Science, Faith & New Technologies:

Transforming Life

Volume I

Convergent Technologies

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&
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with Bossey Ecumenical Institute

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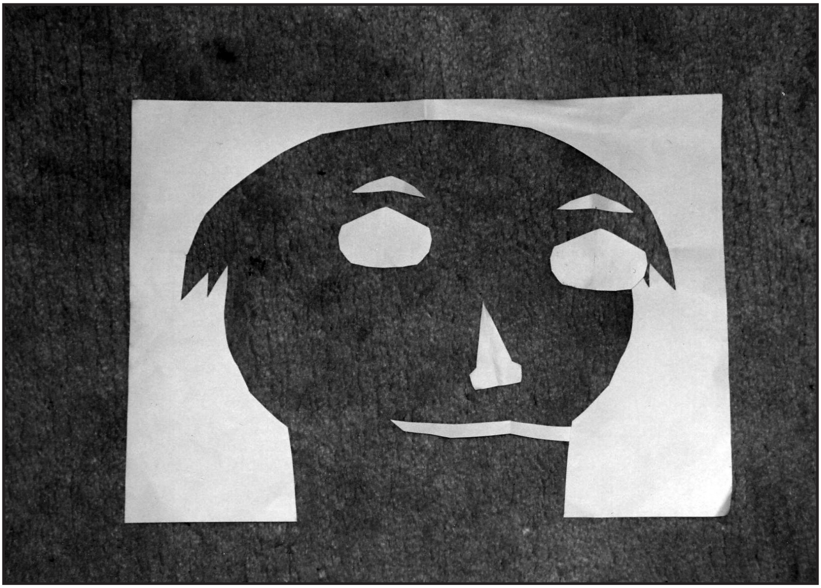
Contents



FOREWORD

This publication presents the challenges posed by newly emerging technologies to people of faith. It is a discussion starter and wants to encourage urgently needed study and reflection by churches, theological faculties and ecumenical bodies in close cooperation with each other. The new technologies represent a new stage of development, which requires a fresh approach and change of perspective.

The rapid advance of information technologies linked to the equally revolutionary progress of micro-electronics has made it possible to develop strong links between the smallest operational units of newly emerging technologies: bits, atoms, neurons and genes (BANG). With reference to nanotechnology (atoms), biotechnology (genes), information technology (bits) and neuroscience (neurons), NBIC is often used as an acronym to identify the symbiotic relationship between these new technologies.

The term “convergent technologies” that is also often used describes the leap towards a more basic, broader and, therefore, much more powerful platform combining these different scientific approaches and their technological applications. This leap can be compared to the first industrial revolution that reshaped life in society in a radical way.

Previously, ecumenical social thought and action has addressed the challenges of science and technology in a framework of middle axioms, i.e. a responsible society with an emphasis on situations of rapid social change or, integrating environmental dimensions, a just, participatory and sustainable society. This work culminated in the famous 1979 MIT Conference on Faith, Science and the Future, which focused on a framework that would allow scientists to look at their work from an ethical perspective. There was hope that the ethically informed scientist would apply such insights and adjust his (there was little sensitivity to gender issues) own approach and practice accordingly.

The context, however, has changed. While there are remarkable scientists who have shown an outstanding sense of responsibility and solidarity with the poor and marginalized, a majority of them have accepted a more and more corporate dominated and market-driven approach to scientific research and its technological applications. Much of the funding for basic research depends today on government funding for military research or on a private sector that takes control of the results through patenting and copyright regimes. New technologies need to be assessed in terms of social (marginalization), cultural (perspectives of life), economic (monopolies, profits), political (dominance and power), and military (new weapons of mass destruction) impact and consequences.

It is important not only to notice, but to understand, the shift away from science and technology as instruments and tools for human development towards the much more sophisticated notion of its power and capacity to transform and to re-design the basic elements of matter – and thus the building blocks – of the community of life as we know it. The newly emerging technology are paving the way for the commodification of life at a much more basic level. The debate on patent laws and corporate power show this clearly. But the process has even deeper consequences for the understanding of the earth community and the broader web of life as well as the place and role of human beings for life in community and creation.

Looking at these developments from the perspective of those victimized in this process, the focus on the poor and marginalized in the human community has to be extended to those marginalized and excluded from the wider community of life. New and emerging technologies not only impact on the social fabric of life in community, but on the whole set of relationships in and between all life forms. Any viable solution will depend not only on human choice and action. Other life forms too are affected and react in often unpredictable ways, exposing the human species to new risks. Required is the recognition of the common destiny and purpose of all belonging to the wider earth community. The task today is to learn how to live together on planet earth not only as human beings, but for all creatures of God.

This task requires a shift away from an emphasis on security based on the production of the tools to dominate and control nature towards an understanding of the interdependence, mutual vulnerability and solidarity of all life. Such a shift implies a major change in the prevailing development paradigm and the economic, political and military dynamics driving it. The underlying understanding of security and stability based on products and protection continues to marginalize and destroy an understanding of cultures and peoples' traditions of prudence based on the strength and solidarity of community.

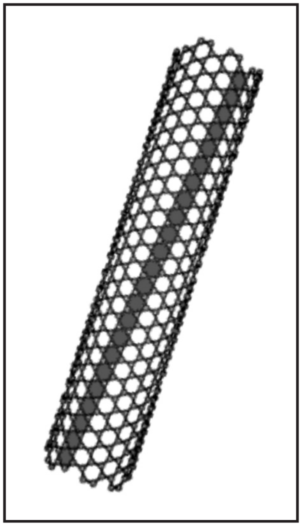
While advocating such a paradigm shift, it should be clear to everybody that a major re-orientation of the dominant political economy and culture is not a simple undertaking, but requires an enormous effort of resistance, struggle for alternatives, un-learning of threatening attitudes, habits, values and world-views, and learning what it means to live in conviviality with all life on earth as our common home. In the light of the theme of the 9th General Assembly of the WCC in 2006 in Porto Alegre/Brazil "God, in your grace, transform the world", such a paradigm shift would resonate with the theological conviction that God is at the origin of all life. The Holy Trinity offers itself as a key to understanding the relational character of all life carrying the signature of divine love.

This publication does not pretend to offer a comprehensive exploration of the issues at stake or to preempt necessary study and discussion by churches and their appropriate bodies. It rather hopes to encourage ethical and theological reflections informed, in particular, by the experience and perspective of persons with disabilities. This first volume concentrates more specifically on nanotechnology. It is followed by a second volume with a focus on biotechnology and genetic engineering.

Both of the volumes grew out of close co-operation between the World Council of Churches (WCC), the World Association for Christian Communication (WACC) and the Bossey Ecumenical Institute. The three partners acknowledge with great appreciation the expert input to this first volume by the ETC-Group, the Canada based Action Group on Erosion, Technology and Concentration. They are also grateful to the ETC-Group for permission to use some of their texts, illustrations and tables for this publication. As the editors, we want to express our sincere gratitude to Eunice Kamaara, Kathy-Joe Wetter, Hope Shand, Kim Yong-Bock, and Gregor Wolbring who contributed to the text of this volume.

Philip Lee (WACC), Martin Robra (WCC)

Geneva, December 2005



CONVERGENT TECHNOLOGIES
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WHAT ARE THEY ALL ABOUT?

For at least the past two decades different scientific disciplines have been "converging" by means of computer-mediated technologies. A useful definition appears in a recent National Science Foundation report: "The phrase 'convergent technologies' refers to the synergetic combination of four major 'NBIC' (nano-bio-info-cogno) provinces of science and technology, each of which is currently progressing at a rapid rate: (a) nanoscience and nanotechnology; (b) biotechnology and biomedicine, including genetic engineering; (c) information technology, including advanced computing and communications; and (d) cognitive science, including cognitive neuroscience."[1]

Scientists are agreed that, in order to advance as rapidly as possible, each field must combine in what has been described as a "new renaissance" based on the unification of science and technology. It is envisaged that:

- "Material unity at the nanoscale" (1 nanometre equals one billionth of a meter) will enable scientists to harness natural processes to engineer new materials, biological products and machines from the nanoscale up to the scale of meters allowing control over complex microsystems (such as neurons and computer components) and macrosystems (such as human metabolism and transportation vehicles);

- "NBIC transforming tools" will be constructed, including scientific instruments, analytical methodologies, and radically new materials systems;

- Developments in systems approaches, mathematics, and computation in conjunction with NBIC will allow scientists to understand the natural world and cognition in terms of "complex hierarchical systems";

- "Improving human performance" by substantially enhancing mental, physical, and social abilities will enable social, political and economic problems to be more easily overcome.

Digital technologies lie at the heart of these transformations. Computers today are not merely used by bio-tech firms to store, analyze and retrieve data, they are being used to model, design, simulate and fabricate products and processes, and to re-programme life itself. Computers enable global communications systems that are the basis of all kinds of social transactions and exchanges, including the international banking system, satellite communications and global telephony, news networks, radio, television and the Internet, and countless surveillance and security systems.

Social critic Jeremy Rifkin has observed that the operational language of the computer is the "...common language that is creating a seamless web between the information and life sciences and making possible the joining together of computers and genes into a single, powerful, technology revolution."[2] Policy-makers, decision-makers and ordinary women and men are faced with the myriad implications and challenges posed by the convergence that computers have made possible.

It is precisely because of the intimate nature, texture and depth of this convergence that these technologies can be described as "hegemonic". In other words, information has not only given rise to a coherent and systematic, globally applicable, world-view, it has become the principle of organization at the core of a variety of societal institutions. As the technologies flood the market and tighten their embrace on our lives, it is crucial that scientists and non-scientists find the time and space to interrogate, critique and, if necessary, subvert these technologies to the real needs of humanity.

WHAT DOES CONVERGENCE MEAN?

The power of nano-scale science lies in the convergence of diverse technologies – biotechnology, cognitive sciences, informatics, robotics, etc., with nanotechnology as the key enabler. The logic behind technological convergence lies in the fact that the building blocks of all matter, fundamental to all sciences, originate at the nano-scale. Scientists and governments have a strategy to merge the sciences based on "material unity at the nano-scale". Since all materials and all processes operate from the bottom up (beginning with atoms that combine to form molecules and all larger structures), proponents of convergence believe they can control events on the macro-scale by manipulating events at the nano-scale.

According to this view, every substance, as well as every biological or cultural system, is the result of molecular processes operating on different levels. The action group on Erosion, Technology and Concentration (ETC) uses the term "BANG" to describe convergence. Bits, Atoms, Neurons and Genes add up to a little BANG theory – the technological quest to control all matter, life and knowledge, as the following chart shows:

Information Technology	controls	Bits
Nanotechnology	controls and manipulates	Atoms
Cognitive Neurosciences	enables control of the mind by manipulating	Neurons
Biotechnology	manipulates	Genes

In the little BANG theory, neurons will be reengineered so that our minds "talk" directly to computers or to artificial limbs; viruses can be engineered to act as machines or, potentially, as weapons; computer networks can be merged with biological networks to develop artificial intelligence or surveillance systems. According to many, technological convergence will "improve human performance" in the workplace, on the playing field, in the classroom and on the battlefield.

If realized, the goal of enhancing human performance will exacerbate the ever-widening gulf between those who will be "improved" through technological convergence and those who will remain "unimproved", either by choice or lack of choice. As BANG (and the marketing of BANG) helps shift our concept of what is 'normal', everyone will be playing catch-up or be left behind. Whatever benefits BANG could bring, they will not be cheap or equitably distributed.

What will happen to the "unimproved"? Will physical enhancement become a social imperative as well as an enforceable, legal one? In 2004, for example, a US court ruled that prison officials were allowed forcibly to medicate a death row inmate to make him sane enough to execute.[3] In a world where human improvement or "enhancement" becomes a technological imperative, the rights of people who do not meet the "norm", for example people with disabilities, will be further eroded and impairments or disabilities will be perceived as technological challenges rather than as issues of social justice. How long before democratic dissent is viewed as a correctable "impairment" as well?

WHAT IS NANOTECHNOLOGY?

Nano-scale technology is a suite of techniques used to manipulate matter at the scale of atoms and molecules. "Nano" is a measurement – not an object. Unlike "biotechnology", where bios (life) is being manipulated, "nanotechnology" speaks solely to scale.

A "nanometer" (nm) equals one billionth of a meter. One human hair is about 80,000 nanometers thick. It takes ten atoms of hydrogen side-by-side to equal one nanometer. A DNA molecule is about 2.5 nm wide. A red blood cell is vast in comparison: about 5,000 nm in diameter. Everything on the nano-scale is invisible to the unaided eye and even to all but the most powerful microscopes.

Key to understanding the unique power and potential of nanotech is that, at the nano-scale (below about 100 nanometers), a material's properties can change dramatically – these unexpected changes are called "quantum effects". With only a reduction in size and no change in substance, materials can exhibit new properties such as electrical conductivity, elasticity, greater strength, different color and greater reactivity – characteristics that the very same substances do not exhibit at the micro or macro scales.

Scientists are exploiting property changes at the nanoscale to create new materials and modify existing ones. Companies are now manufacturing nanoparticles (i.e. chemical elements or compounds less than 100 nm in size) that are used in hundreds of commercial products. Nanotech's 'raw materials' are the chemical elements of the Periodic Table – the building blocks of everything – both living and non-living.

Nanotech tools and processes can be applied to virtually any manufactured good across all industry sectors, and that's why the US National Science Foundation (NSF) predicts that nanotech will capture a $1 trillion market by 2012.

What does nano-technology mean for the global South?

Nanotech's new designer materials have the potential to topple commodity markets, disrupt the trade and livelihoods of the poorest and most vulnerable workers who do not have the economic flexibility to respond to sudden demands for new skills or different raw materials.

A 2004 report by industry analysts, Lux Research, Inc., highlights the potential of nanotech to "ultimately displace market shares, supply chains, and jobs in nearly every industry." If a new nano-engineered material outperforms a conventional material and can be produced at low cost, we can expect the nanomaterial to replace the conventional commodity. For example, the US National Aeronautics and Space Administration (NASA) is investing $11 million dollars to develop “quantum wires” made from carbon nanotubes as a replacement for traditional copper wires. Copper-producing countries beware!

It is still too early to map with confidence which commodities or workers will be affected and how quickly, nations that are most dependent on agricultural and natural resource exports will face the greatest disruptions. Some predict that nanotech will trigger an economic and cultural utopia combining material abundance, sustainable development and profit. The history of technology waves suggests otherwise: major new technologies, at least initially, destabilize marginalized peoples while the wealthy anticipate, manipulate and ride the wave’s crest. They have the economic flexibility to remain buoyant while those who are already floundering get washed away along with the obsolete economy. Two examples suffice:

Rubber: Industry is designing nanoparticles to strengthen and extend the life of automobile tires and creating new nanomaterials that could substitute for natural rubber. Demand for natural rubber could plummet with devastating consequences for millions of small rubber tappers and the national economies of Thailand, India, Malaysia and Indonesia. The point is not that the status quo should be preserved – but that society is ill-prepared.

