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The Strategy for Converging Technologies:
The Little BANG Theory

A mix of Bits, Atoms, Neurons and Genes (B.A.N.G.) make the world come 'round – for the USA!

Issue: In the USA, senior science policy makers and industry players are devising a new-style 'Manhattan' or 'Apollo' project to merge strategic technologies at the nano-scale (one billionth of a meter). Their aim is to combine biotechnology, information technology and cognitive (neural) science with atomtechnology at the nano scale (see *The Big Down* at www.etcgroup.org). The operative unit in information science is the Bit; nanotechnology manipulates Atoms; cognitive science deals with Neurons and biotech exploits the Gene. Together they make B.A.N.G. Merging these technologies into one, proponents say, will drive a huge industrial revolution and a societal "renaissance" that will guarantee American dominance – military and economic – through the 21st century. The US Government's National Science Foundation refers to this convergence of technologies as NBIC (nano-bio-info-cogno); ETC Group calls it the Little BANG (Bits-Atoms-Neurons-Genes) Theory.

On December 3-4, 2001, the National Science Foundation (NSF) and Department of Commerce (DOC), at the request of the Interagency Subcommittee on Nanoscale Science, Engineering and Technology (NSET), convened a workshop in Washington DC entitled "Converging Technologies for Improving Human Performance." The purpose of the workshop was to explore technological convergence at the nano-scale – bringing together NBIC/BANG technologies. Eighty-one people from government, academia and industry participated. As the organizers put it, "convergence of diverse technologies is based on material unity at the nanoscale and on technology integration from that scale."[1] In other words, when the known world is reduced, literally, to atoms and molecules made up of chemical elements, the difference between life and non-life – between biology and art – ceases to exist. The fundamental building blocks of bio, info and neuro are 'materially unified' at the nano-scale and therefore can be combined, or otherwise manipulated through, atomtechnology. Rather than a convergence of equals, the Little BANG Theory represents a coup by atomtechnologists asserting the primacy of the atom as the key to advancing other powerful technologies.

Impact: If government, academia and industry succeed to make the Little BANG Theory a reality (they will advance their projects at a seminar in Los Angeles, CA, February 6-7, 2003), it will profoundly affect national economies, trade and livelihoods – in countries of both the South and North. Human security and health – even cultural and genetic diversity – will be firmly in the hands of a convergent technocracy. Atomtechnology will also have profound implications for global food and agricultural production. The US government's National Nanotechnology Initiative is preparing a report on the impact of nano-scale technologies on food and agriculture and the US 2004 nanotechnology budget proposes a 900% increase in the Department of Agriculture's allotment to $10 million.[2]

Policies: None so far, but ETC Group urgently recommends that a transparent international process is begun through the United Nations to establish an International Convention for Evaluation of New Technologies (ICENT).

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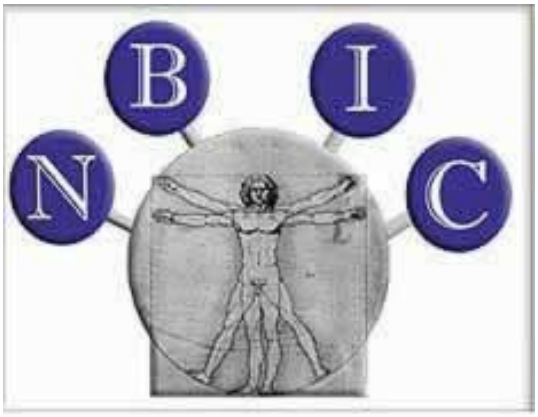
Participants: A draft workshop report (posted in June 2002 without change to February 6 2003) (www.itri.loyola.edu/ConvergingTechnologies) expressly states that the conclusions and recommendations of the workshop do not necessarily represent the views of the US government. Nevertheless, the meeting was opened by senior White House, Department of Commerce and National Science Foundation officials. Other government representatives came from Energy, NASA and ranking scientists from both Air Force and Navy research labs, as well as DARPA (Defense Advanced Research Projects Agency). Among the academic institutions were UC Berkeley, Princeton, Rutgers, MIT, Duke, Stanford, Harvard and Carnegie-Mellon. Industry was represented by Hewlett-Packard, Boeing, IBM, Raytheon and Lucent Technologies, among others. Most tellingly, however, leadership for the converging technologies concept comes from government officials who successfully convinced the Clinton White House to launch the National Nanotechnology Initiative in 2000 and to persuade the Bush White House to continue and substantially upgrade the same initiative.



