his Papal Inauguration Mass on April 24, 2005, and took possession of his cathedral, the Basilica of St. John Lateran, on May 7, 2005. http://en.wikipedia.org/wiki/Pope_Benedict_XVI March 23, 2006 12:01PM EST

³ Wrye Sententia is director of the Center for Cognitive Liberty and Ethics (CCLE), a nonprofit research, policy, and public education center working to advance and protect freedom of thought into the 21st century. Dr. Sententia has guided the CCLE in sponsoring the National Science Foundation's initiatives aimed at "Converging Technologies for Improving Human Performance." In 2002, Sententia provided comments to the appointed President's Council on Bioethics in Washington D.C. on the topic of cognitive enhancement technologies and in October 2004 debated members of the Council on the democratic values of the US Declaration of Independence in relation to emergent enhancement biotechnologies and human freedom. http://www.cognitiveliberty.org/pressroom/wrye_sententia.htm March 23, 2006 12:27PM EST

⁴ . "In this wise, well-researched, and important book ("Enough: Staying Human in an Engineered Age"), Bill McKibben addresses the burning philosophical question of the new century, and the one that counts for the long haul: how to control the technoscientific juggernaut before it dehumanizes our species." --E. O. Wilson, author of *The Future of Life* <http://www.henryholt.com/holt/enough.htm> March 23, 2006 12:47PM EST

⁵ The Women's Bioethics Project is the leading nonprofit, nonpartisan public policy think tank dedicated to ensuring that women's voices, health concerns, and unique life experiences strongly influence ethical issues in health care and biotechnology. Through education, reports, legislative testimony, articles, public conferences and debates, media coverage, and a publicly accessible website we serve as a bridge between scholarship and policymaking; bringing new knowledge to the attention of decision makers and affording scholars, scientists and corporate leaders greater insight into public policy issues. <http://www.womensbioethics.org/> March 23, 2006 12:58PM EST

⁶ The New Atlantis is an effort to clarify the nation's moral and political understanding of all areas of technology—from stem cells to hydrogen cells to weapons of mass destruction. We hope to make sense of the larger questions surrounding technology and human nature, and the practical questions of governing and regulating science—especially where the moral stakes are high and the political divides are deep. <http://www.thenewatlantis.com/about/> March 23, 2006 1:02PM EST

⁷ . Eugenics is the study of hereditary improvement of the human race by controlled selective breeding. <http://dictionary.reference.com/search?q=eugenics> March 23, 2006 3:01PM EST

⁸ . *The Action Group on Erosion, Technology and Concentration (ETC) is dedicated to the conservation and sustainable advancement of cultural and ecological diversity and human rights. To this end, ETC group supports socially responsible developments of technologies useful to the poor and marginalized and it addresses international governance issues and corporate power. ETC group works in partnership with civil society organizations (CSOs) for cooperative and sustainable self-reliance within disadvantaged societies, by providing information and analysis of socioeconomic and technological trends and alternatives. This work requires joint actions in community, regional, and global forums.* <http://www.etcgroup.org/about.asp> March 23, 2006 3:05PM EST

⁹ *FM-2030 was a name adopted by the transhumanist philosopher and futurist Fereidoun M. Esfandiary (October 15, 1930–July 8, 2000), who professed "a deep nostalgia for the future." He wrote one of the seminal works in the transhumanist canon, Are You a Transhuman?. He also wrote a number of works of fiction under his original name F.M. Esfandiary. The son of an Iranian diplomat, he had lived in 17 countries by the time he turned eleven, and later served on the United Nations Conciliation Commission for Palestine from 1952 to 1954. On July 8, 2000, FM-2030 succumbed to pancreatic cancer and entered cryonic suspension at the Alcor Life Extension Foundation in Scottsdale, Arizona, where he remains today.* <http://en.wikipedia.org/wiki/FM-2030> March 23, 2006 4:23PM EST

¹⁰ *John Locke (b. 1632, d. 1704) was a British philosopher, Oxford academic and medical researcher, whose association with Anthony Ashley Cooper (later the First Earl of Shaftesbury) led him to become a government official charged with collecting information about trade and colonies, economic writer, opposition political activist, and finally a revolutionary whose cause ultimately triumphed in the Glorious Revolution of 1688. Locke's monumental "An Essay Concerning Human Understanding" concerns itself with determining the limits of human understanding in respect to God, the self, natural kinds and artifacts, as well as a variety of different kinds of ideas. It thus tells us in some detail what one can legitimately claim to know and what one cannot. Locke also wrote a variety of important political, religious and educational works including the "Two Treatises of Government", the "Letters Concerning Toleration", "The Reasonableness of Christianity" and "Some Thoughts Concerning Education".* <http://plato.stanford.edu/entries/locke/> April 17, 2006 12:09PM EST

¹¹ *The Yuck Factor: The things that are just too yucky for a civilized society to tolerate.* ProfessorBainbridge.com http://www.professorbainbridge.com/2004/02/the_yuck_factor.html March 23, 2006 4:54PM EST

¹² *Germinal Choice: Sowing the seeds of genius: in search of genetic excellence. The Repository for Germinal Choice is a sperm bank that only takes sperm from high-achieving donors such as Nobel Prize winners.* Fortune; 2/3/1997; Brown, Ed.

¹³ *The Singularity is a common matter of discussion in transhumanist circles. There is no clear definition, but usually the Singularity is meant as a future time when societal, scientific and economic change is so fast we cannot even imagine what will happen from our present perspective, and when humanity will become posthumanity. Another definition is used in the Extropians FAQ, where it denotes the singular time when technological development will be at its fastest. Of course, there are some who think the whole idea is just technocalyptic dreaming.* <http://www.aleph.se/Trans/Global/Singularity/> March 23, 2006 5:18PM EST

¹⁴ *Worldchanging is a blog which covers environmental, humanitarian and design issues.* <http://en.wikipedia.org/wiki/Worldchanging> March 23, 2006 5:28PM EST



The Risk/Benefit Yardsticks Were Just Moved Off the Field: How Technological Convergence Renders Current Risk Assessment Models Obsolete and What to Do About It

Douglas Mulhall

This article was adapted from a lecture given Douglas Mulhall, at the 1st Annual Workshop on Geoethical Nanotechnology on July 20, 2005 at the Terasem Retreat in Lincoln, VT.

Douglas Mulhall is coauthor of "The Calcium Bomb", a recent book about the link between nanobacteria and many common diseases, such as heart disease and cancer. Mulhall argues that nanotechnology can be used to possibly eradicate these diseases by targeting calcification, their root cause. Posthumans will be in our midst sooner than we think and we might find ourselves on a lower rung of the ladder quite suddenly. Mulhall urges us to address some of the major human-created problems in our world before this happens, in the hope that these posthumans will see the human race as an asset rather than a liability. By using nanotechnology to eradicate disease, we will also help to promote it in the eyes of public opinion.