Cotton: Natural fibers like cotton, and the farmers who grow them, are also vulnerable. One product in the pipeline is a synthetic fiber manipulated at the nano-scale that has the same texture as cotton – but is much stronger. What will nanotech’s fibers mean for the 100 million families engaged in cotton production worldwide? The value of world cotton production was US$24 billion in 2003; 35 of the 54 African countries produce cotton – 22 are exporters.

In a just context, nanotech could bring useful benefits to the poor. There could also be environmental gains from replacing some conventional materials with new nanomaterials. But in a world where privatization of science and unprecedented corporate concentration prevail, democracy and human rights are being eroded and national sovereignty is undermined. The grab for patents on nano-scale products and processes could mean mega-monopolies on the basic elements that are the building blocks of the entire natural world. If current trends continue, nanoscale technologies will further concentrate economic power in the hands of multinational corporations. How likely is it that the poor will benefit from a technology that is outside their control?

What are the implications of nanotech for human rights?

Sophisticated molecular-level manipulations will produce stronger, lighter materials, more precise and pervasive sensors and faster, smaller and more energy-efficient computers. These products are being developed simultaneously for civilian and military uses. Experts predict that nanotechnology will change the way wars are fought more than the invention of gunpowder. Soldiers will have "enhanced" bodies and brains. Nanotechnology will also lead to the development of chemical and biological weapons that are more invasive, harder to detect and virtually impossible to combat. The invasive and invisible qualities of nano-scale sensors and devices could become extremely powerful tools for repression – posing a major threat to democracy and dissent and fundamental human rights.

All of this is likely to contradict the concept of a Global Ethic that sees the human person as infinitely precious and inextricably linked to the lives of animals and plants and the biosphere: "As human beings we have a special responsibility – especially with a view to future generations – for Earth and the cosmos, for the air, water, and soil. We are all intertwined together in this cosmos and we are all dependent on each other. Each one of us depends on the welfare of all. Therefore the dominance of humanity over nature and the cosmos must not be encouraged. Instead we must cultivate living in harmony with nature and the cosmos."[4]

WHAT IS BIOTECHNOLOGY?

In a general sense, biotechnology has been used by humans for over 10,000 years. Early humans recognized that microscopic organisms such as bacteria and fungi were useful in making cheese, bread, wine, and beer. A giant step for biotechnology occurred in the 1860s when Gregor Mendel explained the genetic basis of heredity, thereby providing a scientific foundation for the rapid improvement of plant and animal species through natural selection and cross-breeding (hybridization).

These fundamental processes are still being used, but now scientists have the ability to select specific genes and manipulate them much quicker, to exchange genetic information between different species and to alter the genetic code. So today the term "biotechnology" is used in a more restricted sense to mean the application of molecular biology techniques to identify the genes responsible for particular traits; to clone, study, characterize, and manipulate them; and finally, to insert them into different organisms. No area of agriculture or life remains unaffected.

Current biotechnological research activities include:

- Developing crops with increased resistance to salt, heat, cold, drought, or flooding. "Frostban", a genetically altered bacteria that gives plants greater resistance to frost, is currently being tested on strawberries in California.

- Conferring nitrogen-fixation capabilities on a wider variety of plants, including grains and vegetables. This would reduce the need for expensive fertilizers.

- Controlling photosynthesis in farm and forest crops. Genetic changes that result in reduced photorespiration (the loss of photosynthate to oxygen) would help raise productivity in many major crops.

- Disease and weed control. For example, popular herbicides containing triazines would be more effective if crop plants were protected by genetically imparted triazine resistance.

· "Engineered" animal embryos to improve growth rate, disease resistance, and protein content of the developing animal.

· Enzyme and protein products to improve animal digestion and increase the efficiency of milk and meat production.

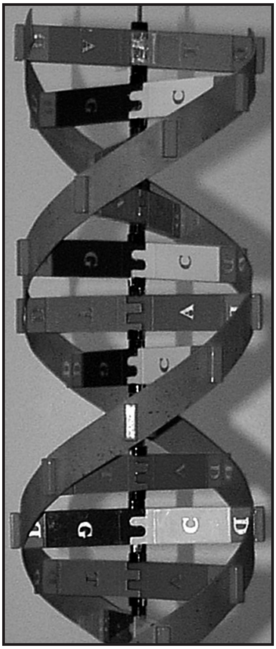
The development of this new technology has raised concerns about public safety and welfare. The most publicized risk of biotechnology is the inadvertent escape and subsequent establishment of recombinant organisms in the environment. Scientists involved in biotechnological research are keenly aware of this and other potential risks, and they seek to minimize and control them. However, fears abound that researchers at universities are no longer scientifically neutral, or that politicians are moved by special interest groups. The public should know if narrow, short-sighted, research goals are being put ahead of long-term, public welfare.

How does gene technology fit in?

The terms "gene technology", "genetic engineering" and "genetic modification" mean the same thing, and refer to one type of modern biotechnology. Since the 1940s scientists have known that DNA — deoxyribonucleic acid — in the cells of all living things is like a blueprint that is passed from one generation to another. Genes are made of DNA. They contain coded instructions for proteins, which give living things their particular characteristics like hair and eye color. All living organisms use DNA as the genetic code.

Gene technology includes a range of techniques to copy genes and modify them so that they will work in a new host either to produce or reduce a product. It also involves transfer of the reconstructed gene to a new host. Using gene technology, scientists aim to introduce, enhance or delete particular characteristics of a living thing, depending on whether they are considered desirable or undesirable.

The use of gene technology in biomedicine, agriculture, food production and processing is an issue that has evoked strong public interest and concern. The debate has focused on the use of genetically modified organisms (GMOs) in food,



their safety and potential impact on the environment. Gene technology is developing at a rapid rate and it will continue to revolutionize basic biological research and development. It provides the potential to improve our health, create a safer and more secure food supply, generate greater prosperity and attain a more sustainable environment.

In relation to human medicine, scientists can now locate and study the genes that cause genetic diseases, or those making some individuals prone to cardiovascular disease, degenerative brain disorders like Alzheimer's disease and motor neuron disease, certain forms of cancer, diabetes and other auto-immune disorders like rheumatoid arthritis and lupus. Gene technology has provided a host of precise new tests for rapid diagnosis of infectious diseases in humans and livestock, and new vaccines to protect against diseases where conventional vaccines have been unsuccessful.

Scientists are now mapping and cataloguing the complete genetic blueprints of the world's most common infectious bacteria, to identify new targets for "designer" antibiotics. Gene technologists have also made promising progress towards understanding two of the world's biggest killers — the malaria parasite, and the human immunodeficiency virus that causes AIDS — and developing vaccines to prevent them.

Even so, the development of biotechnology and gene technology has raised serious concerns, particularly around issues such as human cloning, so-called germline gene therapy (which would introduce permanent, inheritable changes into the human gene pool), the privacy of genetic information, and the enhancement or repair of "impairments". Such developments are justified by the promise to fix or help to fix perceived disabilities, impairments, diseases, and defects and to diminish suffering.

The question is, who decides what is a disability, a disease, an impairment or a "defect" in need of fixing? Who decides what the mode of fixing should be, and who defines what is suffering? How will such developments affect societal structures? These questions must be answered from a human rights perspective if there is to be any chance that new technologies will enhance human life creatively, instead of perpetuating or deepening the prejudices and misconceptions of the past.

In essence every biological reality can be shaped and seen as a defect, as a medical problem, or as a human rights and social problem. Are "disabled people" or (to put it differently) "people who do not fit society's expectation of normal ability" to be seen as a medical "problem" or as part of the diversity of humankind? Using a medical model, disability is viewed as a defect, a problem inherent in the person, directly caused by disease, trauma, or other health condition and a deviation from certain norms. Management of the disability of the disabled person or person-to-be is aimed at cure, prevention, or adaptation of the person (e.g. using assistive devices). Medical care and rehabilitation are viewed as the primary issues, and at the political level, the principal response is that of modifying or reforming health care policy.

NBIC-technologies are not a panacea. The implications of their application for people with disabilities, indigenous peoples, poor and marginalized peoples – and especially where agriculture and traditional or natural medicines are involved – need to be carefully studied in close consultation with the people most likely to be affected.

WHAT IS COGNITIVE NEUROSCIENCE?

Cognitive neuroscience is usually defined as the scientific study either of mind or of intelligence. It is highly interdisciplinary and often collaborates with psychology (especially cognitive psychology), artificial intelligence, linguistics and psycholinguistics, philosophy (especially philosophy of mind), neuroscience, logic, robotics, anthropology and biology (including biomechanics).

For many laypeople, the relationship between cognitive science and artificial intelligence has led to expectations of lifelike robots that can interact and cooperate with people and play a part in their daily lives. Massachusetts Institute of Technology's Artificial Intelligence Laboratory has been developing a series of sociable humanoid robots that can communicate using facial expression, body posture, gesture, gaze direction and voice.

MIT has developed an expressive anthropomorphic robot called Kismet that engages people in natural and expressive face-to-face interaction. Inspired by infant social development, psychology, ethology, and evolution, MIT's work integrates theories and concepts from diverse viewpoints to enable Kismet to enter into natural and intuitive social interaction with a human caregiver and to learn from them, reminiscent of parent-infant exchanges. The robot has been designed to support several social cues and skills that could ultimately play an important role in socially situated learning with a human instructor.

A second robot, called Cog, is a set of sensors and actuators that tries to approximate the sensory and motor dynamics of a human body. Except for legs and a flexible spine, the major degrees of motor freedom in the trunk, head, and arms are all there. Sight exists, in the form of video cameras. Hearing and touch and a system for vocalization are also being designed. Cog is a single hardware platform that seeks to bring together each of the many subfields of artificial intelligence into one unified, coherent, functional whole.

The newest member of this humanoid menagerie is Coco. Unlike the other robots in the humanoid robotics group, Coco is able to walk around giving him the potential to have a level of autonomy unavailable to the other platforms. Coco will be able to investigate the impact of a fully mobile body on behaviors, social interactions and intelligence. This crucial distinction gives the possibility for Coco to exhibit behaviors that are closer to their evolutionary origins. Coco will have the ability to naturally investigate his environment, potentially discovering important aspects of the world without always being dependent on a human caregiver.

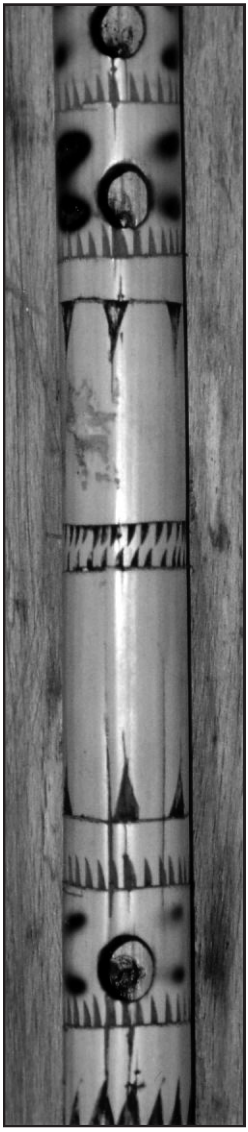
Current research into cognitive science is felt to be limited without the potential of NBIC-technologies. According to scientists there are five areas in which integration of the NBIC sciences might enhance the cognitive and communicative aspects of human performance:

A Human Cognome Project would chart the structure and functions of the human mind, including a complete mapping of the connections in the human brain. Central to the project would be wholly new kinds of rigorous research on the nature of both culture and personality, in addition to fundamental advances in cognitive science, such as uploading aspects of individual personality to computers and robots, thereby expanding the scope of human experience, action, and longevity.

Personal Sensory Devices to enhance human abilities to perceive and communicate. Faced with the limitations of human senses, research can develop high bandwidth interfaces between devices and the human nervous system, sensory substitution techniques that transform one type of input (visual, aural, tactile) into another, effective means for storing memory external to the brain, knowledge-based information architectures that facilitate exploration and understanding, and new kinds of sensors that can provide people with valuable data about their social and physical environments.

Information Sources. Over the next two decades, as nanotechnology facilitates rapid improvement of microelectronics, personal digital assistants (PDAs) are likely to evolve into “smart” portals to a whole world of information sources, acting as context-aware personal brokers interacting with other systems maintained by corporations, governments, educational institutions, and individuals. Global Positioning System (GPS) units could become comprehensive guides to the individual’s surroundings, telling the person his or her location and also locating everything of interest in the immediate locale.

Educational Tools. Interactive multimedia, graphical simlations, and game-like virtual reality aimed at enhancing learning not merely from kindergarten through graduate school but also throughout a person’s life, new kinds of curricula, and dynamic ways to represent mathematical logic



could be developed based on new understandings of how the human mind processes concepts like quantity and implication, allowing more people to learn mathematics more quickly, thoroughly, and insightfully.

*Enhanced Tools for Creativit*y. As technology becomes ever more complex, engineering design becomes an increasingly difficult challenge. Investment in research and development of wholly new industrial design methods, biologically inspired techniques such as evolutionary design methods analogous to genetic algorithms, and radically new methods will enhance small-scale design activities in such fields as commercial art, entertainment, architecture, and product innovation.

WHAT ARE INFORMATION AND COMMUNICATION TECHNOLOGIES (ICTs)?

At the broadest level, information and communication technologies are any type of equipment people use to exchange information and knowledge. This may be as simple as a megaphone or camera, or inexpensive as a silk-screen printing system. However, when people talk of ICTs they often mean electronic media, including the Internet, email, mobile phones, community radio and video.

It has long been argued that ICTs, and the new forms of economic and social activity they make possible, will transform the way people live. Social movements linked by means of global networking see the potential of concerted action on environmental, economic and political issues. Optimistic projections have also emerged about the ability of ICTs and global networks to create economic opportunities in developing countries and in the poorer areas of developed countries, to empower marginalized people, to make governments more responsible and transparent, and to make the world's knowledge available to those who need it to improve their lives.

However, as one commentator has pointed out: "Strictly speaking, the poor don't need ICTs. What the poor need is economic opportunity, improved nutrition and health care, healthy environments, education, and other components of a rewarding and sustainable livelihood. To the extent that ICTs can help achieve these other goals, they are a worthwhile tool of development efforts, but they remain tools, not goals."[5]

Goals that ICTs can help achieve include such issues as:

· *Access to information*: ICTs can be used in a variety of ways to provide people in rural or marginalized areas with the information they need, or a space to make their voices heard. For example, the Internet has been used to provide rural medical workers with specialized advice and information, for distance education, or to provide relevant local information on prices, weather, government schemes etc.

· *Internet diversity and equity*: The average user of the internet is male, urban and well-educated. For the internet community to be more diverse requires content in more languages, and access through other means than text and special attention to be paid to the needs of other types of users.

· *Information services*: NGOs can take a role providing information services to the poor and marginalized: researching, translating and disseminating information in response to their stated needs.

· *Strengthening the voices of the poor*: NGOs may use ICTs to capture and disseminate the voices of the poor and marginalized, pushing local perspectives onto broader policy platforms and diversifying the content of the Internet and other information sources. These same systems should enable the voices of the poorest and most marginalized to be heard in the NGOs' own planning and reporting processes.