Renaissance Men: Although the workshop organizers pushed its members to think "outside the box" to explore how science could overcome disabilities and enhance the disadvantaged, the participants themselves were overwhelmingly from "the inside." Like Leonardo's 'Vitruvian Man' depicted on the logo of the Los Angeles NBIC conference (above), participants in the Washington DC workshop were overwhelmingly male, white and able-bodied. Only a handful were women; and only two came from the workshop's primary "target" population – the disabled. No one was present from civil society or from any intergovernmental organization outside the USA.

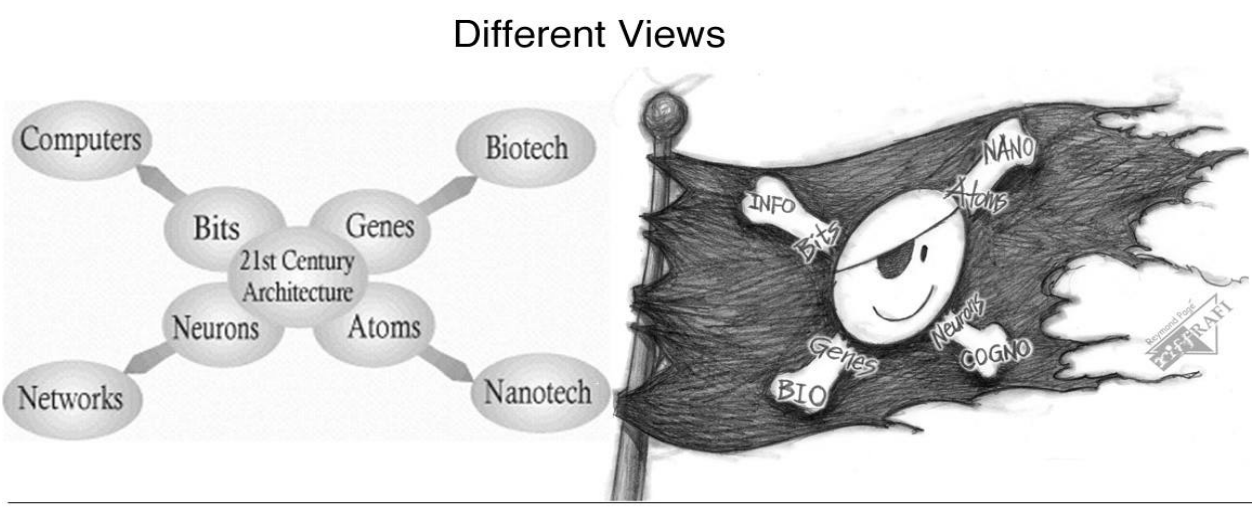
Promises*:* The **w**orkshop focused on ways that converging technologies could "enhance" the physical and cognitive capabilities of humans, both individually and collectively. The question of the day, in the words of one participant, was how can NBIC "make us all healthier, wealthier and wiser?"[3] The answer weighed in at over 400 pages. The Little BANG Theory goes like this: humanity (at least those in the USA) will become smarter (by beefing up and 'broadbanding' our brains, upgrading memory management and by unifying the scientific curriculum), younger (by stopping or reversing the aging process), and healthier (through individualized genome mapping and enhancement regimes). In the report, nano-scale convergence takes on almost bible-scale conversion – the "sightless who will see…lame who will walk…infertile couples who will be able to conceive children."[4] Project proposals, from the fantastic to the frivolous, offer to upgrade the lives of whoever can access the technologies. Converging technologies may, says the report, offer "active and dignified life far into a person's second century," along with wearable computers disguised as "scintillating jewelry," cosmetics that change with the user's moods and "smart clothing" that adjusts to the wearer's social environment.[5]

But the intended reach of this convergence goes further than the individual. To achieve improved human performance, the Little BANG Theory seeks to wire together tools that could extend human control over all matter, life, knowledge and even the collective mind – fundamentally changing nature and society in the process. The Atomtechnologies of the Little BANG will also ultimately affect agriculture and economies of Northern and Southern countries alike.