Introduction

The following is a little sampling of what is going on in the popular media today regarding post- and transhumanism.

The Sunday *Los Angeles Times* recently published an article about enhanced humans entitled "You're Not Good Enough". The first paragraph begins, "The next few years, your child will come home from school in tears. He'll say, once again, that he is unable to compete with the children who are brighter, better behaved, and physically more capable than he is, because their parents have bought them technology enhancements and you have not. What would you do?"

The Financial Times recently published a review of several books on the post-human future: "More Than Human", "Posthuman Future", "Fantastic Voyage", and "Citizen Cyborg". The headline of the review was "Eternal Life: The Most Dangerous Idea on Earth".

The media is not painting a very positive view of posthumanism, is it?

Superintelligence on the Horizon

Posthumanism is upon us. The biggest benefit and risk – superintelligence - will occur in the next 25 to 35 years. When that happens, it is inevitable that superintelligence will turn around and evaluate us human beings. This is the biggest possible benefit and the biggest risk of posthumanism.

The scientific community and the general population are not aware of how quickly the development of superintelligence is moving and how logarithmic this scale really is. This is significant because when it arrives, our whole perception of everything will change, as well as its perception of us.

Learning from the Past

Just four or five centuries ago, aboriginal cultures were annihilated in both North and South America in a very short time. Settlers invaded two continents and completely erased a series of civilizations. Because they were erased, there is very little written information to show that these magnificent civilizations existed.

How did this happen in such a short period of time? There is a book entitled, *Guns, Germs & Steel*, which is an extraordinary piece of work because it shows that the people who had the weapons, who unwittingly carried diseases to which they themselves were immune, and who possessed new construction technologies became the dominant ones.¹ They wiped out whole civilizations in a matter of a few decades with guns, germs, and steel. It is very important to understand that literally a quarter of the surface area of the world had all of its populations wiped off the map.

What will happen tomorrow? Engineered germs and intelligence are the guns, germs, and steel of the future. Are humans going to be the next Incas? When superintelligence suddenly emerges and nobody is prepared for it except a select few, are we going to find the conquistadors on our doorstep, our leaders kidnapped and held for ransom? Will we be held in cages like animals, or in ecosystems that are reserved for us?

When I refer to super-intelligent beings, I am not only talking about artificially intelligent systems, but also enhanced humans and variations of both. Thus it might not be a question of machines taking over Homo sapiens. It might be a case of enhanced Homo sapiens who have enhanced brain power and physical

capabilities, along with artificially intelligent machines, and various combinations of all of these, taking over.

When this happens, we Homo sapiens are suddenly going to find ourselves at the lower level of intelligence. No one has faced up to the possibility that suddenly there will be someone above us.

"How do we prepare to be on the second rung?" This idea is not found anywhere in posthumanism literature. It has not been discussed much. How do we prepare to be on the second rung? It is inevitable that some of us will end up there as not all six billion people on the planet will be able to elevate to new levels of mental and physical capabilities simultaneously.

Monkeys Designing Humans

Monkeys unwittingly contributed the DNA that led to Homo sapiens. They had no idea they were doing it at the time, and they still do not. Had they known what we were going to do to them, they might not have thought it was such a good idea.

This is significant because monkeys do not have the faintest conceptual capacity to understand how we think and how we behave as humans. They can emulate and relate to us, but they cannot perform many of the upper-level functions that we are able to do.

The reason I am using this comparison is quite simple. Soon, we will find ourselves in a similar situation. The chances are very good that we will not have the faintest idea what these super-intelligent beings are thinking, how they are communicating, or what they are doing to us or why.

This begs the questions, are we designing something over which we will have no control? Is there any way to program ethics into these super-intelligent beings?

If we do not program ethics into them, we may end up on the garbage pile because there is a good chance that they will unwittingly or deliberately treat us just as we treated the Incas and many animal species. In all of our wisdom, we still have many disasters going on. We must acknowledge this fact when we are talking about what type of ethics this superintelligence is going to have.

The question is, how will super-intelligent beings - which we will have no capacity to influence whatsoever - judge us? Unfriendly artificial intelligence is the most daunting challenge because if they make up their minds based on our performance or what they have seen in our history, they might just say, "No, sorry, this is no longer relevant. We're getting rid of this one."

This could potentially be a huge problem for the human race, especially if different levels of superintelligence evolve. Some of these levels will be in computers, some autonomous, some attached to the human brain. Thus we will not just have one level of superintelligence above us, but varied levels of superintelligence. Some of them might be friendly and some of them not, and some of them might go to war with each other, let alone us.

What Were They Thinking?

Imagine if super-intelligent beings look back at us and wonder, "What were they thinking?"

Let's examine our behavior. We can acknowledge that we have not done too badly in some areas, but we have been completely stupid in others.

The first area in which we have failed is "oil silliness." We have had the technology for the past 25 years to eliminate our dependency on fossil fuels for a good portion of our economy (such as electricity generation) and we are very rapidly gaining the capacity to replace it in many other areas (such as transportation). When we look at what oil is doing to us, it is absolutely silly from the viewpoint of the outside observer

that we have not done this. Everyone is aware of the pollution problems related to oil production, and the geopolitical problems of oil are becoming very destructive.

If you look around the world today, you will notice many human rights violations that are being supported by democracies in the name of oil. There are the troubles in Iraq and Russia, where semi-dictatorships are being propped up by oil; and all of the dictatorships in the Middle East are propped up by oil.

Several recent articles in the news about this issue indicate that the worst is yet to come in the battle for oil. A recent headline states, "*China Stakes a Claim to Major Access to Oil Around the World*". The United States and China are starting to go head-to-head over fossil fuels. This will make Iraq look like a party.

This is also from a recent newspaper: "*A New Player in the Sand Box*". China is investing heavily in Canada's tar sands, which contain more oil than all of Saudi Arabia and Iraq put together. This is making the United States very nervous.

Oil is starting to become a bigger problem, and yet we have the technology to avoid it. If we increased our fuel efficiency by about 20%, the Middle East problem would disappear because we would no longer need their oil. You can imagine how an outside observer would think that we are engaged in total silliness, and surely a super-intelligent being looking back on it will say, "What were they thinking?"