· *Networking for change*: the Internet and other ICTs have an important role to play in networking people and organizations working towards the same ends. This may mean people learning from each other, or using technology to facilitate international campaign actions.

ICTs also play a critical role in governance. Because of the fundamental link between technological learning and the ways societies and their industrial transformations evolve, it is important to situate technological innovation and the application of ICTs at the centre of governance discussions.

The benefits of the new technologies are the result not only of an increase in connectivity or broader access to ICT facilities. They accrue from the facilitation of new types of development solutions and economic opportunities that deploying ICTs makes possible. When strategically integrated into the design of development interventions, ICTs can stretch resources farther. At the same time, as a facilitator of knowledge networking and distributed processing of information, ICTs can be used to foster increased sharing of knowledge and the global commons.

NEW TECHNOLOGIES REQUIRE SOUND ETHICAL POLICIES

Enormous claims are made for NBIC-related technologies. They are supposed to solve problems of hunger and poverty, cure cancer and clean up the environment. Scientists say they will bring better, cheaper disease diagnostics for people and crops and improve water purification and the efficiency of solar cells, reduce raw material demands, increase recycling and slash transport and energy costs. But even if it is possible diagnose diseases better, will corporate research focus on the problems of poor and marginalized people, and will technological improvements and patented drugs be affordable?

The simple truth is that new technologies cannot solve old injustices. Globalization – in the form of today's trade, finance and patent systems – ensures that the control of new technologies will remain with the rich. Intellectual property regimes and marketplace oligopolies along with government collusion have usually managed to dictate which technologies advance and whose interests they serve.

The reluctance or refusal of scientists to make moral and political judgments about, and to take responsibility for, these convergent technologies: "both legitimizes and is legitimized by the self-expanding dynamic of these technologies, their cumulative results and their opaque, long-term effects. Not only is responsibility difficult to locate amidst the unintended and unpredictable consequences of genetic engineering, but the biotech industry may well be fashioning a world so dangerous, complex and uncontrollable that our species' modest capacity for responsibility – and with it the anguish of guilt and suffering which marks the alienation of this responsibility – may itself become a problem, a deficiency to be corrected by the same technology and expertise."[6]

THE POWER OF NANOTECHNOLOGY AND WHY GOVERNMENTS AND COMMERCIAL INTERESTS SEEK TO CONTROL IT

sThe real power of nano-scale science lies in its potential to bring together disparate technologies – including biotechnology, cognitive sciences, informatics, and robotics. With applications spanning all industry sectors, technological convergence at the nano-scale is poised to become the platform for a convergence of power that will allow global control of manufacturing, food, agriculture and health in the immediate years ahead.

Nanotech's "raw materials" are the chemical elements of the Periodic Table – the building blocks of everything – both living and non-living. At the nano-scale, where quantum physics rule, a material's properties can change dramatically. With only a reduction in size (below about 100 nanometers), and no change in substance, materials can exhibit new properties related to electrical conductivity, elasticity, strength, color and chemical reactivity – characteristics that the very same substances do not exhibit at the micro or macro scales. For example, some forms of nano-scale carbon can be stronger than steel and six times lighter; zinc oxide – opaque at the micro-scale – becomes transparent at the nano-scale; nano-scale copper becomes highly elastic; nano-aluminum can spontaneously combust at the nano-scale.

Companies are now manufacturing nanoparticles (chemical elements or compounds less than 100 nanometers) for use in hundreds of commercial products – from crack-resistant paints and stain-resistant clothing, to odor-eating socks, to food additives, pesticides and cosmetics, to self-cleaning windows and anti-graffiti coatings for walls. And that's just the beginning. Nanotechnology also makes possible "bottom-up" manufacturing where self-assembling molecules become the modules for constructing nano-scale devices.

Building devices from molecular scratch is still in the early stages. Nanofabricated products are being developed for use as electronic circuitry, for example. Chip-makers envision the use of self-assembling molecular structures to store data or turn the flow of electrons on and off in a circuit. If molecular transistors work, carbon nanotubes could replace silicon, yielding ultra-fast computers that perform "orders of magnitude" beyond silicon. Both Intel and Hewlett-Packard have announced strategies to replace silicon with nano-engineered materials to keep computer processing power growing at exponential rates.

Scientists are also developing nano-devices for molecular drug delivery. For example, biological engineers at the Massachusetts Institute of Technology (MIT) are testing a nano-structured drug delivery device in mice, which can chemically target and penetrate a tumor cell when injected in the bloodstream. Dubbed the anti-cancer "smart cell", it first releases a chemical that cuts off the tumor's blood supply and then as the outside shell of the nano-device dissolves, the inner core releases a chemotherapy drug to kill the cancer cells from the inside.

Invisible and highly-invasive nano-scale sensors are being developed for a wide range of applications. For example:

- MIT's Institute for Soldier Nanotechnologies, created in 2002 with a $50 million grant from the US Department of Defense, aims to create a "21st century battlesuit" to enhance "soldier survivability". One research team is using nanotech to develop a battlesuit that incorporates: 1) highly sensitive chemical and biological sensing technologies; 2) protective fiber and fabric coatings that will neutralize bacterial contaminants and/or chemical attack agents (i.e., nerve gas and toxins). The battlesuit's fabric may feature nanopores that "close" upon detection of a biological agent. Researchers are also developing infrared monitoring based on nano-crystals (quantum dots) to detect the presence of chemical agents.

• Scientists at Hebrew University of Jerusalem and at the US Department of Energy's Brookhaven National Laboratory have implanted a gold nanoparticle into the enzyme glucose oxidase – a step that researchers say will pave the way for a nano-scale device that can more accurately measure blood glucose in diabetic patients.

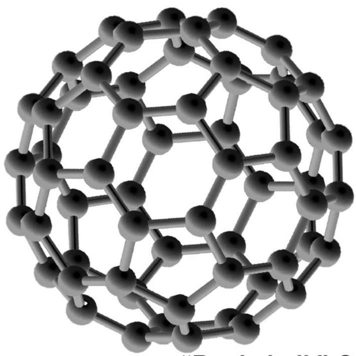
• Scientists at Kraft Foods, as well as researchers at Rutgers University and the University of Connecticut, are working on nano-particle films with embedded sensors to detect food pathogens. Dubbed "electronic tongue" technology, the sensors can detect harmful substances in parts per trillion and would trigger a color-change in food packaging to alert the consumer if a food is contaminated or has begun to spoil.

Though nanotech products came to market over the past two decades in the absence of public awareness and regulatory oversight, in more recent years, a growing number of scientific studies and government reports have warned that engineered nanoparticles could pose unique risks to human health and the environment. Over 475 products containing unregulated and unlabeled nano-scale particles are commercially available – and thousands more are in the pipeline – but no government has developed a regulatory regime that addresses the nano-scale or the societal impacts of the invisibly small.

While nano-scale particles have existed in our environment for millennia (salt nanocrystals in ocean air or nanoparticles of carbon in soot), attention is now focused on these new, manufactured nanoparticles that result from miniaturizing chemical elements or compounds, such as gold, carbon or silicate. New, manufactured nanomaterials – including nanotubes, buckyballs and quantum dots – are now under scrutiny for their potential hazards.

Amazing (and worrisome) properties of buckyballs:

- Hollow - can be filled up
- Can cause brain damage in fish
- Changeable solubility
- Enormous ability to withstand pressure
- Inhaled by rabbits, they increase susceptibility to blood clotting



"Buckyball," C_{60}

Only a handful of toxicological studies exist on engineered nanoparticles, but it appears that nanoparticles as a class are more toxic due to their smaller size. When reduced to the nano-scale, particles have a larger surface area that can make them more chemically reactive. As particle size decreases and reactivity increases, a substance that may be inert at the micro or macro scale, can assume hazardous characteristics at the nano-scale. One concern is that the increased reactivity of nanoparticles could harm living tissue, perhaps by giving rise to “free radicals” that may cause inflammation, tissue damage or growth of tumors.

Nanoparticles can be inhaled, ingested or pass through the skin. Once in the bloodstream, nanoparticles can slip past traditional guardians of the body’s immune system such as the blood-brain barrier. Ironically, the very same properties that make engineered nanoparticles so attractive for the development of targeted drug delivery systems – namely, their mobility in the bloodstream and ability to penetrate cell membranes – could also be qualities that make them dangerous.

Recent toxicological studies on the health and environmental impacts of manufactured nanoparticles indicate that there’s reason for concern:

· A study published in July 2004 found that nano-scale molecules of carbon (a type known as buckyballs) can cause rapid onset of brain damage in fish.

· In 2005 researchers at the US National Aeronautic and Space Administration (NASA) reported that when commercially available carbon nanotubes were squirted into the lungs of rats it caused significant lung damage. (The researchers indicated that the nanotube “dosage” was roughly equivalent to worker exposure levels over a 17-day period.)

· In a separate study, researchers at the US National Institute of Occupational Safety and Health reported in 2005 substantial DNA damage in the heart and aortic artery of mice that were exposed to carbon nanotubes.

· In 2005 University of Rochester (USA) researchers found that rabbits inhaling buckyballs demonstrate an increased susceptibility to blood clotting.

· A 2005 study shows that buckyballs clump together in water to form soluble nanoparticles and that even in very low concentrations they can harm soil bacteria, raising concerns about how these carbon molecules will interact with natural ecosystems.

In response to heightened concerns about nanoparticles, some scientists suggest that it might be possible to mitigate potential toxic effects by controlling the surface chemistry of nanoscale materials, or by coating them in protective substances. These efforts are complicated by the fact that there is currently no standardized method for measuring or characterizing nanoparticles, no regulatory regime to ensure that particles have been made "safe," nor is it possible to know how long protective coatings might last.

Given the knowledge gaps, expert reports are urging caution, and recommending that release of nanoparticles be restricted or prohibited:

"*Until more is known about their environmental impact we are keen that the release of nanoparticles and nanotubes in the environment is avoided as far as possible. Specifically we recommend as a precautionary measure that factories and research laboratories treat manufactured nanoparticles and nanotubes as if they were hazardous waste streams and that the use of free nanoparticles in environmental applications such as remediation of groundwater be prohibited.*" – Royal Society and Royal Academy of Engineering (UK), July 2004.

Currently, nano-scale chemicals are escaping regulatory oversight if the same chemical compound has been approved at the micro- or macro-scale. Manufacturers of carbon nanotubes, for example, sometimes simply identify their product as "graphite" – another type of pure carbon molecule – even though nano-scale carbon has vastly different properties and applications. Similarly, if a substance has already been approved as a food additive at a larger scale (such as titanium dioxide), nanoparticles of the same substance don't trigger new regulatory action – even though, by definition, nano-scale ingredients have new and different properties. And although some companies claim that they have conducted their own toxicological studies on nanoparticles, those studies are rarely in the public domain.

While US and European governments are belatedly conceding that some type of regulation is needed, it remains to be seen if nanotech regulations will be cobbled together using existing regulations for chemicals or if a new, precautionary approach will prevail. In May 2005 the US Environmental Protection Agency revealed that it was "considering a potential voluntary pilot program for nanoscale materials that are existing chemical substances."[7] The proposed voluntary initiative was slammed as "inadequate and inappropriate" by 17 environmental, health and civil society groups.[8]

Nanotechnology and Development

Nanotech enthusiasts insist that nanotech will address the South's most pressing needs,[9] and European governments have identified nanotechnology as an important tool for achieving the United Nations Millennium Development Goals.[10] Current research on energy and water are two oft-cited examples of nanotech's potential contributions to environmental sustainability and human development.

Today, more than a billion people lack access to safe drinking water. Polluted water contributes every year to the death of an estimated 15 million children under age five.[11] Researchers are developing both nanofilters and engineered nanoparticles to clean contaminated water. For example:

- Nanotechnologists at Rensselaer Polytechnic Institute (Troy, New York) and the Banaras Hindu University (Varanasi, India) are teaming up to develop carbon nanotube filters to remove contaminants from water. The filters allow water molecules to pass through a cluster of carbon nanotubes while trapping harmful bacteria like E. coli and poliovirus as tiny as 25-nanomters wide. Their goal is to develop a low-cost water filter that can be cleaned and re-used.

- With funding from the US Air Force, Vermont-based Seldon Technologies is developing a portable, hand-held filter that can quickly purify water from any source – a mud puddle, river or ground water – and render it clean enough to use on the battlefield for emergency medical treatment.

- In countries like Bangladesh, naturally occurring arsenic in wells is a major threat to public health, afflicting an estimated 10-20% of the Bangladeshi population. Researchers at Rice University's Center for Biological and Environmental Nanotechnology are developing magnetite (iron oxide) nanocrystals to capture and remove arsenic from contaminated water. At Oklahoma State University, chemists are experimenting with the use of zinc oxide nanoparticles to clean up arsenic in water. Although research is ongoing, the UK's Royal Society and Royal Academy of Engineering recommends that the use of engineered nanoparticles in groundwater remediation be prohibited until more is known about their health and environmental impacts.[12]

Access to inexpensive, safe and renewable energy is key to sustainable development worldwide. In the developing world, an estimated 2 billion people lack access to modern energy sources. Nanotech enthusiasts point to cheap, flexible and efficient solar cells as one of the most promising areas of "green nanotechnology".

In 2004, the US Department of Defense granted over $18 million to three nanotech start-up companies to develop military applications of solar energy. With additional backing from corporate partners and venture capitalists, Nanosys (Palo Alto, CA), NanoSolar (Palo Alto, CA) and Konarka (Lowell, MA) are developing a new generation of light-weight, flexible solar cells that are based on semi-conducting nanoparticles. Inorganic nanomaterials such as "quantum dots" that absorb a wide spectrum of light are printed on large sheets of metal foil that can be rolled out onto rooftops – allowing homes or office buildings to generate their own power. Nanosolar is also developing a semiconductor paint that could allow nano-powered solar cells to be applied to any surface.

In addition to current research related to water and energy, nanotech proponents point to the future environmental benefits of revolutionary manufacturing processes associated with bottom-up construction "that leaves no wasted material behind" and of new materials that can be designed to exhibit specific properties needed for particular applications.

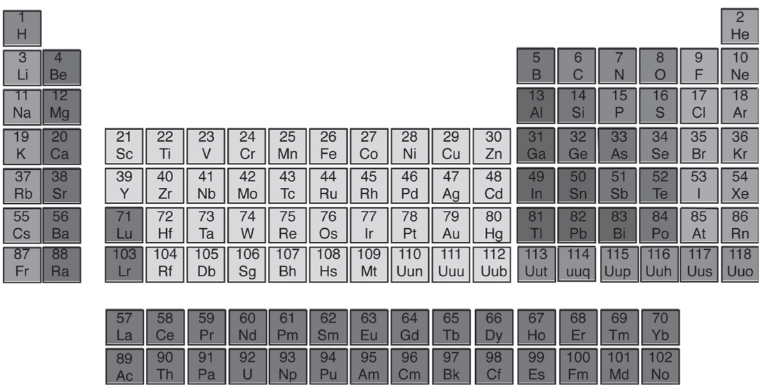
Beyond minimizing waste, however, nano-scale manufacturing platforms and engineered nano-materials could also make geography, raw materials, as well as labour, irrelevant.