Projects: The NBIC report recommends a "national R&D priority on converging technologies focused on enhancing human performance."[6] The organizers challenged the workshop to come up with projects that could prove workable within the next 10-20 years. Among the specific ideas and general themes that dominate the NBIC report, there are nine that are particularly alarming:

Human Cognome Project: The report notes that "the mind is the final frontier" and anticipates that it will be possible to map the human brain just as

Spelling out the N.B.I.C. / B.A.N.G. matrix:



Atomtechnology [Nanotechnology] enabling control of **matter** through manipulation of **Atoms**

converges with
Biotechnology enabling control of **life** through manipulation of **Genes**

converges with
Information Technology enabling control of **knowledge** through manipulation of **Bits**.

converges with
Cognitive Neuroscience enabling control of **mind** through manipulation of **Neurons.**

Participants at the Washington DC workshop on NBIC also enthusiastically embraced
Memetic Engineering enabling control of **culture** through manipulation of **Memes** (ideas)

scientists have mapped the human genome. The idea is that we will eventually be able to manipulate thoughts and emotions as easily – and as hazardously – as we manipulate DNA. For example, some participants highlighted the long-term potential for "uploading aspects of individual personality to computers and robots, thereby expanding the scope of human experience, action and longevity.[7]

Memetic Engineering: A " meme" is a fundamental element of culture analogous to the gene in living organisms. It is proposed that memetic scientists could locate and manipulate memes within human cultures not unlike the way scientists manipulate genes. Creating linguistic and cultural databases can be the starting point for cultural outcomes, forecasting and management. Two participants explained the importance of a hard science approach to culture: "If we had a better map of culture, analogous to the Linnean system that classifies biological organisms into species and genera, we could help people find the culture they want and we could locate 'uninhabited' cultural territories that could profitably be colonized by growing industries. Many of the social problems faced by contemporary American society seem to have substantial cultural aspects, so the findings of scientific memetics would be extremely valuable for both the government agencies and private organizations that have to deal with them."[8] Participants from the National Science Foundation explained that "memetic science could help us deal with challenges to American cultural supremacy" [9] Specifically they saw scientific and practical merits in creating "a distributed digital library devoted to all aspects of Islamic culture with special attention to how it evolves and divides"[10].

"Socio-Tech" is envisioned as a *predictive* science of societal behavior.[11] Through the "accumulation, manipulation, and integration of data from the life, social, and behavioral sciences," Socio-Tech would be able to "identify drivers for a wide range of socially disruptive events and allow us to put mitigating or preventive strategies in place before the fact."[12] The authors see Socio-Tech as a powerful weapon in the war on terrorism.

False insecurity? The report places enormous importance on the use of converging technologies for military and police purposes. The belief is that the proliferation of unmanned vehicles, remote sensors, and augmented biological and chemical technologies will reduce the likelihood of war by providing an "overwhelming US technological advantage."[13] However, history cautions that expanding the technological arsenal of war merely escalates tensions and conflict. Also the development of non-lethal weapons threatens democracy everywhere as it enables regimes to exercise "crowd control" – the peace to end all peace.

Cyborgs, including human/machine interfaces, are given surprising scientific and political currency within the report. One of the prevailing assumptions is that human evolution can be accelerated by the merger of people with machines into posthumans: "This implies that we are more complex than any creatures before, and that we may not have yet reached our final evolutionary form. Since we are still evolving, the inescapable conclusion is that nanotechnology can help drive our evolution."[14]

Machine Love: One participant argued that understanding human psychology is essential in order to understand how to create machines that will be accepted by society: "In order to make technology enhance humans, we will humanize technology."[15] The argument goes further by claiming that "sociable technologies" will give us more satisfactory relationships with our machines but may also vitalize our relationships with each other "because in order to build better sociable objects we will have learned more about what makes us social with each other."[16] Having exploited understanding of human psychology to emotionally bond us with machines (and better market them to us), will we then become dependent on them as our "social interlocuters"[17] replacing direct human relation?