Another area where we might be judged harshly is mass animal slaughter. We live in wonderful surroundings and we enjoy our wonderful food, but underneath it all is an unbelievable current of mass slaughter that was very well documented in a recent book entitled, "*Eternal Treblinka: Our Treatment of Animals and the Holocaust*", by Charles Patterson. This book catalogues the billions of animals that are currently kept unnecessarily under inhumane circumstances in order to feed us, largely to entertain our over-the-top eating habits. Here we

have, underneath our sheen of civilization, an enormous slaughter and inhumane keeping of wildlife. A super-intelligent being will look back on this and conclude, "What were they thinking?"

Finally, we have the end of pipe medicine. We have a medical system today, in the United States and Europe (and beginning in other parts of the world), that supports a Mr. Fix-It approach. It waits until an ailment gets totally out of hand, and then begins to bankrupt our economy by making us pay to try and fix it. We already have a growing capacity to fix the sources of many illnesses today. We could fix our obesity problem in the United States and in many other countries. We have the capacity to do it, but we are not doing it. Again, a super-intelligent being will look at this and wonder, "What were they thinking?"

Focus is Needed

These are not the only examples of problems that we can fix, but they are big ones that have a huge impact. We need to take a crack at showing some intelligence about these things right now

"... what is most needed is an approach to human welfare that provides the greatest benefit for the most people in the shortest period of time."

in order to demonstrate to these superior beings that we are actually worth keeping around. Incremental changes are insufficient as the future is flying at us at great speed. Before we know it, we will have to explain ourselves to something that is just as smart as or smarter than we are.

We need big thinking now. We need to attack the big problems in our society with the tools that we have at our disposal right now. We need to get our act together and focus on a few selected areas instead of just biting around the edges.

Replace Oil

First, I suggest that we replace oil now. Why not do it? We have the technology to do it and many emerging technologies will make it even easier.

One example is a company named Nanosolar in Silicon Valley that will soon roll out a nano-structured solar cell that, according to published news reports, has at least three major innovations. The first innovation is quantum dots that absorb solar energy, including from the infrared spectrum, from all directions (not just unidirectional), which makes it incredibly efficient. The second innovation is that it is contained on a super-thin film that can be rolled up, eliminating the need for these nonsensically huge, heavy panels that many cities will not approve because they violate space ordinances. Nanosolar has also made it about five times more efficient and cheaper than any solar cell on the market today, which makes it more cost-effective - without any subsidies - than coal-fired and oil-fired energy.

Replace Animal Protein

We should also replace animal protein as a major food source. Technology is allowing us to begin to grow meat with artificial processes. We will not need to kill billions of animals any more or keep them around in horrible conditions. The technology is here in some areas, and if we focus on it and invest in it, we could really accelerate it.

Eradicate Diseases

The third change that we must make is to fix the very worst diseases. At the end of our book, *Our Molecular Future*, we asked what we should focus all of our new wonderful technologies on. We came to the conclusion that what is most needed is an approach to human welfare that provides the greatest benefit for the most people in the shortest period of time. This is necessary to counteract the many fear-mongering headlines about artificially enhanced humans. We need to generate hope and confidence so that people will not get swept up in the backlash against

scientific research and development in nanotechnology and transhumanism.

We must develop a hopeful scenario so that if something does go wrong with nanotechnology, which it inevitably will, we are there first with the solution that has given people hope. Then people will acknowledge the mishap, but they will also remember that the technology has saved billions of lives and so it is worth the risk. We must be proactive with a big idea right now.

Calcification

Where do we focus these efforts? In order to answer this question, we asked three questions. First, what condition occurs in most of the diseases on the "leading cause of death" list? The answer to that is inflammation.

Everyone has seen the headline stories about inflammation in heart disease and inflammation being associated with all kinds of things. *Newsweek* recently published a series of articles about 21st Century Health, in which there was a big section about inflammation being associated with just about everything: cancer, diabetes, heart disease, and so on.

Second, we asked – which factor is associated with precancerous conditions and basic organ dysfunction? The answer to that is rapid cell division. The third question we asked was what is the common denominator to aging; and what does everybody have by the age of 70, almost without exception?

The answer to these three questions is calcification. Most people have a vague idea about calcification, but they do not understand the extraordinary depth and breadth of its influence.

By the age of 70, almost everyone has calcification within their arteries, organs, skin,

or elsewhere in their body. The reason calcification is so important is that it has long been thought to be a result of disease, a response to disease, or part of the body's healing process. Yet there are questions concerning that. First, despite all of our scanning, we have never been able to spot where calcification begins in vivo, within the capillaries in the body. Suddenly, it shows up when a disease is well developed thus we conclude that it must be a response to the disease.

The last three years of research have shown quite clearly that this is not the case, but that basic calcium phosphate crystals actually *cause* acute inflammation and an acute immune response by the human body.

Recently, a paper was published in the journal, *Circulation Research*, by a leading group of researchers in London with proof that calcium phosphate crystals cause inflammation in heart disease.² This confirmed the findings that have been revealed for years now in arthritis and other illnesses where doctors have long known that calcification generates this kind of inflammation.

That is important because inflammation is associated with so many illnesses. Scientists have recently discovered that heart patients have had heart attacks after their dentists have performed a root canal. Dental pulp stones are comprised of calcium phosphate crystals, which are released into the bloodstream by drilling where they may then provoke heart problems in patients who already have heart disease.

Calcification is found in many illnesses, from cataracts to diabetes, gall stones, kidney stones, liver cysts, parathyroid disease, prostatitis, sclerodermas, stroke, tendonitis, and so on. Young athletes often contract Pitcher's Elbow, which also contains calcium phosphate crystals. Bursitis, tendonitis, and arthritic conditions all involve calcification.

Calcification provokes acute inflammation and stimulates rapid cell division. It is also one of the only visible markers of both breast cancer

and heart disease. Breast cancer is often detected through a biopsy of calcium deposits in the breast as basic calcium phosphate crystals are not only endotoxic, but promote rapid cell division.

Calcium phosphate crystals physically block blood vessels and organs. Calcium phosphate comprises

"... there are extremely primitive, self-replicating organisms ... that have been around for several hundred million years ... and possess the ability to adapt to many environments, including human beings."

about twenty percent of all the plaque in the arteries; the so-called "hard plaque." It is also found in the soft plaque and vulnerable plaque that has been identified as leading to heart attacks. It is not often identified in the soft plaque because it cannot be seen unless a tissue sample is taken and specially stained to reveal these tiny calcium phosphate crystals.

The definition of calcification is the deposit of calcium phosphate in parts of the body where it is not supposed to be. It is different from the normal, healthy process that builds bone and teeth. It is not very different, but that difference is all the difference in the world. Less than one percent of the calcium in the body goes haywire, but this is enough to cause a lot of trouble because calcium phosphate is toxic to human tissue. Calcification, as well as hardening the arteries, hardens the skin. Scleroderma, aging of the skin, is also related to calcification, making movement difficult when it invades the joints.