At the first North-South dialogue on nanotechnology sponsored by the United Nations Industrial Development Organization in February 2005, scientists from developing countries pondered the opportunities and challenges posed by nano-scale science and technology.[13] While most of the discussion focused on promoting nanotech R&D and preventing a "nano-divide" between South and North, representatives from India and South Africa warned that raw materials and labor in developing economies risk becoming "redundant in the nano-age." According to South Africa's Minister of Science and Technology: "With the increased investment in nanotechnology research and innovation, most traditional materials ...will... be replaced by cheaper, functionally rich and stronger [materials]. It is important to ensure that our natural resources do not become redundant, especially because our economy is still very much dependent on them."[14] To counter the potential loss of markets, the South African government has initiated Project Autek to develop new, industrial uses for gold – South Africa's largest export earner.

Nanomonopoly: Nanotechnologies and Intellectual Property

Ultimately, intellectual property will play a major role in deciding who will capture nanotech's trillion dollar market, who will gain access to nano-scale technologies, and at what price. According to Stanford University Law professor, Mark Lemley, "...patents will cast a larger shadow over nanotech than they have over any other modern science at a comparable

The Periodic Table of Elements



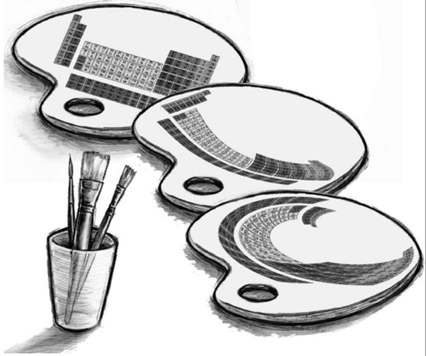
stage of development."[15] The world's largest transnational companies, leading academic labs and nanotech start-ups are all racing to win monopoly control of tiny tech's colossal market.

"*It is true that one cannot patent an element found in its natural form; however, if you create a purified form of it that has industrial uses – say, neon – you can certainly secure a patent.*" - Lila Feisee, Biotechnology Industry Organization's Director for Government Relations and Intellectual Property[16]

The current nanotech patent grab is reminiscent of the early days of biotech. Whereas biotechnology patents make claims on biological products and processes, nanotechnology patents may literally stake claims on chemical elements, as well as the compounds and the devices that incorporate them. In short, molecular-level manufacturing provides new opportunities for sweeping monopoly control over both animate and inanimate matter. At stake is control over nano-scale materials, devices and processes that cut across multiple industry sectors and between biological and non-biological materials. A single nano-scale innovation can be relevant for widely divergent applications.

Today, broad patents are being granted that cut across multiple industry sectors and include sweeping claims on entire areas of the Periodic Table. Patents on individual chemical elements are not unprecedented. Glenn Seaborg, the 1951 Nobel Prize winning physicist won US patent #3,156,523 for the chemical element Americium (element no. 95 on the periodic table) on November 10, 1964. Seaborg's second patented element was Curium (#96) – US patent #3,161,462 granted on December 15, 1964. More recently, when Harvard University's Charles Lieber obtained a key patent (US patent 5,897,945) on nano-scale metal oxide nanorods, he didn't claim nanorods composed of a single type of metal – but instead claimed nano-structured compounds composed from any of 33 chemical elements. Patent lawyers have identified Harvard's patent (licensed exclusively to Nanosys, Inc.) as one of the top 10 patents that could influence the development of nanotechnology.[17]

Researchers seek to exploit the Periodic Table of Elements in the way that a painter uses a palette of pigments. The goal is to create new materials and modify existing ones.



Although industry analysts frequently assert that nanotech is in its infancy, “patent thickets” on fundamental nano-scale materials, tools and processes are already creating thorny barriers for would-be innovators. To the extent that these are “foundational” patents – that is, seminal breakthrough inventions upon which later innovations are built – researchers in the developing world could be shut out. Researchers in the global South are likely to find that participation in the “nanotech revolution” is highly restricted by patent tollbooths, obliging them to pay royalties and licensing fees to gain access.

Diamond vs. Chakrabarty Remembered

June 16, 2005 marked the 25th anniversary of Diamond vs. Chakrabarty, the landmark US Supreme Court decision that opened the floodgates to the patenting of all life forms. The anniversary offered a timely opportunity to examine current trends in intellectual property relating to nano-scale technologies – the world’s newest technological wave. In 1971, Ananda Chakrabarty, an employee of General Electric, applied for a patent on a genetically modified, oil-eating microbe. His patent application was rejected by the US Patent & Trademark Office (US PTO) on the grounds that animate life forms were not patentable.

When Chakrabarty won his case on appeal, the PTO Commissioner, Sidney Diamond, took the case to the US Supreme Court. On June 16, 1980 by a narrow 5-4 margin, the US Supreme Court ruled that Chakrabarty’s oil-eating microbe was not a product of nature; living organisms could be seen as human made inventions and are therefore patentable subject matter. An ironic footnote to the saga is that the “invention” didn’t work.

The monumental importance of the Chakrabarty decision did not register with the Court – or the public – at the time. (Some environmentalists were eager to embrace life patenting if it meant microbes could devour oil spills.) In 1980 the Supreme Court specifically noted that the Chakrabarty decision was a narrow case that would not affect the “future of scientific research”. The Court got it wrong. According to lawyer and activist Andrew Kimbrell, “The complete failure by the Court to correctly assess the impacts of the Chakrabarty decision may go down as among the biggest judicial miscalculations in the Court’s long history.”

As a result of Chakrabarty, the slippery slope of IP on living organisms became a patent landslide, and a bonanza for the biotech industry. Over the course of a single decade, the US government re-interpreted intellectual property laws to allow for exclusive monopoly control over all biological products and processes. After Chakrabarty, the once unthinkable patenting of genes, plants, animals, microorganisms and human genetic material would become common practice in the US – positioning industry and the US government to set the precedent for IP regimes worldwide via the World Trade Organization and through bilateral and regional trade agreements.

Lessons learned from Chakrabarty

· Historic decisions allowing exclusive monopoly control of all biological products and processes involved no public input or wider societal debate; these decisions were made by a handful of individuals in the courts and patent offices – not by the US Congress. In essence, it was the courts and not citizens who gave biotech the green light in the US. Similarly, at the international level, intellectual property rules have been crafted by and for a narrow group of corporate interests.

· Following Chakrabarty, the US government’s aggressive life patenting policies set the bar for the rest of the world – especially at the World Trade Organization.

· The slope is slippery indeed. The history of patent monopoly (see below) demonstrates that patent holders typically seek wider patentability, more expansive scope of patent claims, longer patent terms and greater harmonization of patent rules worldwide.

· For many developing nations the rationale for accepting stronger IP regimes has been the argument that their economies would prosper from increased technology transfers and foreign direct investment. In the case of biotechnology, however, the vast majority of key enabling technologies are proprietary products and processes, tightly concentrated in the hands of multinational gene giants. Under these conditions, stronger levels of IP obligate developing countries to make a massive transfer of resources to the North, in order to acquire licenses for proprietary technologies. A new study by the World Bank concludes that the effects of stronger intellectual property regimes in creating greater trade flows to developing countries are "theoretically ambiguous".[18] The authors conclude, however, that stronger levels of intellectual property in developing countries are not a factor in spurring high-technology trade flows.

Nanobiotechnology

"Nanobiotechnology" refers to the integration of biological materials with synthetic materials to build new molecular structures. Similarly, synthetic biology refers to the construction of new living systems in the laboratory that can be programmed to perform specific tasks. When synthetic biology involves the integration of living and non-living parts at the nano-scale, it's synonymous with nanobiotechnology.

With the rapid emergence of nanobiotechnology, genetic engineering is suddenly so last-century. The world's first synthetic biology conference convened in June 2004. Two months later, the University of California at Berkeley established the first synthetic biology department in the United States. By July 2005 venture capitalists had raised $43 million to bankroll two start-up companies specializing in synthetic biology.

"*Much of what we manufacture now will be grown in the future, through the use of genetically engineered organisms that carry out molecular manipulation under our digital control. Our bodies and the material in our factories will be the same...we will begin to see ourselves as simply a part of the infrastructure of industry.*" – Rodney Brooks, director of

Artificial Intelligence Laboratory, Massachusetts Institute of Technology (MIT)[19]

Nanobiotechnologists aim to harness nature's self-replicating "manufacturing platform" for industrial uses. Today, researchers are building biological machines – or hybrid organisms employing both biological and non-biological matter. The implications of human-directed, made-to-order life forms are breathtaking:

· Engineer Carlo Montemango has created a device, less than a millimeter long, made from rat heart cells combined with silicon. Muscle tissue growing on the device's "robotic skeleton" allows it to move, and researchers believe it could someday power computer chips. Montemagno describes his creations as "absolutely alive...the cells actually grow, multiply and assemble – they form the structure themselves".[20]

· Scientists at the University of California's new synthetic biology department are designing and constructing "biobots" – autonomous robots designed for a special purpose that are the size of a virus or cell, and composed of both biological and artificial parts.

· Chemists at New York University have created a two-legged, DNA robot capable of bi-pedal motion. In the future, the researchers hope that they can coax cells to manufacture DNA-based robots. If nano-scale manufacturing is to become a reality, molecular-scale robots will need to assembly other nanomachines and be able to move molecules.

· Researchers are using proteins from spinach chloroplasts to create electronic circuits – resulting in the world's first solid-state photosynthetic solar cell.

· Angela Belcher, material scientist at MIT, has genetically engineered the DNA of viruses, inducing them to grow tiny inorganic wires with magnetic and semiconducting properties that may someday provide circuitry in high-speed electronic components.

· With funding from the US Department of Energy, the J. Craig Venter Institute is building a new type of bacterium using DNA manufactured in the laboratory. His goal is to build synthetic organisms that can be programmed to produce hydrogen or be used in the environment to sequester carbon dioxide.

- Researchers at the Scripps Institute in La Jolla, California have created an artificial base that can be added to the four naturally-occurring bases of DNA (A, G, C and T). As the DNA strand replicates, the artificial base (known as 3FB) pairs up with another 3FB to form a completely new base pair. The goal is to incorporate the new and improved DNA into a microbe to learn how it evolves. Other researchers at the University of Florida have been able to add a second artificial letter – so that there are six in all – and, more remarkably, to coax the newly-expanded DNA molecule to make copies of itself. The research team was able to “evolve” its artificial DNA through five generations.

“*I suspect that, in five years or so, the artificial genetic systems that we have developed will be supporting an artificial life form that can reproduce, evolve, learn and respond to environmental change.*” – Professor Steven Benner, Chemist, University of Florida

In the wake of startling advances in the field of synthetic biology, the potential “for abuse or inadvertent disaster” is enormous. In January 2005 scientists unveiled a new, automated technique that makes it faster and easier to synthesize long molecules of DNA. But researchers warn that this revolutionary advance for synthesizing DNA will also permit the rapid synthesis of any small genome, including the smallpox virus or other dangerous pathogens that could be used for bioterrorism.

Nanobiotechnology raises many concerns: Will new, self-replicating life forms, especially those that are designed to function autonomously in the environment, open a Pandora’s box of unforeseen and uncontrollable consequences? Some researchers in the field have begun to acknowledge potential risks and ethical implications of their work. In 2004 the editors of Nature called on scientists working in the field of synthetic biology “to consult and reflect carefully about risk – both perceived and genuine – and to moderate their actions accordingly”.[21]

Nanotechnology in Agriculture and Food

Nanotechnology has the potential to radically transform food and agricultural systems. Over the next two decades, the impacts of nano-scale convergence on farmers and food will exceed that of farm mechanization or of the Green Revolution. Converging technologies could reinvigorate the battered agrochemical and agbiotech industries, igniting a still more intense debate – this time over "atomically modified" foods. A handful of food and nutrition products containing invisible, unlabeled and unregulated nano-scale additives are already commercially available. Likewise, a number of pesticides formulated at the nano-scale are on the market and have been released in the environment.

From soil to supper, nanotechnology will not only change how every step of the food chain operates but it will also change who is involved. At stake is the world's $3 trillion food retail market, agricultural export markets valued at $544 billion, the livelihoods of some 2.6 billion farming people and the well-being of the rest of us who depend upon farmers for our daily bread. Nanotech has profound implications for farmers (and fisher people and pastoralists) and for food sovereignty worldwide.

Just as GM agriculture led to new levels of corporate concentration all along the food chain, so proprietary nanotechnology, deployed from seed to stomach, genome to gullet, will strengthen the grasp of agribusiness over global food and farming at every stage – all, ostensibly, to feed the hungry, safeguard the environment and provide consumers with more choice.

For two generations, scientists have manipulated food and agriculture at the molecular level. Agro-Nano connects the dots in the industrial food chain and goes one step further down. With new nano-scale techniques of mixing and harnessing genes, genetically modified plants become atomically modified plants. Pesticides can be more precisely packaged to knock-out unwanted pests, and artificial flavourings and natural nutrients engineered to please the palate. Visions of an automated, centrally controlled industrial

agriculture can now be implemented using molecular sensors, molecular delivery systems and low-cost labour.

Agriculture, according to the new nano-vision, needs to be more uniform, further automated, industrialized and reduced to simple functions. In our molecular future, the farm will be a wide area biofactory that can be monitored and managed from a laptop and food will be crafted from designer substances delivering nutrients efficiently to the body. Nanobiotechnology will increase agriculture's potential to harvest feedstocks for industrial processes. Meanwhile tropical agricultural commodities such as rubber, cocoa, coffee and cotton – and the small-scale farmers who grow them – will find themselves quaint and irrelevant in a new nano-economy of "flexible matter".

The idea that thousands of tiny sensors could be scattered like invisible eyes, ears and noses across farm fields and battlefields sounds like science fiction. But ten years ago, Kris Pister, a professor of Robotics at University of California Berkeley secured funding from the US Defense Advanced Research Projects Agency (DARPA) to develop autonomous sensors that would each be the size of a match head. Using silicon-etching technology, these motes ("smart dust" sensors) would feature an onboard power supply, computation abilities and the ability to detect and then communicate with other motes in the vicinity. In this way the individual motes would self-organize into ad hoc computer networks capable of relaying data using wireless (i.e., radio) technology.

DARPA's immediate interest in the project was to deploy smart dust networks over enemy terrain to feed back real time news about troop movements, chemical weapons and other battlefield conditions without having to risk soldiers' lives. However, like that other groundbreaking DARPA project, the Internet, it swiftly became clear that tiny surveillance systems would have endless civilian uses, from monitoring energy-use in office buildings to tracking goods through a supply chain to environmental data monitoring. Today, wireless micro and nanosensors like the ones pioneered by Kris Pister are an area of intense research for large corporations from Intel to Hitachi, a focus of development at all US national defence

laboratories and in fields as wide apart as medicine, energy and communications.