Techno- tutor: Another pet project identified in the report is the development of personal "communicators" – robotic instructors/companions – attuned to individual personalities. Computer-assisted education will make it possible for the converging technocracy to efficiently determine or "enhance" social attitudes and outcomes. Workshop participants identified "*The Communicator"* as a research priority for individualized instruction and mediating communication.[18] "The Communicator" aims to "equalize" social interaction, revealing to others a person's inner state by monitoring biological information (e.g., heartbeat, sweating) and then tailoring the information that person receives to reduce stress and increase 'productivity.'

Windfall Wellness: Among the hoped-for benefits of converging technologies will be substantially reduced research costs for drug discovery, new markets for well people, and the targeted re-introduction of already-developed drugs that were disallowed because of side effects in the broad population. Individual gene mapping may help to identify allergic customers and customized prescription medicines, but the trade-off will be that everyone (especially workers) will have to submit to full genetic disclosure. Human genetic diversity research can serve not only to target specific populations, it will also allow the pharmaceutical industry to use diverse peoples to reach their primary commercial market: well people who can afford to buy high-priced drugs.

Diss-memberment? Throughout the report (with one notable exception[19]), disabled people seem to be seen as objects not subjects. The concepts of enhancement, progress, disability and disease are not understood as societal constructions; rather they are viewed only through the lenses of medicine and technology in which disability is to be eradicated rather than embraced. After the little BANG, will physical "enhancement" through new technologies become a social imperative, further marginalizing the 'unimproved'? Will "self-improvement" become enforceable by law providing an excuse to undermine civil liberties? Recent rulings in the US Supreme Court, for example, state that the Americans with Disabilities Act does not apply to persons with correctable impairments.[20]

Presumptions: The workshop report assumes the problems of the world can be resolved through

scientific understanding and technological fixes. According to the Little BANG Theory, humankind stands at the threshold of an era in which it will be technologically possible to solve both the Great Physical Issues (what the report erroneously describes as the resource-based underpinnings of poverty, disease, hunger, pollution) and the Great Psychic Issues (the self-based conundrums of desire, personal enhancement, happiness, fulfilling relationships, knowledge). To achieve these lofty goals, society must place its faith in scientists and industry and acquiesce to a societal transformation that will have an impact on every life everywhere on earth. Virtually everything will change – from our educational systems to our sense of culture and humanity. However, to achieve the promise of the Little BANG Theory, societies will have to gamble on unproven, extraordinarily powerful technologies that will cost (directly or indirectly) trillions of dollars.

Partial-truths: There is the half-truth that anything scientists can devise can be accomplished. Although it would be naïve to presume that the specific technological advances suggested in the report are unlikely, it is equally presumptuous to suggest that these advances can be safely and successfully introduced for the benefit of humanity. The recent global experience with genetically modified crops shows that defective technologies can effectively erode the environment and commandeer markets in the absence of social benefits.

Which brings us to the half-truth that science serves humanity. By themselves, new technologies can never be a solution for old injustices. In the absence of just and equitable governance, science will be pressed into activities that exacerbate fundamental problems, rather than solve them. Powerful new technologies in the hands of those who have benefited by – and perpetuated – inequity, will exacerbate the gap between rich and poor. It is irresponsible to contemplate such a massive technological change without first enacting positive social change. *NBIC - nano, bio, info, cogno* – must be superseded by *politico, enviro, econo, socio, and equal*.

Polemics: It is often helpful to examine the kinds of words employed in a text that aims to be persuasive. What kinds of values are assumed and what values are open for discussion? Which social groups figure prominently and how are they described? In what light are the issues presented? What are the stated aims of the authors? What operational tools do they say will be used to achieve these goals? Words that aren't used may be as significant as words that are. By making a list of the words and terms that one would expect to find in a given document and counting the frequency of their usage, it is possible to obtain a subjective but often helpful analysis of the text's main perspective and points. Word counts, however, are no substitute for reading the text thoroughly!

ETC Group conducted a "word search" of the 400 page NBIC report (see next page)– including singular and plural, logical extensions, reasonable variations – and also confirmed proper context.

While there is considerable discussion about ethics and morality (especially about ethicists) in the NBIC report, there is almost nothing about human rights or democracy (although several references to the Democratic Party) and no mention whatsoever of governance. Most of the discussion about goals centers around military uses of converging technologies, especially in the fight against terrorism – whether it be bioterrorism, cyberterrorism or plain old terror – with a secondary emphasis on curing disease and assisting those who are disabled. Passing references are made to the needs of the poor or hungry, women indigenous peoples or ethnic minorities.