Better Detection

The good news is we are getting much better at finding calcification. In the last 18 to 24 months, CT or CAT (Computerized Axial Tomography) scanners have been able to show the physical progress of calcification for the first time. Many people do not recognize it because it goes by many other names, such as calcified deposits, calcium buildup, calcium salts, crystallization,

dystrophic calcification, micro-calcification, ossification, plaque, spurs, and stones.

Many pathogens have been blamed for calcification in heart disease and for heart disease in general, but the interesting thing is that every time we try and attack them, there has been no impact on reducing heart attacks. For example, Chlamydia, Herpes, and Hepatitis A have all been implicated in heart diseases, yet every time we get rid of them, it does not appear to impact heart disease.

Nanobacteria

Here's the good news. Recent studies show, for the first time, that researchers have been able to reverse coronary artery calcification with a medical treatment. This is a huge breakthrough. It was discovered when NASA scientists identified a tiny nanoparticle that calcifies, and in the lab they found out how to get rid of it. The particle is called nanobacteria.

The reason I have not mentioned the nanobacteria until now is because it is a completely wrong name. They named it in 1992 when they did not know what it was. It is not bacteria; it is not a virus; and it is not a prion (a microscopic protein particle). It is a self-replicating particle that appears to lack sufficient DNA to replicate in the normal way.

It is now hypothesized that there are extremely primitive, self-replicating organisms out there that use calcium and phosphate and that have been around for several hundred million years. These organisms possess the ability to adapt to many environments, including human beings.

The nanobacteria do one particular thing. They create a rock-hard and toxic calcium phosphate shell that is identical to the calcification found in humans. Studies have recently found these nanobacteria within ovarian cancer, heart disease, vaccines, cows, and many other places where they are not supposed to be. This fact was revealed to the FDA in the early 2005.

Scientists are now working very hard to characterize this particle. There is a large debate over it. Some people say that it does not exist, even though many laboratories around the world have succeeded in culturing it. The problem is that its DNA has never been sequenced; though it self-replicates, it does not appear to have a full set of DNA.

This takes us to the other reason that we investigated this particular item. These nanobacteria could be at the very source of new life forms and we can certainly use nanotechnology to research them. We could use

atomic force microscopes, develop better ways of characterizing calcification, and so on.

Because calcification has such a huge impact on humanity and is the defining characteristic of aging, it should be addressed as a major area of nanotechnological focus to benefit humankind. In this manner, we can focus on a hopeful and positive outcome that will also help in garnering public support for the future of the nanotechnology field.



Douglas Mulhall is a leading nanotechnology journalist, an award winning documentary filmmaker, and broadcast executive. Douglas has also led at least one other life as a pioneer in scientific research. His landmark book, Our Molecular Future, describes powerful new tools to save the globalized economy from "nature's time bombs." That cutting edge approach is reaffirmed with a new co-authored book, The Calcium Bomb, about a nanobacteria link to heart disease and cancer that is shaking the medical world.

References

¹ *Guns, Germs, and Steel: The Fate of Human Societies*, Jared Diamond. W. W. Norton & Company (April 1999)

² *Proinflammatory Activation of Macrophages by Basic Calcium Phosphate Crystals via Protein Kinase C and MAP Kinase Pathways, A Vicious Cycle of Inflammation and Arterial Calcification?* *Circulation Research*. 2005;96:1248



Proactionary Nano-Policy: Managing Massive Decisions for Tiny Technologies

Max More, Ph.D.

This article was adapted from a lecture given by Max More, Ph.D. at the 1st Annual Workshop on Geoethical Nanotechnology on July 20, 2005 at the Terasem Retreat in Lincoln, VT.

More is the Chairman of the Extropy Institute, a philosophical and cultural non-profit organization with the mission "...[T]o serve its members by ensuring a reputable, open environment for discussing the impact of emerging technologies and for collaborating with diversely-skilled experts in exploring the future of humanity." More urges a proactionary approach in developing policy that addresses the wonders and risks of nanotechnology. The basic point of the proactionary principle is that we need to protect the freedom to innovate because it is critical to our future survival and well-being. Of course, new technology needs to be regulated as it develops, but More argues for an approach to regulation that allows it to flourish, rather than an overcautious, precautionary approach that may end up limiting its potential.

Christmas-time for Nanotechnology

In a way, we could say that this is "Christmas-time for nanotechnology". It is a festive time and everyone is paying attention to it and enjoying all the funding that is being thrown their way. Yet, as at Christmas-time, we have to ask whether nanotechnology has been naughty or nice. The answer is both: Nanotechnology is naughty and nice.

We know about all the possible risks of nanotechnology, from the minor things to the huge world-eating problems. Yet we also need to make sure that people understand the benefits, which can be substantial. Nanotechnology is naughty when one wonders about the

possibilities of dangerous nanoparticles, targeted nano-weapons, and cancerous self-replication. Nanotechnology is nice when we imagine possible consequences such as abundance, health, super-longevity, and environmental restoration.

In imagining the potential of nanotechnology, we must consider both the good and bad. We do not want to err too far on the side of caution, but we also do not want to get too carried away either. How do we find the right balance? The thrust of this article is to ask the question - what is the problem with constraining nanotechnology? How far do we want to constrain it and what is the right way to do so?

Unfit Brains

We start off with the problem that we are equipped with brains that are wonderful on one level, but are not very fit in an evolutionary sense for modern society. They are not well equipped to deal with the type of problems and risks that we face. They are designed to handle repeated attacks and to learn from specific events. Our brains are not that good at handling highly complex subjects, abstractions, and what is often referred to as "black swans," which are extremely unlikely events that happen once in a million years.

Our brains also come with a bestiary of biases that lead us to agree or disagree with one another for other than rational reasons, including:

- availability
- recency
- representativeness
- overconfidence
- framing effects (prospect theory)
- mental accounting
- risk aversion
- status quo bias
- endowment effect
- anchoring
- sunk cost effect
- escalation of commitment
- herding instinct
- misestimating future hedonic states
- flawed consensus-confirmation bias
- selective recall
- biased evaluation
- groupthink

In addition to our cognitive limitations, we have institutional limitations. Therefore, any discussion about how we will constrain or regulate nanotechnology (or any other technology) must recognize that regulators are not optimizers.

Regulators Are Not Optimizers

We might think that regulators exist to optimize results, but we must take the institutional context into account. Regulators are there to do their jobs as they see them. Their main goals might be to build up their departments, power, and

control. Regulators tend to over-regulate, even if they are not doing it consciously. They tend to over-emphasize risks and dangers, and discount the benefits of new technologies. This may simply be because when we do not see things, we cannot directly see many of the benefits. The dangers are more easily seen.