Touted by *The Economist*, *Red Herring* and *Technology Review* as the "next big thing", ubiquitous wireless sensors embedded in everything from the clothes we wear to the landscapes we move through could fundamentally alter the way we relate to everyday goods, services, the environment and the State. The aim is to develop what researches call "ambient intelligence" – smart environments that use sensors and artificial intelligence to predict the needs of individuals and respond accordingly: offices that adjust light and heating levels throughout the day or clothes that alter their colours or warmth depending on the external environment.

"*Improvements in sensor technology will take us to a completely new level of measuring the growth process, the surrounding environment, the operation of machinery and much more. It will automate the processes that used to require human intervention. So rather than adjust the power levers on our tractor, the environment is sensed and implements adjust automatically. In some cases, reduced skills will be needed to accomplish certain tasks.*" – Mike Boehlje, Purdue University's Center for Food and Agricultural Business

In a recent article in the journal *Nature Materials*, a researcher at the Cavendish Laboratory of Cambridge University urged her material scientist colleagues to consider agriculture not as a "feedstock with an essentially uncontrollable composition", but as "a rich and diverse category of materials," many of them "nanostructure composites, in which self-assembly may play a key role." One scientist points out that the variability of feedstocks, an unavoidable characteristic of all natural products due to regional differences of soil, climate and cultivar, produce "unreliable" ingredients that nanotechnologists will be able to make more uniform, stable and even more nutritious. Recognizing that, at least in Europe, "science has lost out to emotion" in the GM debate, she has greater hopes for nanotechnology to "improve raw products" in a way that will be acceptable to the public.

A handful of food and nutrition products containing invisible nano-scale additives are already commercially available. Hundreds of companies are conducting research and development (R&D) on the use of nanotech to engineer, process, package and deliver food and nutrients to our shopping baskets and our plates. Among them are giant food and beverage corporations, as well as tiny nanotech start-ups. According to Jozef Kokini, the Director of the Center for Advanced Food Technology at Rutgers University (New Jersey, USA), "every major food corporation has a program in nanotech or is looking to develop one."

Despite the obvious enthusiasm for nano-scale science and its applications to food engineering and processing, the food & beverage industry is generally conservative and cautious when talking about the future of nanotech and food. After witnessing widespread rejection of genetically modified foods, the food industry may be especially skittish about owning up to R&D on "atomically modified" food products. "The food industry is more traditional than other sectors like IBM" [where nanotechnology can be applied], explains Gustavo Larsen, a professor of chemical engineering and a former consultant to Kraft. "My take is that there are good opportunities and it's often more feasible to realise these opportunities [in the food sector]. You can make nanoparticles and use them in foods – you don't have to assemble them first."

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Today, food-packaging and monitoring are a major focus of food industry-related nanotech R&D. Packaging that incorporates nanomaterials can be "smart," which means that it can respond to environmental conditions or repair itself or alert a consumer to contamination and/or the presence of pathogens. According to industry analysts, the current US market for "active, controlled and smart" packaging for foods and beverages is an estimated $38 billion – and will surpass $54 billion by 2008.

Nano-Food

In 1999, Kraft Foods, the $34 billion Altria (formerly known as Phillip-Morris) subsidiary, established the industry's first nanotechnology food laboratory. The next year, Kraft launched the NanoteK consortium, enveloping fifteen universities and public research labs from around the globe. None of the scientists involved in the consortium are food scientists by training; rather, they're a mix of molecular chemists, material scientists, engineers and physicists.

The products of nanotechnology have already begun to "appear" in food (though they are too small to see – and consumers would have no way of knowing since there is no requirement for labelling and no size-specific regulation). BASF, for example, produces a nano-scale version of carotenoids, a class of food additives that imparts an orange colour and that occurs naturally in carrots and tomatoes. Some types of carotenoids are antioxidants and can be converted to Vitamin A in the body. BASF sells its nanoscale synthetic carotenoids to major food & beverage companies worldwide for use in lemonades, fruit juices and margarines. Nano-scale formulation makes them more easily absorbed by the body but also increases shelf-life.

Is it safe to add nanoparticles to foods? The short answer to the question is: No one knows for sure. The issue has yet to be confronted head on by either regulators or the scientific community.

Conclusion

With public confidence in both private and government science at an all time low, full societal debate on nano-scale convergence is critical. It is not for scientists and governments to "educate" the public, but for society to determine the goals and processes for the technologies they finance. How can society assert democratic control over new technologies and participate in assessing research priorities?

Firstly, society must engage in a wide debate about nanotechnology and its multiple economic, health and environmental implications. Secondly, some civil society organizations have called for a moratorium on nanotech research and new commercial products until such time as laboratory protocols and regulatory regimes are in place to protect workers and consumers, and until these materials are shown to be safe. Given the regulatory vacuum and inertia by leading nano nations to act, the call for a moratorium is justified and deserves public debate.

Thirdly, at a time when truly transforming technologies are emerging far faster than public policies can evolve to address them, it is critical to broaden the community of participants who play a role in determining how emerging technologies should affect our future. Society must gain a fuller understanding of the direction and impacts of science and technology innovations in a broader socio-political and ethical context.

In the coming decades, technologies converging at the nano-scale will revolutionize the design and manufacture of new materials across all industry sectors, blur the distinction between living and non-living matter, and change the very definition of what it means to be human. The challenge is to go beyond the tired and familiar approach of technocratic regulations related to “risk” and gain an innovative capacity for democratic control and assessment of science and technology.

CHALLENGING MAINSTREAM THINKING

Throughout history, science and technology have had, and will have in the future, both positive and negative consequences for life on planet earth. It is falsely claimed that science and technology are value-neutral, and that inanimate technological inventions cannot harbour values. The very term “technology” combines the Greek terms techné and logos meaning techniques embedded in the discourse that comes with it.

Intentions, purposes and actions that shape advances and policies in regard to research and development embody the perspectives, purposes, prejudices, particular objectives and cultural, economical, ethical, moral, spiritual and political frameworks of different social groups of any given society in which these human activities take place. Technologies reflect and, in fact, incorporate social arrangements and power relations. Moreover, the science and technologies themselves are interrelated; the governments seeking to regulate them are linked by trade and aid relationships; the companies looking to develop and sell them use the processes of globalization to reach larger markets and to locate more resources and raw materials for that development.

Technological development often brings benefits to large numbers of people and is often appropriately understood as a testament to human prowess. But today, the development and adoption of powerful new technologies often takes place very rapidly, with little pause for investigation of potential risks and downsides. Further, in an era of increasing privatization, new technologies are often brought to market with few or no regulatory mechanisms in place. On the one hand research and development follows social norms, expectations and economic considerations, on the other hand they change and influence the quality of our lives, our perception as to what is a "good life" and our ability to pursue "the good life".

It is believed that many negative consequences of science and technology could be avoided by using ethical principles to govern them. However, how do we arrive at ethical principles? There are different schools of thought one can use to develop secular, religious and spiritual ethical positions. Furthermore, one can follow schools of thought that are tailored towards the needs of certain groups of society (the social group approach to ethical reasoning). For example, feminist approaches to bioethical theories are now more widely recognised. They were developed because the existence and use of new technologies are changing how different women and men experience the world, the choices they make, and the work they do. At the same time, certain new technologies, like the internet, bio-technologies, and nano-technologies are considered important tools for development, meaning they are increasingly presented as key components of solutions to long-standing problems like hunger, poverty, and environmental degradation.

New technologies raise the stakes for those who advocate equality of women and men. Some new technologies have the potential drastically to change women's environments and their lives. Women's rights are particularly threatened by new genetic technologies because their development requires extensive testing on women and their genetic material. Debating the merits of cloning and this kind of human experimentation is premature without considering the health and safety of the women that would be required to pursue the research. Beyond safety, there are a number of other specific women's rights issues that need to be addressed: access and equity, reproductive choice, the commodification of life and, specifically, of women's bodies. Some women are involved in developing new technologies, but many more could become involved in critically interrogating it, asking important questions about its use, and presenting alternatives.

An analysis of the impact of women is also crucial yet often missing regarding genetically modified foods and other issues related to agricultural technology. While women are the majority of the world's farmers, in most patriarchal systems they have very little access to resources and very little power. In other words, they are doing the work to feed their families and communities, but are disempowered when it comes to getting their needs met or demanding appropriate technologies for that work. Women have typically been the holders of indigenous knowledge and wisdom, including seed saving and food and medicine preparation.

Some technologies are immediately related to women and their specific social or biologically defined roles, but this does not mean that women should not be involved in debating other technologies such as biological weapons. It is important to highlight not only what impacts on women directly, as women, but also what impacts on their equality and their ability to access and enjoy their rights. Women also need information and communication channels to help them improve their livelihoods and to secure the implementation of their human rights.

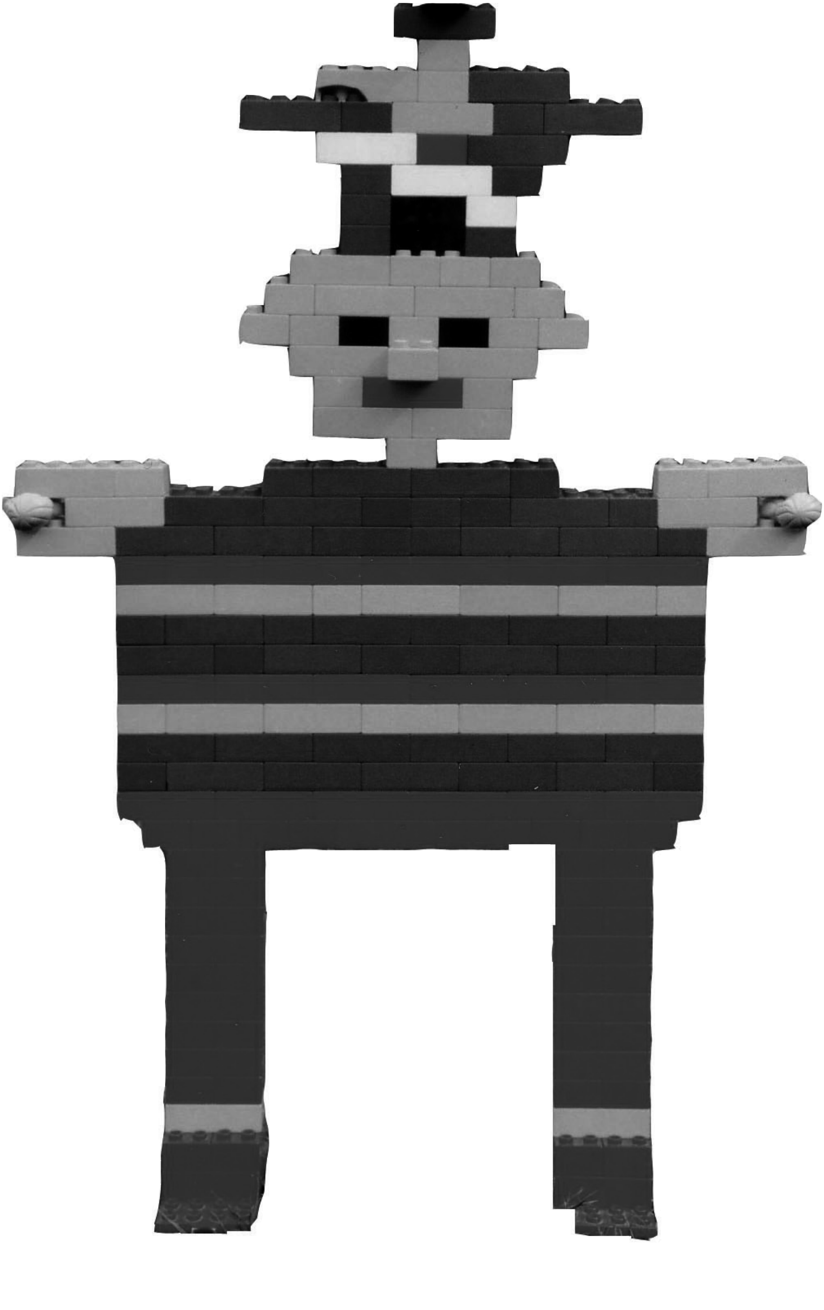
All of this represents a formidable challenge to all societies in today's world, and especially to developing countries. Due to systemic gender biases in information and communication technologies and their applications, women are far more likely than men to experience discrimination in the information society. Even resource-poor and non-literate women and their organizations are aware of the power of information technologies and communication processes and, if given the opportunity to do so, will use them to advance their basic needs and strategic interests.

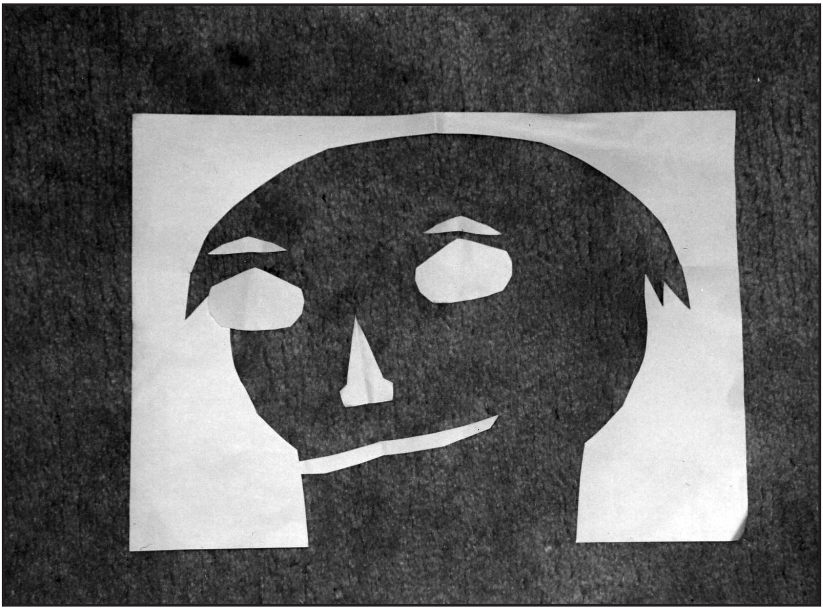
If a social group approach to ethical reasoning shows such important results concerning women, one would expect that ethical reasoning based on the lived experience and wisdom of other social groups such as persons with disabilities and Indigenous Peoples would also be pursued more vigorously. Nearly every bioethics issue -such as end of life decision-making, the allocation of healthcare resources, the use of genetic technology (gene therapy, genetic testing, genetic enhancement), research on individuals who are not competent, questions of futile care, selective non-treatment of newborns, debates about personhood, mercy killing and disability adjusted life years, nanotechnology, bionics, and info ethics - affects many social groups besides women as well as their self-perception and how they are perceived by others. However, disabled and Indigenous Peoples' approaches to ethical reasoning are totally marginalised in the development of ethical theories.

Within academic debate over bioethical issues, certain ethical principles are put forward time after time, namely the principles of autonomy, beneficence, nonmaleficence, and justice. However, different philosophies and approaches to bioethics interpret the concept and boundaries of autonomy, beneficence, nonmaleficence and justice in different ways and come up with additional principles to define ethical behaviour. These variations in philosophies and principles give raise to different possibilities to govern science and technology.