While the references to physical sciences are legion, references to social sciences are scarce. Most disturbing – in a government-created document – there is very little reference to the need to engage the public in decision-making on science policy and purpose.[21] There is no suggestion that society should discuss the kind of world it wants to create. There is no substantive discussion about the implications for democracy nor about the need to create new governance systems at the national and international level that would safeguard human rights. The workshop's failure to address these issues calls into question the organizers' role as responsible advisers on technological introduction into society. Here and there are comments about the need to 'educate the public.' Almost all of the conversation about risk focuses on business or military risks. The precautionary principle is not mentioned.

Language Indicators

Indicators	#	*Indicators*	#
Who are presented as stakeholders?		***What values are articulated?***	
Gov't/Public Sector/Politician, etc.	170	Ethics/Ethicist/Moral/Morality, etc.	90
Scientist	129	Equity/Fairness/Justice, etc.	6
Industry/Private Sector/Corporation, etc.	98	Democracy/Democratic	2
Academia, University, etc.	64	Human Rights	2
Nongovernmental/Civil Society, etc.	4	Governance	0
Intergovernmental	0	***What are presented as key issues?***	
Who is included?		Defense/Military/War/	210
Inclusion/Inclusiveness	10	Disease	97
Public Interest, etc.	6	Disability, etc.	60
Public Consultation, etc	0	Terrorism	32
		Climate change/Pollution	17
What economic terms are used?		Poverty/Hunger	7
Productivity/Efficiency	91	Peace/Conflict Resolution	6
Trade/Market, etc.	85	Racism	1
Investment/Profit, etc.	81	***Who are the identified social groups?***	
Intellectual Property/Patent	10	Disabled	47
Are the safety issues addressed?		Poor/Disadvantaged	13
Risk	6	Gender/Women	12
Precautionary Principle	0	Indigenous/Ethnic/Minority, etc.	8
What are the priority "health" issues?		***What are the priority disciplines?***	
Memory/Alzheimer's	69	Biology	125
Heart disease	44	Chemistry	48
Human Enhancement, etc.	40	Physics	29
Cancer	28	Anthropology/Sociology/Political Science	10
Deaf/Hearing Impaired	22		
Blind/Visually-impaired	17		
HIV/AIDS	5		
Malaria	1		

Policies: In ETC Group's view neither the convergent technologies of the little BANG nor any of the specific projects proposed by the workshop should go forward without broad societal dialogue. There is an urgent need to engage all sectors of society in a comprehensive debate about the future that is being planned for them. The sweeping economic, social and political issues raised by converging technologies range far beyond the boundaries of any single country and must be debated worldwide through the United Nations. The international community must have the capacity to monitor and regulate the public and private governance as well as control and ownership of technologies represented by the Little BANG. Beyond governance, the international community must create the capacity to track, evaluate and accept or reject new technologies and their products through an International Convention on the Evaluation of New Technologies (ICENT).