Regulators fear Type I errors (errors of commission) more than Type II errors (errors of omission). An example of an error of commission is when the FDA approves a drug and as a result, children are born horribly deformed. This happened with thalidomide, for which the FDA was severely criticized.^{1,2} An error of commission can result in a regulator ending up on the front page of the newspapers, being pilloried by the press, possibly even losing his or her job.

A Type II error, on the other hand, results in few or no repercussions. If the FDA prevents a drug from being distributed even though the drug has benefits, no one would ever hear about it. No commissions would be held in Congress to investigate why the drug was not approved. A regulator does not get into trouble for an error of omission, so they tend to be biased towards over-regulating.

In addition, we have a general cultural bias towards emphasizing catastrophe. This is the reason that there is so much bad news on television and why so many catastrophe movies are made. Catastrophes are exciting and draw our attention.

Regulators' Required Reading

For a little fun, I have made a list of required reading for regulators. Regulators must be well-read in "The Fall", Pandora's Box, the Tower of Babel, Icarus, and Prometheus. They must read Rachel Carson's "Silent Spring", Paul Ehrlich's "The Population Bomb", "Frankenstein", and of course, they must watch the movie, "The Terminator".

The Brain Analogy

Here is an amusing parallel. Some say that nanotechnology could be dangerous and that we had better stop it and/or regulate it. Imagine if we had a parallel argument about brains. Brains are dangerous things. They are potentially fatal and could cause the destruction of the human race. Brains are insidiously clever devices that hide inside skulls where we cannot observe them, just like nanodevices, which are too small to see. Even worse, they can make copies of themselves and the instructions within them via human reproduction. All of these statements are true, literally speaking. Yet we do not want to regulate brains in that respect.

However, we may need to regulate brains in a different sense. We may need to regulate them in the sense that we need to structure our decision-making procedures for attaching risks and benefits. In other words, we do not want to let people loose regulating or deciding whether to release something or how to employ the technology without thinking very carefully. We want to structure these decision procedures in a specific way.

The Wisdom of Structure

This leads me to the wisdom of structure. To counter both these organizational and cognitive biases, we need to use intelligent methods to structure our decisions. By structure, I am talking about using the best knowledge that we have in the decision sciences, in cognitive psychology, and in the social sciences to understand factors, such as who can direct us. For example, in a group of people, certain people dominate the discussion and lead to certain conclusions that may not be the best given the knowledge in the room. How can you remove those biases?

How can we allow for the bestiary of biases listed above? There are actually many methods of doing so, but they are rarely used, even when much is at stake.

I think we need to institute a procedure that encourages people to use them more often and

more effectively. If that were to happen, we would see the following benefits:

- Improves decision accuracy by specifying methods and inputs
- Raises quality of each step of the decision process by drawing systematically on the best available knowledge
- Enhances convergent, analytical capabilities
- Enhances divergent thinking and the generation of alternatives
- Minimizes excessively risky and excessively conservative judgments by systematically comparing elements of the decision and by critically integrating diverse perspectives
- Reduces risk by finding and evaluating more threats
- Contributes to organizational transparency

Still, we do not commonly see regulators sit down and say, “We have to make decisions that will affect the next few decades. What are the best procedures that the social sciences have identified for making forecasts?” This question is rarely asked. If we are lucky, they might do a scenario analysis, but I do not think that even this is done very often at the government level. Yet these are good principles.

One source of procedures is Scott Armstrong's "Principles of Forecasting". In it, Armstrong systematically examines all forecasting methods, including how reliable they are and the types of problems for which they are most appropriate.

Another intriguing source is Gordon Ruggs' “Verify Approach”, which was recently written about in *Wired Magazine*. Ruggs has devised a method for accurately verifying experts when you are not an expert in their area. He shows how to come in from the outside and apply certain methods to testing whether the experts are missing something. He famously proposed the solutions of the Voynich manuscript problem, where he showed how it could have

been forged at a certain time when nobody else had really figured that out.

There are many examples of sources like Armstrong's and Ruggs' that are available and yet go unused.

The Precautionary Principle

That leads me to the precautionary principle, which is very well known in Europe, but less so in the United States. The precautionary principle is the regulator's favorite principle. They like to use it because it embodies a bias on the side of caution or precaution. It is actually embodied in the European Union Constitution[1], which I find a little bit frightening.³ The precautionary principle is also implicit in many U.S. regulations.

There are many ways of stating the precautionary principle. The following, from *Nature* magazine, is often quoted:

"When an activity raises threats of serious or irreversible harm to human health or the environment, precautionary measures that prevent the possibility of harm shall be taken, even if the causal link between the activity and the possible harm has not been proven or the causal link is weak and the harm is unlikely to occur."

In practice, that means if someone has managed to raise a scare about something with no basis in reality at all, we must stop it until it is proven safe. This tends to be rather discouraging for the activity and has many, very conservative effects.

One effect is that it bolsters the position of existing technology in an institution because there is a bias against innovation. If someone proposes a better way of doing things, he or she must prove that it is safe and better in every way before it is even considered.

The precautionary principle also discourages learning through experimentation. It assumes that we can figure everything out without doing

anything. It is very much a rationalist view of discovery as opposed to an empiricist view, encouraging one to sit in an armchair and think carefully about something and make the best decision without actually taking any action. Whereas I think most of us would agree that you need to actually try something out and learn by doing.

Bill Joy: Precautionary Relinquishment

Bill Joy is quite well known for his version of the precautionary principle - called precautionary relinquishment - which is applied to genetic engineering, nanotechnologies, and robotics (GNR). Joy believes that GNR threatens to make humans an endangered species. He concludes that we therefore must limit our pursuit of certain kinds of knowledge. This is a frightening view.

Joy backs precautionary restriction on the freedom to innovate, saying "The only realistic alternative I see is relinquishment: to limit the development of the technologies that are too dangerous, by limiting our pursuit of certain kinds of knowledge. With their widespread commercial pursuit, enforcing relinquishment will require a verification regime similar to that for biological weapons, but on an unprecedented scale. This, inevitably, will raise tensions between or individual privacy and desire for proprietary information, and the need for verification to protect us all."

This is a terrifying claim about the kinds of enforcement that would be needed. It leaves a lot to the imagination, but sounds as though it is really quite drastic.

It is possible to say that Bill Joy is just one person, but there are many others on this wavelength. One reason for this may be that as we develop as a society and economy to a fairly comfortable level, we tend to get more focused on dangers and threats and less so on survival.

Tragically, we often impose that preference on countries that are not as well off as we are. For example, we may stop them from developing in

ways that are direly needed because it might put a little bit of smoke into the atmosphere. Yet they might actually be more interested in feeding their children and surviving past the age of twenty than in protecting the environment.