How do we decide which philosophy, which ethics, to use? It is assumed that the academic development of ethical principles is free from political intervention, but such is not the case (see, for example, the research initiative funding system and who is seen as an expert to be used by policy makers). It is also not free from prejudice and judgements are often assumed.

In the same way that science and technology are shaped by societal perspectives, so is ethics. Ethics also embodies the perspectives, purposes, prejudices and objectives of society, and of powerful social groups within society. The problem is that because the ethics discourse is not free of politics and prejudice, by itself it cannot lead us to an ethics with which we could govern science and technology for the good of everyone in society. The following chapter presents challenging insights concerning NBIC seen from the perspective of disability advocates.





TRANSFORMATION OF A SOCIAL GROUP – PEOPLE WITH DISABILITIES

In 2003 the interim statement "A Church of All and for All" was presented by the Ecumenical Disability Advocates Network (EDAN) to the Central Committee of the World Council of Churches. WCC General Secretary Konrad Raiser, said of it, "Churches must develop a new culture of caring and affirming life that includes people considered by others to be disabled."[22] In his opinion, "Its theological reflections also have a direct bearing on the ethical challenges arising in the field of bio-technology."[23]

Why did the EDAN report have a direct bearing on the ethical challenges arising in the field of bio-technology as Raiser said? And if that is the case one can assume that it also has a bearing on the ethical challenges arising from other technologies such as the NBICs. May be the below quotes by the bioethicist Caplan give us a hint.

"The understanding that our society or others have of the concept of health, disease and normality will play a key role in shaping the application of emerging knowledge about human genetics... "However, it does seem that the definition of disease and health is closely tied to those differences or abnormalities that are disvalued by the individual or group" (Caplan, 1992).

Nanomedicine and nanotechnology could usefully be added to Caplan's quote because parts of nanotechnology development are inherently linked with bio/genetechnology as the following illustrates:

"Recent insights into the uses of nanofabricated devices and systems suggest that today's laborious process of genome sequencing and detecting the genes' expression can be made dramatically more efficient through use of nanofabricated surfaces and devices. Expanding our ability to characterize an individual's genetic makeup will revolutionize diagnostics and therapeutics" (NSF, 2001: 7)

In addition, nanomedicine and nanotechnologies must be included because in many eyes they:

"Hold promise for contributing to a wide range of assistive solutions, from prosthetic limbs that adjust to the changes in the body, to more biocompatible implants, to artificial retinas or ears. Other opportunities lie in the area of neural prosthesis and the spinal patch, a device envisioned to repair damage from spinal injuries" (NSF, 2001: 41.)

All such solutions are linked to particular concepts of normalcy and ability, and to perceptions of what needs to be assisted. Of course, different responses will be made and different solutions sought depending on how the problem is defined. How the problem is defined depends on our concepts of, and beliefs about, such things as health, disease, disability, impairment, and defect.

In the case of NBIC-medicine it is important to investigate the understanding that society and individuals have of the concept of health and disease. Furthermore, as so-called disabled people are often highlighted as the beneficiaries of NBIC-medicine products, we have to ask ourselves what perception of disabled people and what concept of disability - a concept more contentious than is commonly recognized - guides NBIC research and development and what role disabled people are playing in this process.

Models of "disability/impairment"

1) Medical Model of "Disability/Impairment"

In the medical model, "disability/impairment" is viewed as a defect, a problem inherent to the person, directly caused by disease, trauma or other "medical health condition" and a deviation from certain norms. The person is given the label "patient".

Managing the "disability/impairment" of the person or person-to-be is aimed at cure, prevention of birth, de-selection at the embryo level, or normative adaptation. Medical individualistic care and prevention (in the case of the fetus/embryo) and individualistic normative rehabilitation are viewed as the primary endpoint and at the political level the principal response is to make curative and preventive medicine more efficient.

"Disabled" people can opt to see themselves and can be seen by "non-disabled people" as inherently defective and subnormal, as impaired (in relation to non-disabled people) and in need of being returned by science and technology to a societal norm of so-called non-disability (e.g. giving legs to amputees which will be as good or better than biological legs.

2) Medical model/social determinants/social well-being combination model of "disability/impairment"

Rarely does one employ the concept of "social determinants of health" within the medical model of "disability/impairment" to investigate how external negatively affect the social well-being of the "patient", the person with a disability/impairment. Even more rarely does one seek modifications of social determinants to make them instrumental to diminish ill/bad "social health" and to increase the social well-being of the "patient".

In contrast to the medical model, here disabled people can opt to see themselves and can be seen by "non-disabled people" as in need of having the physical environment, their interaction with the physical environment, and the societal climate changed to accommodate their biological reality (e.g. giving wheelchairs to amputees and making the physical environment wheelchair accessible – or using teleportation devices if they are ever developed) and to improve their social wellbeing.

3a) Medical model/transhumanist/enhancement determinants/social well-being combination model of "disability/impairment"

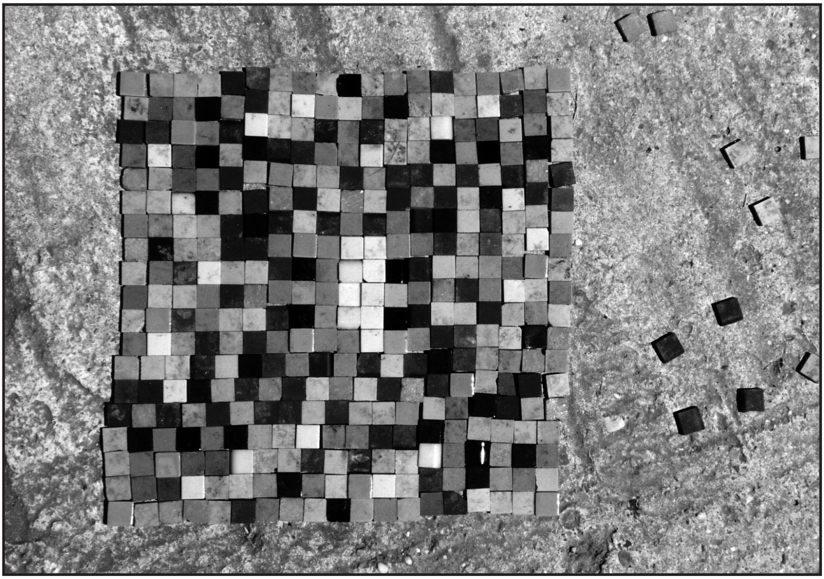
Disabled people who have a sub-normative functioning or who are perceived to have non-normative functioning of their biological can opt to see themselves and can be seen by "non-disabled people" as inherently defective. They can choose not only to be returned to the "norm", but also to be enhanced, augmented beyond species-typical boundaries (e.g. by giving bionic legs to amputees, which work better than "normal" biological legs or using brain-machine interfaces for thought-controlling the environment).

3b)The pure transhumanist model of "disability/ impairment"

The transhumanist model of health and disease sees every human body as defective and in need of improvement (beyond species-typical boundaries). Every human being is, by definition, "disabled" in the impairment /patient sense and fits the transhumanist model of "disability".

In the transhumanist model of "disability/impairment", disabled people are any people who perceive their normative functioning of biological systems as deficient. They might or might not be seen by "non-disabled people" as inherently defective and opt not only to be returned to a norm, but to be enhanced, augmented beyond species-typical boundaries.

The transhumanist model of "disability" views science and technology – including NBIC – as having the potential to free everyone, since everyone is now "disabled", from the "confinement of their genes" (genomic freedom) and the "confinement of their biological bodies" (morphological freedom).



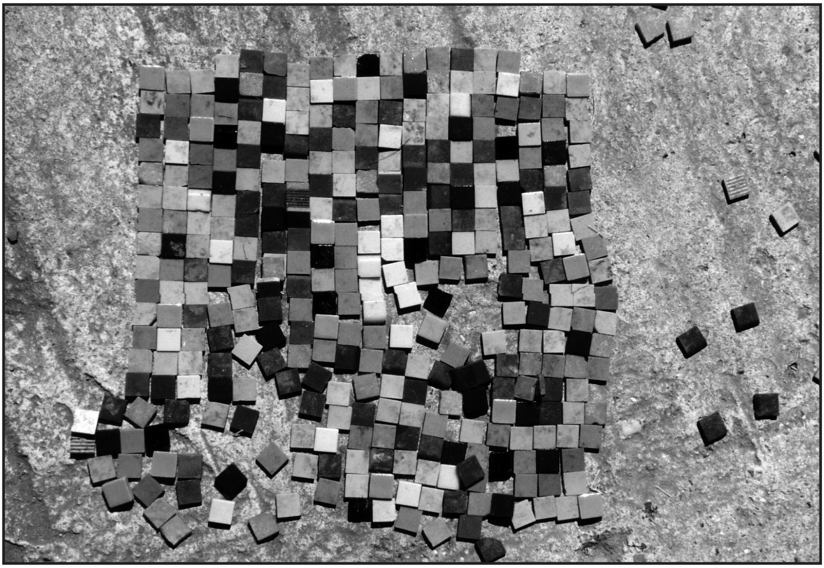
4) Social Model of Disability

The social model moves beyond the medical model by linking social determinants to social well-being and by uncoupling social determinants from the prerequisite of being or becoming medically ill. The biological reality of disabled people is seen as a variation of being – not in need of fixing, but in need of having the physical environment (or their interaction with the physical environment) and the societal climate changed to accommodate their biological reality. It does see disability mainly as a socially created problem and as a matter of fully integrating individuals with different biological realities and abilities into society. Disability is not seen as an attribute or defect of an individual, but as caused by the reaction of society towards the biological reality of the individual.

Disabled people can opt to see their biological reality as a variation of being (on a par with "non-disabled people") not in need of "fixing", but in need of having the physical environment, their interaction with the physical environment, and the societal climate changed to accommodate their biological reality (e.g. by giving wheelchairs to amputees and making the physical environment wheelchair accessible) and to improve their social wellbeing.

What kinds of NBIC products are envisioned for disabled people?

"For the deaf, we will have systems that provide subtitles around the world. We're getting close to the point where speaker-independent speech recognition will become common. Machines will create subtitles automatically and on the fly, and these subtitles will be a pretty accurate representation of what people are saying. We will have listening systems that allow deaf persons to understand what people are saying. For blind people, we actually will have reading machines within a few years that are not just sitting on a desk, but are tiny devices you put in your pocket. You'll take pictures of signs on the wall, handouts at meetings, and so on. You will be able to wear one on your lapel and scan in all directions. These



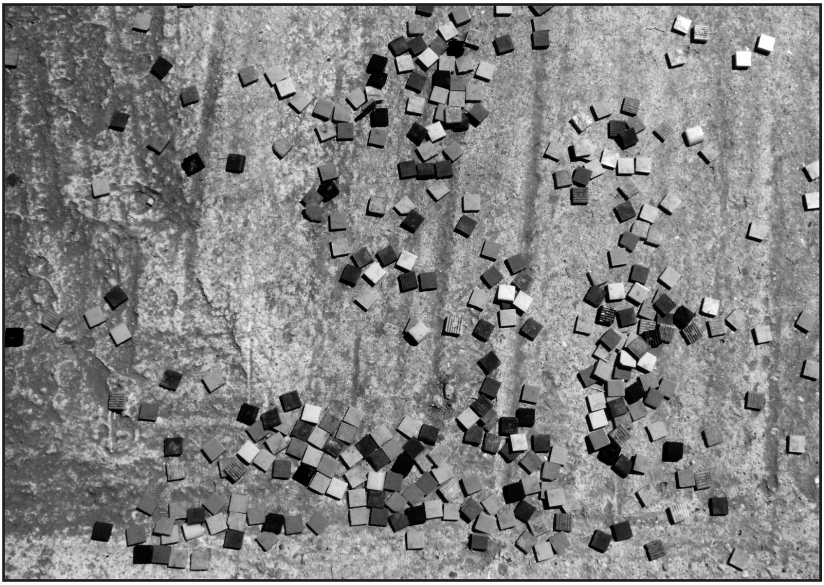
devices probably will be used by the sighted as well, because they will allow us to get visual information from all around us. Such devices also will translate the information from one language to another for everyone."[24]

"One outcome of combining nanotechnology with biotechnology will be molecular prosthetics — nano components that can repair or replace defective cellular components such as ion channels or protein signaling receptors. Another result will be intracellular imaging, perhaps enabled by synthetic nano-materials that can act as contrast agents to highlight early disease markers in routine screening. Through self-delivered nano-medical intervention, patients in the future will be able in the comfort of their homes to perform noninvasive treatments autonomously or under remote supervision by physicians."[25]

Science has demonstrated that human thoughts can be converted into radio waves and used by paralyzed people to create movement. Unable to move, Matthew Nagle can play Tetris, draw and turn on the TV using the chip in his brain.[26] One team of scientists implanted miniature transmitters into the brains of terminally ill people suffering from degenerative conditions that rendered them unable to communicate. Their thoughts alone enabled them to create movement. It was said: "Ultimately the technology will be used for people whose spinal cords are destroyed in accidents or those handicapped by strokes."[27]

As of 2000, more than 20,000 people worldwide had bionic ears. Australian researchers found that injecting recombinant nerve growth factor into the inner ear could stimulate nerve fibres to regrow. The market for cochlear implants is already well established, although some problems with the technology remain. These include interference with strong magnetic fields, and the risk of infection, eczema or dizziness. Nanotechnology can be applied in antimicrobial coatings on hearing aids including cochlear implants.

Retinal implants are being developed partially to restore sight for blind patients suffering from diseases which destroy the photoreceptor cells of the retina at the back of the eye,



but leave the visual nerve and visual cortex intact. Since the late 1990s there have been at least two fundamental retinal implant research projects in the USA and a further two in Germany, funded by the Federal Ministry for Education and Research.

Many companies are working on bionic legs. A robotics company has created a bionic limb that allows an amputee to walk and climb stairs with natural motion. About 8% of the estimated 387,500 amputees in the United States are those that have lost their arms. The potential market is huge: roughly 260,000 people undergo lower-limb amputations in the USA each year. The number of implants in use indicates their importance to health care and the economic impact of the biomaterials industry. For example, it was estimated that 170,000 people worldwide received artificial heart valves in 1994.

Science and technology, disabled people and transhumanism

The transhumanist model/transhumanist determinant combination is seen by an increasing number of disabled people as a valid solution for two reasons. One is that the medical model views disabled people as deficient in relation to non-disabled people. Another is that many disabled people do not feel that society will ever accept them for who they are and will never provide the "social cures" needed. In their eyes the transhumanist model allows disabled people to seek out transhumanist solutions without feeling inferior to so-called non-disabled people and without having to wait for social cures.

John Hockenberry a paraplegic journalist states in Wired magazine:[28]

"We live at a time when the disabled are on the leading edge of a broader societal trend toward the use of assistive technology. With the advent of miniature wireless tech, electronic gadgets have stepped up their invasion of the body, and our concept of what it means and even looks like to be

human is wide open to debate. Humanity's specs are back on the drawing board, thanks to some unlikely designers, and the disabled have a serious advantage in this conversation. They've been using technology in collaborative, intimate ways for years - to move, to communicate, to interact with the world."