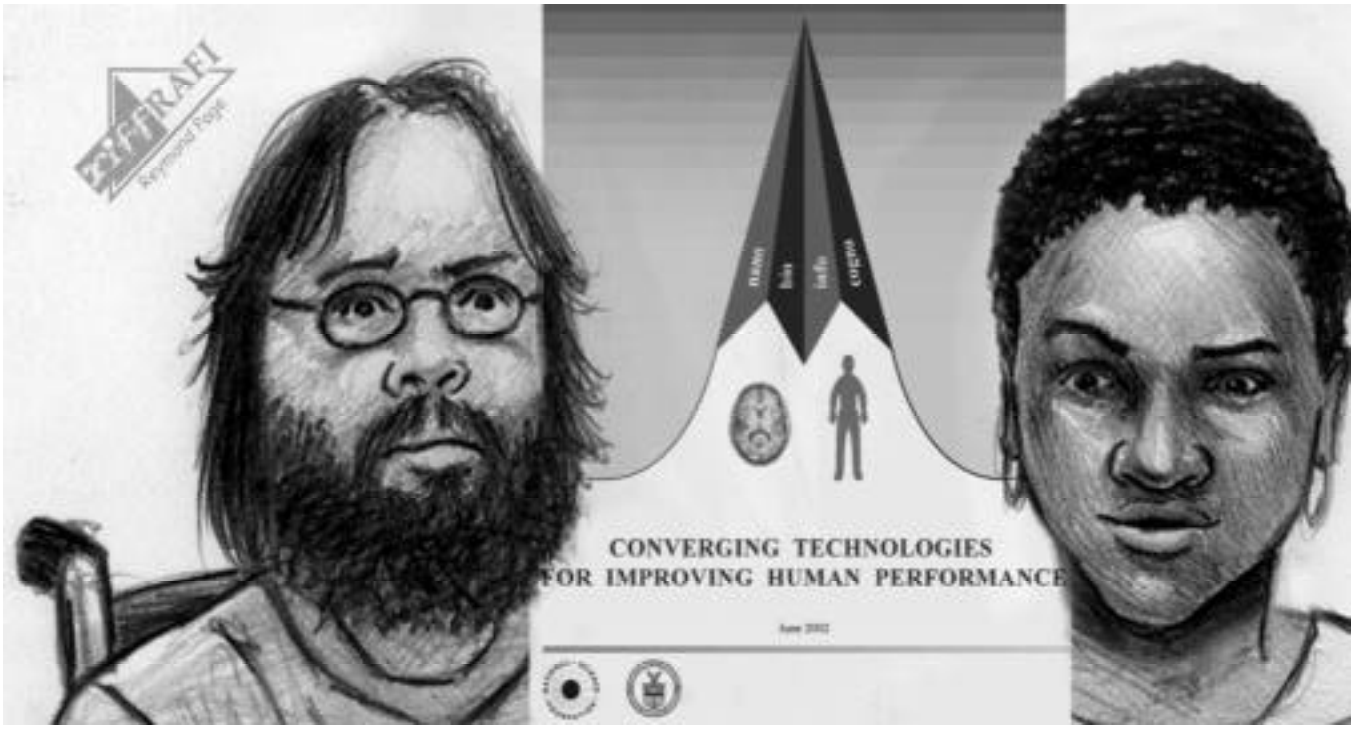
Post script: It is tempting to dismiss the Little BANG Theory as science fiction, but there is sufficient scientific reality and political muscle to take it very seriously. We have entered a point in history where technologies are so powerful and their risks so great that government/industry co-habitation will be seen as essential for security and progress. Converging technologies make almost everything possible or (worse) plausible. In such a

world, our focus must not be on techno-toys, but on governance and social self-defense. The "promise" of a future in which all difference is erased – differences of income, intellect, imagination, age, physical characteristics, culture and language – is neither do-able nor desirable through a technological "fix." The implications for the erosion of human rights, including the rights of those who are "un-improved" – either by choice or lack of choice – and for the erosion of democratic dissent are awesome.

The Big Bang Theory is about the origins of the universe. The Little BANG Theory could be about the end of society and nature as we know them.

"We envision the bond of humanity driven by an interconnected virtual brain of the Earth's communities searching for intellectual comprehension and conquest of nature." [22]

- Mihail Roco, Senior Advisor, National Science Foundation, and head of the US government's multiagency National Nanotechnology Initiative.



The Action Group on Erosion, Technology and Concentration, formerly RAFI, is an international civil society organization headquartered in Canada. The ETC group is dedicated to the advancement of cultural and ecological diversity and human rights. www.etcgroup.org. The ETC group is also a member of the Community Biodiversity Development and Conservation Programme (CBDC). The CBDC is a collaborative experimental initiative involving civil society organizations and public research institutions in 14 countries. The CBDC is dedicated to the exploration of community-directed programmes to strengthen the conservation and enhancement of agricultural biodiversity. The CBDC website is www.cbdcprogram.org