In our society, we tend to be very, very cautious, which is, in some ways, a sensible approach. We all want to wear our seat belts and have air bags in our cars. That's smart. We did not do that fifty years ago. Obviously, not all caution is bad, but we do tend to lean a bit too much in that direction.

Structuring the Decision Process

It would be useful to ask the following questions about a procedure that someone is using to make a decision:

- Is it transparent?
- Is it as simple as possible?
- Is it comprehensive?
- Is it balanced?
- Does it encourage creative alternatives?
- Does it use the best available scientific knowledge?
- Does it protect the freedom to learn and innovate?

By these measures, the precautionary principle fails. It certainly fails the test of objectivity because it encourages fear-based reasoning. It does not attempt to make it reasonably comprehensive by taking all the possible effects into account, including both good and bad. This wrongly shifts the burden of proof onto innovators. It makes it very hard to get any kind of innovation through. As far as it is concerned, a new idea is guilty until proven innocent.

The following list summarizes the ways in which the precautionary principle fails:

- Fails the test of objectivity
- Fails the test of comprehensiveness in deliberation
- Causes harm, especially to those in need
- Ultraconservative

- Diverts attention and resources away from more urgent matters
- Discourages innovation and creative alternatives
- Denies us the freedom to make trade-offs
- Fails to ensure that reliable decision procedures are used
- Asymmetrical: favors nature over humanity
- Vague and unclear; can enable corruption and bias
- Wrongly shifts burden of proof onto innovators

The precautionary principle denies us the freedom to make trade-offs. This relates to the point made earlier about poorer countries that may need to have different priorities in terms of trading off some of the health of their environment for more economic development at their stage, just as we did decades ago. It does not allow for those kinds of trade-offs because it puts an absolute value on caution.

With regards to the point that it favors nature over humanity, it does not explicitly do that, but does so in the way it is actually deployed. People who use the precautionary principle often tend to be perceived as anti-civilization, anti-progress, and anti-science. They do not apply the principle to nature itself, but rather always to human-made technology or policy. It is not applied to natural viruses, bacteria, floods, and hurricanes. It does not ponder the costs and benefits of nature, but assumes that nature is innocent. It is a throw back to that old view of nature as perfect and innocent, quite the contrary of nature living tooth and claw.

The Proactionary Principle

In place of the precautionary principle, I offer the proactionary principle. The proactionary principle takes a more proactive approach. It is neither inherently biased against innovation nor against caution. It takes both into account. I am still working out a shortened version of the proactionary principle. Here is the long version:

“Freedom to innovate technologically is highly valuable, even critical, to humanity. This implies a range of responsibilities for those considering whether and how to develop, deploy, or restrict new technologies. Assess risks and opportunities using an objective, open and comprehensive, yet simple decision process based on science rather than collective emotional reactions. Account for the costs of restrictions and lost opportunities as fully as direct effects. Favor measures that are proportionate to the probability and magnitude of impacts, and that have the highest payoff relative to their costs. Give a high priority to people’s freedom to learn, innovate, and advance.”

The basic point of the proactionary principle is that we need to protect the freedom to innovate because it is critical to our future survival and well-being. We cannot assume that because we are comfortable now, we always will be. New threats, both natural ones and ones created by other human beings in various places, constantly arise.

At the same time, we do need to consider risks very carefully. Even if we are going to go ahead with the technology, there are better and worse ways of going ahead with it. There are better and worse ways of testing it, and of planning for contingencies. We need to look at all the different ways - not only whether you go or not go, but which way should we go?

We must also ask - to the extent that we do need to apply any kinds of restrictions, whether self-regulation or government regulation, what is the cost of those restrictions and how can we minimize it? How can we get the most benefit from any kind of restriction we do impose?

Objectivity

Objectivity is a particularly important aspect of the proactionary principle. The precautionary principle does not deal well with objectivity. It is not comprehensive. It does not have any way to

encourage you to look at all the risks and benefits in every area. It is an asymmetrical treatment because it is biased against human creation. And it does not seem to have any sense of proportionality. What kind of precaution is a sensible payoff for the benefits of any death or whatever we will lose? Is it worth doing?

The proactionary principle asks that we apply objectivity first by using science instead of popular perception. Do not let people's fears regulate how you make decisions. This is a difficult request to make of a politician or even a regulator who will get pressure from the politicians. Therefore, we need a lot of public discussion about this to pressure people under the political eye so that they do not make decisions based solely on the desires of special interest groups.

Objectivity also means using explicit forecasting processes and other decision processes to ask - how are you making this decision? Let it be publicly known and open to critique.

Another effective measure to enforce objectivity is to use the devil's advocate procedure. Almost no one does this even though it is an amazingly effective procedure. Within companies and government agencies, no one wants to employ a devil's advocate because they assume that they are right; they make an argument, build their charts, give their numbers and say “I've made my case. Let's go ahead.” After some discussion, they make their decision. No one actually appoints a person to prepare and present a case *against* the idea. I think that is absolutely what we should do with all major decisions. In your personal life, it is good to ask somebody who you think will disagree with your decision what they would say against it. Essentially, this method applies the scientific method on a micro scale for particular decisions.

Symmetrical Treatment

In terms of symmetrical treatment, the technological risks should be treated on the same basis of natural risks. In other words, do not treat the risks of gene-splice crops differently from

traditional crops, which is done all the time. If the procedure is natural, such as a natural way of farming, you do not see the same kind of scrutiny that you do to technologically based methods, even though there are major risks in some of those natural processes, too. For example, some ways of fertilizing with perfectly natural substances can cause run off and other problems that are actually reduced by genetically engineered crops, but we automatically assume the opposite is true.

Another important point is that you must fully account for the benefits of technological advances. Of course, you cannot do that totally because you cannot foresee all of them. Therefore, it is important to be comprehensive, to consider all the reasonable alternative actions, including no action.

Do not assume you have to do something. Figure all the possibilities you could go through and choose the one that would yield the best payoff. Carefully consider whether there are any opportunities and possibilities that are being closed off by abandoning or relinquishing or regulating a technology. If you decide not to pursue something, you should ask what else would people do instead? What are the substitutes? If you decide to do something else, the results might be worse. Very importantly, think about second-order and third-order and fourth-order effects, not just first-order effects.

Proportionality

Regarding proportionality, if you are going to restrict the technology, you want to make sure

the payoff is worth it. Regulation itself brings risks. With nanotechnology, we might worry especially about military and terrorist uses. Yet this is exactly where regulation is not going to help very much. No one is going to submit their nano-terrorist device to the FDA or any of the agencies for oversight of regulation. They are not going to show it to the United Nations.