Many see 'disabled/impaired' people as a natural fit for transhumanism and as paving the way for transhumanist philosophies and developments. James Hughes, executive director of the World Transhumanist Association, states:

"The healthy and able-bodied systematically underestimate the quality of life of the technology-dependent disabled. The able-bodied blithely say such things as, "Oh, I'd never want to live hooked up to a machine like that," only to discover that life is still pretty sweet in a wheelchair or with a breathing machine. Transhumanism, on the other hand, argues that we can and should all live better lives in the future through technological enhancement. Although few disabled people and transhumanists realize it yet, we are allies in fighting for technological empowerment."[29]

To quote George Dvorsky a leading non-disabled transhumanist:[30]

"No, this particular prosthetic barely resembled a human arm, looking more like something out of a Terminator movie. It was robotic, sleek and very high tech. In fact, I think I was jealous. Compared to a natural human arm, however, it did lack in functionality and grace. Still, just looking at it made me realize that it won't be long before future prostheses, for all intents and purposes, will be better than my biological appendages. And what's more, the disabled will in all likelihood be encouraged to try out the latest models, to experiment with the latest in prosthetic neural interfacing and advanced cybernetics. Those in the handicapped community tend to be more willing to accept people in various forms and to be more open in their ideas about what it means to be 'normal', or even human. And as the disabled are discovering, when it comes to prostheses and other assistive devices, the sky's the limit; they no longer feel compelled to mimic the

human form. For the handicapped, the impetus towards 'human normalization' is as irrelevant and useless a notion as it is offensive. Indeed, the disabled are no longer accepting the limitations of the 'normal' human body. They are truly bridging the gap between the biological and the mechanical, the human and the posthuman."

George Dvorsky has this to say:

"*Interestingly, many in the disabled community will choose to be willing test subjects; many have nothing to lose and are eager to try out the latest innovations -- if not for themselves, certainly for those in the disabled community who will follow after them... And as the disabled courageously experiment with their bodies and strive to overcome the injustices and indignities of their disabilities, they will subsequently reinvent themselves for the future. They will be undaunted and unfazed by their departure from human morphology and functionality, while the rest of humanity will watch and take inspiration. And then play catch-up.*"[31]

The Ascender Alliance is a transhumanist organisation whose primary motivation is the discussion of the cybernetic augmentation of the human species but, principally, to be an organisation for disabled transhumanists. The manifesto of the Ascender Alliance clearly indicates a misfit with the transhumanist agenda:

"*Technology exists now, and in the future, to enable us to achieve one hundred percent of our potential and even beyond... We have as much right to see the future; we have equal rights to plan our future. Our lives are as valuable as everyone else's. We may have limitations; some of us have overcome them, and others have not. But that does not mean that we should be terminated, bred out and institutionalized. At the same time it is our right to remain as we are, we should not have to change to suit anyone but ourselves. We understand why some DMP (disabled member of the public) are satisfied the way they are and respect their wishes; we support no program of forced normalcy but expect other DMP to understand and respect our wishes. Ascenders do not advocate any program that 'cuts out' any* *proportion of humanity, as would be the case with eugenics and other selective breeding programs. An Ascender needs only the will to improve them selves... An Ascender realizes the potential power of genetic engineering; but we feel that small genetic elite should not control society or dictate the future course of the species. We seek to improve life for all of humanity. Ascenders do not subscribe to the belief that what we believe to be the best course for society will be approved by future generations, hence the desire to limit the amount of irreversible genetic intervention. Moreover, no being should be forced to have superior physical and mental attributes; the right to self-determination begins even before conception. There is only one condition under which pre-natal manipulation is expectable; when it is necessary to repair life-threatening mental and physical deficiencies... We do not want a world were disabled people 'suffer' but it is time for the world at large to realize that a disability does not mean we have a lesser quality of life; disabled people have the same right to life as everyone else and the same rights to use new and emerging technologies to negate their disabilities if they see fit to do so. If we are to end disability, both in terms of the medical effect it has on those who have said disabilities and the way in which society hampers disabled people, it has to be on our terms and not by shedding the blood of innocent men and women.*"[32]

The above quotes contain a few key demands by the Ascender Alliance in regard to the use and development of science and technology:

a) The right for self-determination, which is interpreted to be extended to the pre birth stage and the future generation.

b) The prohibition of negative eugenics through e.g. prenatal de-selection

c) The prohibition of germ line genetic intervention

d) The prohibition of somatic genetic and non-genetic intervention of children and fetuses

e) As it is may be impossible to ensure that somatic manipulations will be confined to somatic cells and won't affect germ line reproductive cells point a) and c) might also mean the prohibition of somatic genetic intervention of adults

f) The prohibition of non-genetic interventions of children and fetuses

g) The acceptance of the right of adults to modify themselves through somatic genetic (may be) and non genetic interventions

The general message is twofold:

a) No one has the right to judge biological realities/characteristics of others independent of the stage of human development available for judging and prevent or change them based on that judgment.

b) Everyone has the right to change themselves as long as the changed abilities are available for everyone and are not transmitted to the next generation.

What should be done?

The inclusion of disabled people – whereby disabled people does not just mean disabled patients – in the governance of science and technology, health research, HTA and other assessments is essential for “disabled” and “non-disabled people” for many reasons. One is that increased emphasis on individualized interventions (medical model, transhumanist model of health) blurs the line between so-called disabled and non-disabled people. The health promotion field has to start involving disabled people actively on a broad scale for the good of disabled people and the health promotion movement. The goal of involving disabled people fits well with the language of all six health promotion conferences, with the recent statement by the Global Forum for Health Research at the conclusion of Forum 8 (Mexico City, 16-20 November 2004), the UN Convention on the Rights of Disabled People[33] (in preparation), many positive national legal advances[34] and suggestions in regard to disabled people in other international documents such as the final documents of the UNESCO World Conference on Science.[35]

A new health policy/research agenda is called for to address: a) the new understanding of disability; b) the needs of disabled people and other marginalized groups; c) the emergence of the transhumanist model of health and disease; and d) the increased medicalization / transhumanisation of human beings and their characteristics.

Using the framework a new research agenda can be developed. From the beginning, this work must actively involve disabled persons and other marginalized groups; their assessment of what they need to be healthy would inform the development of the research framework and the nature of the research questions.

Several core sets of questions would likely emerge. These include questions focused on:

· Identifying the nature of the problem.

· Probing for existing biases in existing policy, research and measurement instruments, and pointing to ways for removal of those biases.

· Identifying the determinants and co-requisites for health of disabled persons.

· Monitoring shifts in the understanding of health and disease.

· Measuring the impact of new technologies on the healt of disabled persons and other marginalised groups.

· How would the emerging and converging NBIC technologies be best used to increase maximum health -- in its fullest sense.

· How can research agendas for emerging and existing technologies be shaped to decrease rather than increase the 10/90 gap?

It will be crucially necessary to monitor and evaluate the governance of the entire research process and subsequent technological developments and the extent to which disabled persons and their values have informed them. Questions would probe for biases in the governance, monitoring and evaluation processes. They would point to ways to ensure that disabled people and other marginalized groups play an active role in the development and applications of research agendas and new technologies, in defining science and technology and health research questions, and in the decision-making regarding health, science and technology and health research priorities.

This work would be underpinned by the establishment of an ethical framework for conducting critical analysis and evaluation of emerging technologies - NBIC - actively involving disabled people and other marginalized groups to ensure that their rights are protected. A core part of the overall governance could be the establishment of a network of disabled and other marginalized people to provide guidance for shaping the policy and research questions, agenda and priorities and the most effective and equitable use of new emerging technologies on a local, national and global scale

A FRESH PERSPECTIVE ON ETHICS AND THEOLOGY

A revolutionary change with radical social and ecological implications

The ecumenical movement has been concerned about the meaning and impact of science and technology on the world and faith itself throughout modern ecumenical history. Sometimes, the ecumenical movement has affirmed the role of science and technology for modernisation and development, at other times it has raised a critical voice.

The modern technological revolution was celebrated as a contribution to solving the economic problems of production; appropriate technology was advocated for development in the "Third World"; ethical concerns were raised in the context of ecological destruction and social inequality. Recently, however, the convergence of advanced technologies such as nanotechnology, cybernetics, biotechnology and artificial intelligence is introducing revolutionary changes in industrial societies. This situation demands a fresh ecumenical quest seen from the perspectives of different social groups and God's concern for creation.

We have stated already that science and technology cannot merely be treated as tools, products and processes of human society. They have an impact on the entire earth; convergent technologies are becoming the "Engine of a New Creation" of the whole order of living beings. Together these new technologies are going radically to transform the whole order of "creation," even re-designing matter, living and non-living. Therefore, recent developments in science and technology must be seen from the holistic perspective of the "whole creation" or the entire earth community of all living beings from local realties to the cosmic. It is not enough to argue just from a limited human perspective and only for the human cause.

The future of the order of all living beings is not dependent only upon human choice, it will also depend on resistance and the possible reactions of all living beings, which are living subjects of earth community with a common destiny and purpose. In the garden of life of all living beings, humans are humble enough to learn how to live together in conviviality with other living beings as inhabitants of the garden of life, i.e. the ecumenical earth.

Such emphasis on conviviality among all living beings is present in the wisdom of local communities as well as in different religious and cultural traditions. In a similar way, wisdom arising from the experiences of suffering and the mutual vulnerability of living beings are teaching the human community the value of convivial living on earth. The life of all living beings cannot be treated only as a human-centred choice; the destiny of life cannot be left to the scientific and technological development trajectory, no matter how wise and ethical it may be. Industrialised civilisation and especially modern science and technology have been so human- centred that all living beings, including human beings, have become objects of manipulation often for human greed and power.

More reflection and research is needed for a new and fresh theological approach concerning these aspects of the "ecumenical earth" as the garden of life which all living beings share as living subjects, not as objects of human manipulation.

Radical social implications of convergent technology

Convergent technologies will radically transform the economy, politics, social relations and structures, and also cultural identities and values. This radical transformation can be compared to the impact of the first "industrial revolution." Traditional ethical codes and approaches may be insufficient, if not deficient, to deal with these issues. Already many people discern that the current ethical debates, e.g. regarding bioethics, are inadequate. What is needed is an integral ethics for conviviality of all living beings on earth. This is especially true concerning the very fact that with the new set of technologies, the life of all living beings and the relationship among them can be arbitrarily designed by human beings. The age-old boundary between living beings and matter or "non-living beings" is increasingly blurred and permeated. Both dimensions are becoming more and more integrated. They will be re-designed according to human scientific imagination. Such developments intend to surpass the limits of natural life. This may entail the vision of an entirely newly designed and recreated order. Convergent technologies, indeed, are pushing the natural limits of life and the natural order in the interests of "improving" life itself.

The messianic vision of "technopia"

The common arguments advanced in favour of converging technologies revolve around the issues of global economic growth, health, human rights, and ecological management. Like all new technologies throughout history, convergent technologies are presented as a cure for societal evils associated with prior technologies especially in terms of improving the lives of the poor and marginalized. Yet, all prior technologies have had their downside, making it very doubtful that the new technologies are capable of delivering what they promise.

Those promoting convergent technologies promise solutions to economic, medical and social problems such as hunger, poverty, disease, violence, and even ecological disaster. Their claims include enhancement, improvement, and artificial redesigning of the created order of "living beings" and their social and ecological relationships. Design, engineering, invention and even creation of artificial living organisms or synthetic bio-organic agents all contribute to the vision of "technopia" – the technological utopia. The US New Science Foundation in commenting on the potentialities of converging technologies in improving human life promises:

"The twenty-first century could end in world peace, universal prosperity, and evolution to a higher level of compassion and accomplishment. It is hard to find the right metaphor to see a century into the future, but it may be that humanity would become like a single, distributed and interconnected 'brain' based in new core pathways of society. This will be an enhancement to the productivity and independence of individuals, giving them greater opportunities to achieve personal goals."[36]

The US Undersecretary of Commerce for Technology, Phillip Bond. described the tiny tech's potential as:

"Truly miraculous: enabling the blind to see, the lame to walk, and the deaf to hear; curing AIDS, cancer, diabetes and other afflictions; ending hunger; and even supplementing the power of our minds... nanotechnology will deliver higher standards of living and allow us to live longer, healthier, more productive lives. Nano also holds extraordinary potential for the global environment through waste-free, energy efficient production processes that cause no harm to the environment or human health."[37]

The new technologies are presented as the messiah that will save the world from the current crises of hunger, disease, and ecological disasters. Faith in technology, which promises immortality, becomes real. Yet, the idea of immortality through technology, even if it were possible, is based on a distorted view of life. Within a framework of interconnectedness and interdependence of all matter, physical death is really not death but rather a process of life. How can disorderly design that is not fully understood by its human designer hope to replace God's design?

In case such blasphemous thinking may not be acceptable to those who are critical of science and technology, proponents of converging technologies also justify them from new ethical perspectives. As in traditional ethics, justice and freedom are central to ethical behaviour, so they also concentrate on these values. To be able to do so, they reinterpret ethical principles in order to justify their actions. They adopt new meanings to such concepts as "justice", "freedom", "person", "health", and "life" and tend to reduce ethics to "cost-benefit" analysis in a utilitarian framework. This reconstruction of ethics makes it functional in terms of meeting the needs of its designers, the powerful, but it makes it dysfunctional with regard to the pursuit pursued of holistic development.

Re-assessing our faith tradition

This situation presents churches and faith communities with the challenge of reassessing faith and ethics and liberating them from abuse. Faith and ethics are theological issues that necessarily begin with the recognition of God as Designer, Creator, Sustainer, Purpose, and Destiny of all creation. This means that authentic theological ethics begins from a clear understanding of God's will and design for all creation as a community.

In reassessing interconnectedness faith and ethics, churches and faith-based communities must deeply engage with social reality and provide a social critique of converging technologies. Moreover, they need to de-centre discourse to listen to one another as well as to the wisdom of the poor, such as women, disabled, Indigenous peoples, and local communities because such wisdom may deliver the earth from imminent destruction (Eccl. 9: 15-18). Real security lies not in the wealth associated with science and technology but in wisdom. Indeed to find wisdom is to find life and to obtain favour from the Lord (Proverbs 8: 35, 2: 1-11).

Traditional African societies, for instance, present great wisdom in their understanding of human life as life in community not just in harmony with other human persons but also with all elements of creation. This may be compared to the natural law tradition and justice-as-solidarity. As far as Africans are concerned, natural law, articulated by African sages (wise men) handed down orally from one generation to the other, is the only law that safeguards all in community. John S. Mbiti sums up the entire African moral philosophy, in the famous statement: "I am because we are and because we are I am."[38]

For traditional Africans, the existence of individuals makes sense only in the context of society and with the rest of creation. Indeed among Africans, even inanimate things are considered to have power, which can be either constructive or destructive depending on human attitudes and behaviour. Therefore, in an ideal African situation, the family together with its entire immediate environment is the smallest unit of analysis of the needs, hopes, aspirations, challenges, opportunities, and threats of individual persons, social groups, communities, and nations. Suffice to mention that the African family is made up of not just the present generation but also the past generation, from whom all in community has been handed down, and the future generation, for whom everything is held in trust. Hence the concept of ownership among traditional Africans entails responsibility in stewardship.