[1] NSF-DOC-sponsored report, *Converging Technologies for Improving Human Performance*, Arlington, VA, June 2002. The report is available in a draft version on the Internet at: http://www.itri.loyola.edu/ConvergingTechnologies.
[2] The proposed USDA budget for nanotechnology would increase from $1 million to $10 million. Doug Brown, "Bush's proposed budget makes nanotechnology a top priority,'' *Small Times*, Feb. 5, 2003, available on the Internet: www.smalltimes.com
[3] Gerold Yonas, as quoted by Jim Spohrer, "NBICS (Nano-Bio-Info-Cogno-Socio) Convergence to Improve Human Performance: Opportunities and Challenges," *Converging Technologies for Improving Human Performance*, p. 90.
[4] Ibid.
[5] M.C. Roco and W.S. Bainbridge, "Overview: Converging Technnologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science (NBIC)," *Converging Technologies for Improving Human Performance*, p. 18.
[6] M.C. Roco and W.S. Bainbridge, "Executive Summary," *Converging Technologies for Improving Human Performance*, p. xii.
[7] W.S. Bainbridge, R. Burger, J. Canton, R. Golledge, R.E. Horn, P. Kuekes, J. Loomis, C.A. Murray, P. Penz, B.M. Pierce, J. Pollack, W. Robinett, J. Spohrer, S. Turkle, L.T. Wilson, "Expanding Human Cognition and Communication, Theme B Summary," *Converging Technologies for Improving Human Performance*, p. 85.
[8] Gary W. Strong and William Sims Bainbridge (National Science Foundation), "Memetics: A Potential New Science," *Converging Technologies for Improving Human Performance*, p.279.
[9] Ibid., p. 284.
[10] Ibid., p. 285.
[11] Gerold Yonas works at the Sandia National Laboratories, operated by defense industry contractor, Lockheed Martin, under contract to the US Department of Energy. Sandia develops emerging technologies to promote national security. Jessica Glicken Turnley is an anthropologist and head of Galisteo Consulting Group, Inc.
[12] Jessica Glicken Turnley and Gerold Yonas, "Socio-Tech…The Predictive Science Of Societal Behavior," *Converging Technologies for Improving Human Performance*, p. 140.
[13] R. Asher, D.M. Etter, T. Fainberg, M. Goldblatt, C. Lau, J. Murday, W.Tolles, G.Yonas, "Theme E Summary – National Security," *Converging Technologies for Improving Human Performance*, p. 288.
[14] Edgar Garcia-Rill (University of Arkansas for Medical Sciences), "Focusing the Possibilities of Nanotechnology for Cognitive Evolution and Human Performance," *Converging Technologies for Improving Human Performance*, p. 202.
[15] Sherry Turkle (Massachusetts Institute of Technology), "Sociable Technologies: Enhancing Human Performance When The Computer Is Not A Tool But A Companion," *Converging Technologies for Improving Human Performance*, p.138.
[16] Ibid., p. 139.
[17] Ibid., p. 137.
[18] Philip Rubin, Murray Hirschbein, Tina Masciangioli, Tom Miller, Cherry Murray, R. L. Norwood, John Sargent, "The Communicator: Enhancement of Group Communication, Efficiency, and Creativity," *Converging Technologies for Improving Human Performance*, pp. 265-270.
[19] Gregor Wolbring, "Science and Technology and the Triple D (Disease, Disability, Defect)," *Converging Technologies for Improving Human Performance*, pp. 206-216.
[20] See, for example, *Sutton v. United Airlines* (130 F.3d 893, 119 S. Ct. 2139), *Albertsons Inc. v. Kirkingburg* (143 F.3d 1228, 119 S. Ct. 2162), and *Murphy v. United Parcel* (141 F.3d 1185, 119 S. Ct. 1331).
[21] Two exceptions to this rule come from academic participants: Michael E Gorman of the University of Virginia suggests involving "potential users as well as interested nongovernmental organizations like Greenpeace in a dialogue over the future of new nanotechnologies" and, separately, Daniel L Atkins of City University of New York recognizes that "it is in America's best interest to ensure equitable participation of all elements in the front-line decision-making circles, in particular, to include groups that are historically underrepresented in leading-edge science and engineering, during this era of anticipated, unbridled growth of NBIC technologies." See Michael E. Gorman, "Combining the Social and The Nanotechnology: A Model for Converging Technologies," *Converging Technologies for Improving Human Performance*, p. 327 and Daniel L. Atkins, "Mind Over Matter In An Era of Convergent Technologies," *Converging Technologies for Improving Human Performance*, p. 362.
[22] Mihail C. Roco,"Coherence and Divergence of Megatrends in Science and Engineering," *Converging Technologies for Improving Human Performance*, p. 80.