It is also important to consider that if we establish some kind of global regulation by the traditional agencies, you could end up with a situation where the most restrictive policies are imposed on all of us.

Alternatives

There are many alternatives to restricting a technology that could be considered, such as developing industry standards, self-regulation, and transparency (score cards and report cards, similar to the [Global Reporting Initiative](#)). Pressure from “socially responsible investing” funds also can apply pressure as a type of regulation. All of these methods can incorporate the proactionary principle.

In summary, regulatory agencies, if involved, should use the proactionary principle, not the precautionary principle. Less harm will be done and more progress will be made.



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References

- [“The Proactionary Principle”](#), May 2004.
- [“Deflecting the Precautionary Principle”](#)
- [“Debugging Executive Decision Making”](#)
- [Maxmore.com](#)
- [Extropy Institute](#)

¹ *Thalidomide is a sedative and hypnotic drug that was withdrawn from sale after it was found to cause severe birth defects when taken during pregnancy. More recently, though, it has been approved as an anti-cancer drug. Stedman’s. The American Heritage Medical dictionary. Boston, New York: Houghton Mifflin Company, 2004. p 817.*

² *Thalidomide was originally developed to prevent morning sickness in pregnant women. Research is now looking to see whether it might be effective as a treatment for some types of cancer. [Cancerbackup.org, Biological Therapies](#). April 17, 2006 10:20AM EST*

³ *Following the two devastating World Wars of the first half of the 20th century, a number of European leaders in the late 1940s became convinced that the only way to establish a lasting peace was to unite the two chief belligerent nations - France and Germany - both economically and politically. In 1950, the French Foreign Minister Robert Schuman proposed an eventual union of all Europe, the first step of which would be the integration of the coal and steel industries of Western Europe. The following year the European Coal and Steel Community (ECSC) was set up when six members, Belgium, France, West Germany, Italy, Luxembourg, and the Netherlands, signed the Treaty of Paris. Referenda held in France and the Netherlands in May-June 2005 rejected the proposed constitution. This development suspended the ratification effort and left the longer-term political integration of the EU in limbo. <http://www.cia.gov/cia/publications/factbook/geos/ee.html> April 17, 2006 10:28AM EST*



Global Geoethical Implementation of Nanofactory Production: Multi-Stakeholder Engagement for Effective Policy and Administrative Structures

Mike Treder

This article is adapted from a presentation given by Mike Treder at the First Annual Workshop on Geoethical Nanotechnology on July 20, 2005 at the Terasem Movement, Inc. Retreat in Lincoln, VT.

Mike Treder, Executive Director of the Center for Responsible Nanotechnology (CRN), describes the positive and negative potential inherent in nanofactories, a nanotechnology product that will be a reality sooner than we realize. Because nanomanufacturing does not require self-replication, it will be easier to achieve than other technologies. Therefore, policies to regulate it must be developed as soon as possible and in a conscientious manner. CRN is working with other groups to come up with a list of areas that will be affected by nanomanufacturing, and then to devise global, multi-stakeholder policy and administrative structures to address them.

Introduction

We can look forward to many exciting possibilities as nanotechnology develops, such as self-replication and super humans. Yet before we reach that level, we will be able to use nanotechnology to manufacture products with

atomic precision and exponential reproduction. These "nanofactories" are closer on the horizon than many realize because this technology will not require self-replication, which will render it easier to achieve than other nanotechnologies.

"One example of a future nano-product is an ultra light aircraft that you can fold up to the size of a camera and then unfold and go for a flight."

This upcoming period of nanofactory production will be fraught with difficulty. Therefore, we

must figure out how to navigate this phase before it is upon us.

What are Nanofactories?

The defining characteristic of a nanofactory is that it accomplishes the reproduction of the means of reproduction. This is different than self-replication. It is a means of reproduction that can create another one of itself on command. This equates to factories making factories within the incredibly short time span of a single day.

Imagine if a huge automobile assembly plant could make a copy of itself overnight, and then those two factories could make copies of themselves. This is guided replication (not self-replication). It is exponential replication because with every new day, you could double what you made the day before.

The products that the factory produces are important, but the most important product of all is the factory itself because it is a means of production that can reproduce itself.

Technical Significance

What is the technical significance of nanomanufacturing? To illustrate the scale significance of molecular nanotechnology, imagine a condor or an eagle flying. The wings of these large birds move slowly. Comparatively, a sparrow's wings move quickly and a bee's wings move so fast that they are barely visible.

At the nanoscale (one billionth of a meter) level, machines can work a million times faster than at our present level because the distances they must cover are so much shorter. Moving one nanometer can be accomplished in an extremely short period of time.

These nano-products and machines will be molecular in size, allowing a tremendous amount of functionality to be included in them. These products will be a hundred times smaller and ten times lighter than today's materials. They will also contain smart computing. One example of a future nano-product is an ultra light aircraft that you can fold up to the size of a camera and then unfold and go for a flight. These unbelievable products are not that far away and will be extremely inexpensive to build - if we are allowed to build them.

Molecular nanotechnology will enable rapid prototyping. We will be able to design a new product or revise an old product and create the prototype within a matter of days, rather than years. Better and better products will evolve at extremely fast rates, which will revolutionize manufacturing. The reverberations of this will be felt in many areas, such as the environment and the military.

Implementation

Molecular nanotechnology will be a general-purpose technology, like electricity. It will be in every economy and in every society. It will use inexpensive raw materials, so it will be easy to create a new nanofactory. The raw materials necessary to create a nanofactory could cost as little as a few dollars.

There exists a potential to create a real economic discontinuity when manufacturing moves from the scale of block-sized factories with their many components such as production, wholesale, shipping, and so on – to a desktop level. Many jobs will be in jeopardy, resulting in inevitable economic and social disruption. The affect on local communities will be immense.

The impact of implementing molecular nanotechnology *"The capability for rapid prototyping could enable countries to increase their military arsenals by the billions within a few days."* is bound to cross borders. Due to the fact that a small nanofactory can make a larger one, a person could easily smuggle the former into a country where nanofactories are prohibited. This small nanofactory could be as small as a penny, and a person could easily conceal it in her pocket as she enters the country. Once inside, she could use it to create larger nanofactories within that country. It may be impossible to control where nanofactories exist or do not exist.

Potential Dangers

Many dangers are inherent in nanofactories. One very serious risk is the potential for an unstable arms race. The capability for rapid prototyping could enable countries to increase their military arsenals by the billions within a few days. Unlike the nuclear arms race, which stabilized as we reached a level of mutually assured destruction, this arms race would never reach that level due to the exponential speed at which weapons could be produced.