Ethically this means that the morality of an act is determined by its impact not just on the individual moral agent but also on the entire world community. This compares with the Christian principle of love which calls for "solidarity with all members of the human family, with special attention to the needs of those who unable to participate fully in the life of the community."[39] This explains why traditional Africans have institutionalized structures to take care of the needs of the less fortunate in society.

Within this understanding humans recognise that they have common destiny not just with fellow humans but also with all other elements of creation. Therefore, they have mutual responsibility and mutual commitment to exercise justice for all. The logic and experience behind this understanding is that all things, be they living or not, are interconnected and interdependent. This means that to be unjust to any element of creation is to be against life including one's own life.

Discerning the presence of the God of life

In liberating the integrity of ethics from abuse by proponents of new technologies, churches need to understand and expose the symbiotic relationship between religious, political and technological power in perpetuation of unjust structures and practices. The major sin committed by the Israelites throughout their salvation history is idolatry of human power in its different forms. A vivid presentation of such idol worship is presented in Exodus 32. Moses, the people's leader went up the mountain to pray and meet God for guidance on His will for the people. He took so long that the people were anxious about both divine and human leadership gaps that the event created. So they turned to Aaron who temporarily took leadership in the human sphere. The people then beseeched Aaron to help them fill the divine leadership gap in creating a golden calf, to which they bowed down in worship.

Unlike for the Israelites, modern gods are not golden calves. They are much more complex, and much more exciting. They are subtle, yet very powerful, less obvious yet much more tempting than the golden calf. They entice people to forget God and seek satisfaction and fulfilment in them. In a similar way, the attraction by science and technology is an expression of the three interrelated temptations of power, property and prestige that are at the centre of sin as illustrated in the Gospel passage on the temptations of Jesus (Luke 4).

Against this background, churches are challenged to engage in a profound critique of convergent technologies thereby exposing who the main actors in the struggle for various forms of power are and at whose expense. This would form the basis for resistance and change. Further, they are challenged to examine how new technologies erode the value of sharing against the modern demands of consumerism and materialism associated with new technologies. Beyond this churches have to renew ethics so that the principle of solidarity/sharing in community towards a common purpose and destiny may be integrated with the Christian principle of love (agape) to become the general principle for all relations in the world community. This transformation of ethics would be part of a process to restore justice and consequently wholeness of life through God's grace (Romans 3: 1-11).

Politics of Life

Such an ethics needs to be translated into a politics of life with the aim of overcoming the oppression of living beings and of establishing their subjecthood, so that they may realise their destiny and the abundance of life. Political sovereignty is not merely for human beings, but in the final analysis entails the convivial sovereignty of all living beings.

Theologically speaking, the politics of Jesus against the Roman empire is the politics of new life on earth. The Book of Revelations describes this politics of life as the messianic politics of the garden of life of the new earth under the new heaven (Rev 21 f.). In this perspective, a politics of life is the art of living together as a community of life on earth, locally, nationally, and globally. It includes justice, participation, peace and conviviality in the community of all living beings. Its horizon is portrayed as a fiesta of life in all the different dimensions: ecological, geo-political, socio-economic, and cultural and spiritual.

Convergent technologies are used to control and manipulate living subjects and their participation in the community of life. A politics of life resists any reduction of life to mere objects or into fragmented parts. It resists at all levels every form of power, which would destroy living beings and their community. This involves the political struggle of all living beings at all levels, which are already dynamically moving in the midst of their suffering, pain and death.[40]

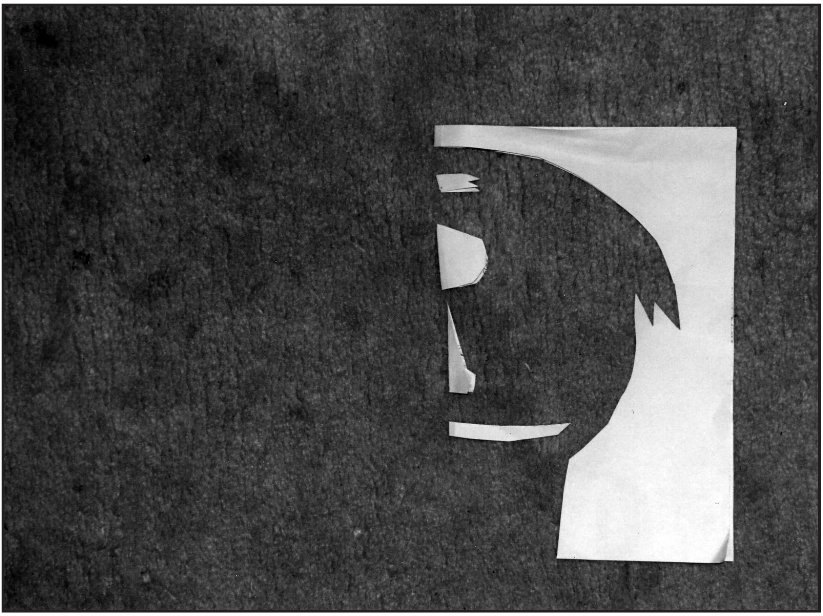
A politics of life has distinctive characteristics:

- All living beings are seen as political subjects of life. Institutionalising the rights of living beings as subjects may be one of the key elements in developing it.

- It supports the oikonomia of the community of living beings at local, national and global levels, but it gives primacy to the local community of life.

- It realises justice among all living beings in the form of eco-justice as an outer framework of social justice. It integrates social and ecological justice as one order of life.
- It is the art of creating the fiesta de la vida, the feast of life, among all living beings There is experience of beauty, style, dignity and spiritual mystery in the celebration of life.
- It fosters a network of sharing among living beings and for communication.
- It creates and sustains peace and justice, overcoming violence and wars.
- It builds creative and just relations among all living beings on earth.

These characteristics point to an active engagement in the transformation of this world, not according to the choices offered by science and technology as we know them today, but informed by the Biblical tradition that portrays God as the giver and lover of life who is ready to share in the pain and suffering of all living beings (Rom 8, Phil. 2) in order to transform this world and to liberate it from the consequences of sin through grace.



Endnotes

[1] Converging Technologies for Improving Human Performance (June 2002). NSF/DOC-sponsored report, ed. by Mihal C. Roco and William Sims Bainbridge, pp. 1-2. The report is controversial because it assumes that the products of convergent technologies are universally beneficial and ethically neutral.

[2] Jeremy Rifkin, The Biotech Century: How Genetic Commerce Will Change the World (London: Phoenix, Orion Books Ltd., 1998, p. 85).

[3] Leah Eisenberg, 'Medicating Death Row Inmates So They Qualify For Execution', Case in Health Law, Vol. 6, No. 9, September 2004.

[4] Declaration Toward a Global Ethic, III.1.D. Parliament of the World's Religions, 4 September 1993.

[5] 1. Information and Communication Technologies, Poverty and Development: Learning from Experience, by Kerry S. McNamara. Background paper for the infoDev Annual Symposium, 9-10 December 2003.

[6] Finn Bowring, Science, Seeds and Cyborgs: Biotechnology and the Appropriation of Life (London: Verso, 2003, p. xi).

[7] Environmental Protection Agency [OPPT-2004-0122; FRL-7700-7] Nanoscale Materials; Notice of Public Meeting. On the Internet: http://www.epa.gov/fedrgstr/EPA-MEETINGS/2005/May/Day-10/m9324.htm.

[8] Natural Resources Defense Council (NRDC) and others comment on EPA proposal to regulate nanomaterials through a voluntary pilot program, Docket ID: OPPT–2004–0122, 9 June 2005. On the Internet: http://www.environmentalobservatory.org/library.cfm?refid=73094.

[9] Fabio Salamanca-Buentello, Deepa L. Persad, Erin B. Court, Douglas K. Martin, Abdallah S. Daar, Peter A. Singer, "Nanotechnology and the Developing World," April 12, 2005, on the Internet: http://medicine.plosjournals.org/perlserv/?request=get-document&doi=10.1371/journal.pmed.0020097#JOURNAL-PMED-0020097-ST001.

[10] On nanotechnology and the UN Millennium goals, see Calestous Juma and Lee Yee-Cheong, lead authors, "Innovation: applying knowledge in development," UN Millennium Project Task Force on Science, Technology, and Innovation 2005, p. 69 ff., available on the Internet: http://bcsia.ksg.harvard.edu/BCSIA_content/documents/TF-Advance2.pdf.

[11] William J. Broad, "With a Push From the U.N., Water Reveals its Secrets," New York Times, July 26, 2005, p. D1.

[12] Royal Society and Royal Academy of Engineering, Nanoscience and Nanotechnologies: Opportunities and Uncertainties, July 2004.

[13] The North-South Dialogue on Nanotechnology: Challenges and Opportunities, 10-12 February 2005, Trieste, Italy, was sponsored by the International Centre for Science and High Technology (ICS), part of UNIDO (United Nations Industrial Development Organization).

[14] Opening Address By The Minister Of Science And Technology, Mr Mosibudi Mangena, Minister Of Science And Technology at a Project Autek Progress Report Function, Cape Town International Convention Centre, 8th February 2005. On the Internet: http://www.dst.gov.za/news/speeches/minister/project_autek.htm.

[15] Mark A. Lemley, William H. Neukom Professor of Law, Stanford University, "Patenting Nanotechnology," unpublished manuscript sent to ETC Group by the author, March, 2005, p. 20.

[16] From a speech by Lila Feisee, available on the Internet (as of June 2, 2004): http://www.bio.org/speeches/speeches/041101.asp.

[17] Steve Maebius, "Ten Patents that Could Impact the Development of Nanotechnology," an article appearing in Lux Research, Inc., The Nanotech Report 2004, p. 242-247.

[18] Carsten Fink and Carlos A. Primo Braga, "How Stronger Protection of Intellectual Property Rights Affect International Trade Flows," in IP and Development: Lessons from Economic Research, World Bank, January 2005, p. 34. On the Internet: www.worldbank.org/research/IntellProp_temp.pdf

[19] Rodney Brooks, "The Merger of Flesh and Machines," The Next Fifty Years: Science in the First Half of the Twenty-First Century, ed. by John Brockman, 2002, p. 191.

[20] Ibid.

[21] Anonymous, "Futures of artificial life," Nature, Vol. 431, 7 October 2004, p. 613.

[22] World Council of Churches Leader Says Life "Not a Commodity" by Steven Ertelt LifeNews.com Editor August 29, 2003; http://www.prolifeinfo.com/intl18.html.

[23] World Council of Churches Press Release 03-29.02e 27 August 2003 CENTRAL COMMITTEE 02 Raiser outlines need for new configuration of ecumenical movement; http://www.districtnet.org.uk/news/wcc/2003/august2003/07.htm.

[24] Kurzweil a futurist who developed the braile machine and the flatbed scanner envisions the following products <http://www.kurzweilai.net/articles/art0595.html>?printable=1.

[25] IMPROVING HUMAN HEALTH AND PHYSICAL CAPABILITIES THEME C SUMMARY Panel: J. Bonadio, L. Cauller, B. Chance, P. Connolly, E. Garcia-Rill, R. Golledge, M. Heller, P.C. Johnson, K.A. Kang, A.P. Lee, R.R. Llinas, J.M. Loomis, V. Makarov, M.A.L. Nicolelis, L Parsons, A. Penz, A.T. Pope, J. Watson, G. Wolbring

page 180 in the book version; Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology and Cognitive Science <http://wtec.org/ConvergingTechnologies/ and edited by Mihail C. Roco National Science Foundation, Arlington, VA, USA William Sims Bainbridge National Science Foundation, Arlington, VA, USA Kluwer Academic Publishers, Dordrecht Hardbound, ISBN 1-4020-1254-3 April 2003.

[26] Implant could free power of thought for the paralyzed 9 October 2004 Source: The Boston Globe By RAJA MISHRA <http://www.wireheading.com/misc/implant.html>.

[27] Sunday, 15 December 2002 10:47 The Sunday Times · www.sunday-times.co.uk · CYBORG IMPLANTS BRING NEW HOPE TO PARALYSED <http://www.bnn-online.co.uk/news_datesearch.asp?SearchDate=15/Dec/2002&Year=2002.

[28] 9.08 | Aug 2001 The Next Brainiacs This is the story of the most fearless entrepreneur ever: the human brain. <http://www.wired.com/wired/archive/9.08/assist.html>?pg=1&topic=&topic_set= .

[29] Battle Plan to Be More than Well Transhumanism is finally getting in gear By James Hughes 6/3/2004 1:38 PM <http://www.betterhumans.com/Features/Columns/Change_Surfing/column.aspx?articleID=2004-06-03-1.

[30] And the Disabled Shall Inherit the Earth Uninhibited about technological modification, they’re poised to be the first posthumans By George Dvorsky 9/15/2003 9:10 AM <http://www.betterhumans.com/Features/Columns/Transitory_Human/column.aspx?articleID=2003-09-15-2> .

[31] And the Disabled Shall Inherit the Earth Uninhibited about technological modification, they’re poised to be the first posthumans By George Dvorsky 9/15/2003 9:10 AM <http://www.betterhumans.com/Features/Columns/Transitory_Human/column.aspx?articleID=2003-09-15-2> .

[32] <http://groups.yahoo.com/group/Ascender_Alliance/files/ASCALLI-14JAN02-DISABLED%20CYBORGS.doc.

[33] Ad Hoc Committee on a Comprehensive and Integral International Convention on the Protection and Promotion of the Rights and Dignity of Persons with Disabilities <http://www.un.org/esa/socdev/enable/rights/adhoccom.htm> <http://www.bioethicsanddisability.org/dislawstatistic.html>.

[34] <http://www.bioethicsanddisability.org/dislawstatistic.html>.

[35] <http://www.unesco.org/science/wcs/; DECLARATION ON SCIENCE AND THE USE OF SCIENTIFIC KNOWLEDGE paragraph 25,34 and 35 <http://www.unesco.org/science/wcs/eng/declaration_e.htm> SCIENCE AGENDA-FRAMEWORK FOR ACTION paragraph 17, 79, 81, 91 <http://www.unesco.org/science/wcs/eng/framework.htm>.

[36] NSF/DOC, Converging Technologies for Improving Human Performance.

[37] Remarks by Phillip J. bond, Under Secretary of Commerce, Delivered September 9, 2003 to the World Nano-Economic Congress, The Fairmont Hotel Washington, DC. http://www.technology.gov/speeches/pPJB 030909.htm.

[38] John S. Mbiti, African Religions and Philosophy, (Nairobi: Heinemann, 1969).

[39] Marriane Sheahan, “The Tragedy of Abortion from the Perspective of the Roman Catholic Tradition of justice- as- solidarity in the United States”, 50.

[40] J. Rifkin, BIOSPHERE POLITICS . A Cultural Odyssey from the Middle Ages to the New Age, New York: Crown, 1991.

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