If one nation, corporation, or individual gains a monopoly over this technology, they would be

able to literally rule the world in a short period of time. We must contemplate the types of restrictions necessary to curtail this.

Nanofactories pose the risk of ubiquitous, intrusive, networked surveillance that could be used by terrorists, the government, corporations, individuals, or even the paparazzi to watch our every move and possibly use it against us. We are close to this type of invasion of privacy already, however; nanotechnology will make it even easier.

A black market could result if the technology is not apportioned in a manner that is viewed as fair. If it is too greatly withheld, someone may attempt to smuggle it out and make it available in a way that might not be as safe.

Environmental damage could easily occur if products are cheap to make and discard and we have not yet created a disassembler. We could end up with a vast heap of nanolitter, which would create an environmental problem in a short period of time.

Solutions

Finding solutions to these potential dangers is not an easy task. Jane Jacobs coined the term “systems of survival” to describe three groups – guardians (government, police, militia), commercial (business and industry), and the open source group which favors the free dissemination of information.¹ Each of these groups will want to make use of this technology in order to achieve their goals, which might be in conflict with one another. This must be taken into account or else we will end up with someone who does not like the rules and will find a way to break them.

No single solution can be applied. A patchwork of solutions - trying to fix this or that problem as it arises - could only make things worse. A fix that applies to one problem could only exacerbate another problem.

In an ideal world, a single development program appears to be the safest solution. This would be

an international cooperative program to simultaneously develop molecular nanomanufacturing. All countries would agree - for the sake of world safety and to save the human race - to develop it together. This would avoid the arms race by applying rules that govern everyone.

The sooner we develop this technology, the sooner "... *the international agreements must be in place before the technology is developed.*" dangers can be averted because we will know what they are. In addition, there are so many inherent benefits to nanomanufacturing - environmental, alleviating poverty and disease, providing clean water, saving energy, humanitarian – that the need to have it as soon and as safely as possible is great. Millions and millions of lives could be saved or improved when this technology is developed.

Geoethical Solution

A global solution is imperative. This will probably require a treaty organization to administer environmental policies that cover all countries because environmental policies in one country can wreak havoc in another. For example, the terrible air pollution in China today is causing acid rain and destroying plants in countries all around the world. Environmental problems know no borders and neither will advanced nanotechnology.

Maintaining adequate product and manufacturing security might also require international agreements. A global approach would also prevent the likelihood of an arms race. Yet in order to achieve these goals, the international agreements must be in place before the technology is developed.

Challenges Ahead

Let's summarize our approach to the many challenges ahead. First, we must understand the risks. We have touched on some of them, but we may have missed or overestimated something. Second, we must create policy that effectively deals with those risks. If we cannot prevent the risks, we cannot gain the benefits. This policy must satisfy multiple groups and not conflict with other policies. This could take years to develop.

Once that policy is developed, we must find the best way to implement it. How long will it take to create institutions on a global level or to encourage existing institutions to adopt the policies? It could take a long time. In fact, our fear is that it will take longer than it will to develop the technology.

No single group in the world can do this alone. It will take cooperation from many different groups and backgrounds, languages, nations, and training. It will take economists, sociologists, and medical, environmental, and military experts.

Battelle is a huge non-profit research company that manages most of the large government research labs in the country.² It has joined with the Foresight Institute to develop a technical roadmap for productive nanosystems, which should take one and one half to two years to finish. The roadmap will outline the technical steps necessary to reach this nanomanufacturing future.

In response to this, the Center for Responsible Nanotechnology (CRN) is organizing a policy task force. CRN believes that this will accelerate development, making it more urgent that we understand the risks, create policy, and design structures to implement them. The gong has been sounded.

CRN's Approach

CRN's task force will study the implications of nanomanufacturing by employing Delphi methods, as pioneered by the Millennium Project at the American Council at the United Nations University.^{3 4} Jerry Glenn, who runs that program, has agreed to work with us to institute the Delphi method.⁵

During the course of our study, we will ask experts from many fields to help us define the scope of the problems that should be studied. We will not define the problems; the experts will. Next, we will compare the policy options, group to group. How does economic policy affect environmental; how does military affect social, and so on? Each group, working separately, will compare results and then try to find integrated solutions that deal with the whole problem. Finally, we will publish recommendations and work to promote the proposals with groups that can implement them.

In conclusion, before molecular manufacturing starts working, we must start working on wise solutions! We cannot wait until the technology arrives. Policy created at the last minute is likely to be ineffective and could even worsen the problems. After evaluating the risks and benefits, CRN is wholly in favor of developing sound geoethical nanotechnology policy.



Mike Treder is a professional writer, speaker, and activist with a background in technology and communications company management. In 2002, Treder co-founded the Center for Responsible Nanotechnology (CRN), a non-profit think tank that promotes public awareness and education, and the crafting of effective policy to maximize benefits and reduce dangers of nanotechnology. Treder is a Research Fellow with the Institute for Ethics and Emerging Technologies, a consultant to the Millennium Project of the American Council for the United Nations University and to the Future Technologies Advisory Group, serves on the Advisory Board of the Global Risks Council, is on the Nanotech Briefs Editorial Advisory Board and on the Board of Directors of the World Transhumanist Association, is a member of the Executive Advisory Team for the Extropy Institute, a member of the New York Academy of Sciences, and a member of the World Future Society.

References

CRN – Center for Responsible Nanotechnology (crnnano.org)

¹ *Jacobs, Jane. Systems of Survival. New York: Vintage, 1992.*

² Battelle is a global science and technology enterprise that develops and commercializes technology and manages laboratories for customers. <http://www.battelle.org/> April 7, 2006 4:42 pm EST

³ *The Delphi Method - The objective of most Delphi applications is the reliable and creative exploration of ideas or the production of suitable information for decision making.* <http://www.iit.edu/~it/delphi.html> April 7, 2006 4:45 pm EST

⁴ *The American Council for the United Nations University is a U.S. non-profit (501)(c)(3) organization that provides a point of contact between Americans and the primary research organ of the UN - the United Nations University (UNU) - which focuses intellectual resources from all nations on world problems. Having scholars on its governing council rather than nations and funding much of its programs through an endowment helps ensure academic autonomy.* <http://www.acunu.org/aboutacunu.html> April 7, 2006 4:47 pm EST

⁵ *Jerome Clayton Glenn is Executive Director of the American Council/United Nations University and Director of the Millennium Project. He worked for over 30 years in futures research and consults and lectures internationally for governments, international organizations, and private industry in Science & Technology Policy, Economics, Education, Defense, Space, and Forecasting Methodology.* <http://www.acunu.org/millennium/resume/jglenn.html> April 7, 2006 4:53 pm EST