KNOWLEDGE POLITICS AND NEW CONVERGING TECHNOLOGIES: A SOCIAL SCIENCE PERSPECTIVE

Work Package 1

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CONTENTS

1. The Converging Technologies Agenda: The Stakes and the Prospects

There is an ongoing struggle between the US and EU to define the direction given to the idea of 'converging technologies (CT) for improving human performance', to recall the title of the influential 2002 report co-authored by Mihail Roco and William Sims Bainbridge, both at the National Science Foundation, the former an engineer in charge of nanotechnology research initiatives, the latter a sociologist in charge of the NSF social informatics unit.[2] All indications are that the US is winning this struggle, at least at the level of ideology. In other words, the US spin on the meaning given to the CT agenda is influencing science and technology policy worldwide. However, it remains to be seen whether this palpable change in policy discourse results in long-term substantive changes in science and technology itself.

The CT agenda may be new in its explicitness but not in its inspiration. It is worth recalling part of the founding policy statement of the Rockefeller Foundation from 1934 that laid the basis for funding on both sides of the Atlantic for what by the 1950s had become the revolution in molecular biology:

> Can man gain an intelligent control of his own power? Can we develop so sound and extensive a genetics that we can hope to breed, in he future,

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[1] Professor of Sociology. University of Warwick, Coventry CV4 7AL, UK. E-mail: s.w.fuller@warwick.ac.uk. This narrative is also informed by the following interviews conducted by Fuller from October 2006 to November 2007: Dr Mihail Roco (US NSF director of nanotechnology initiatives: 1 phone and 1 face-to-face, total 3.5 hours), Dr Ronald Kostoff (US Office of Naval Research, chief scientometrician), Dr Anders Sandberg (neuroscientist and transhumanist advocate, Oxford University), Prof Max Lu, 2 graduate students and 2 postdoctoral researchers (Australian Research Centre for Functional Nanomaterials, University of Queensland), Dr Howard Cattermole (editor, *Interdisciplinary Science Reviews*, journal of the UK Royal Institute of Materials Sciences), Prof. V.V. Krishna (chair of the Centre for Studies in Science Policy, Jawaharlal Nehru University, New Delhi). Fuller also discussed topics related to this report with those in attendance at the second annual meeting of social science partners associated with the US NSF-led CT initiative, which was held at Arizona State University on 19-21 April 2007, courtesy of Prof David Guston (director of the Center for Nanotechnology in Society).

[2] Mihael Roco and William Bainbridge, eds. (2002) *Converging Technologies for Improving Human Performance: Nanotechnology, Biotechnology, Information Technology, and Cognitive Science*, NSF/DOC-sponsored report, Arlington VA.

> superior men? Can we obtain enough knowledge of physiology and psychobiology of sex so that man can bring this pervasive, highly important, and dangerous aspect under rational control? Can we unravel the tangled problem of the endocrine glands…Can we solve the mysteries of various vitamins…Can we release psychology from its present confusion and ineffectiveness and shape it into a tool which every man can use every day? Can man acquire enough knowledge of his own vital processes so that we can hope to rationalize human behaviour? Can we, in short, create a new science of Man?[3]

If we set aside the somewhat dated preoccupation with sex, glands and vitamins, the rhetoric could have from the 2002 NSF document. In particular, the author of the 1934 statement, Warren Weaver, envisaged the field he coined as 'molecular biology' to be fixated on the phenomena of life at the edge of quantum indeterminacy but still within the range of classical mechanics. Thus, we should come to make very fine-grained positive interventions into organisms without adversely disrupting their systemic functions. This is precisely where the magic of nano-biotechnology is supposed to lie today.

To be sure, the Rockefeller Foundation and the NSF have operated under somewhat different sociological conditions. Weaver was inclined to treat the still novel Heisenberg's Uncertainty Principle as a temporary barrier to human mastery of microphysical reality rather than an insurmountable limit to our understanding of nature. His encouraging the flow of physicists and chemists into biology was designed to demonstrate that point. In contrast, while the NSF document's principal author, Mihail Roco, may harbor similar views, a more pressing policy concern is the decline in employment prospects and, more recently, academic enrolments in physics and chemistry, in light of post-Cold War shifts in scientific demand – and not only in the US. Science journalists have been especially sensitive to this 're-branding' exercise. Consider this analysis: [4]

> In March [2003], the Royal Institution (RI) in London hosted a day-long seminar on nanotech called "Atom by atom", which I personally found useful for hearing a broad cross-section of opinions on what has become known as *nanoethics*. [...] First, the worry was raised that what is qualitatively new about nanotech is that it allows, for the first time, the manipulation of matter at the atomic scale. This may be a common view, and it must force us to ask: how can it be that we live in a society where it is not generally appreciated that this is what chemistry has done in a rational and informed way for the past two centuries and more? How have we let that happen? It is becoming increasingly clear that the debate about the ultimate scope and possibilities of nanotech revolve around questions of basic chemistry [...]. The knowledge vacuum in which much public debate of nanotech is taking place exists because we have

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[3] Warren Weaver, quoted in Michel Morange, *A History of Molecular Biology* (Cambridge MA: Harvard University Press, 1998), p. 81.

[4] Philip Ball,.'Nanotechnology in the firing line'. http://www.nanotechweb.org/articles/society/2/12/1/1 23 December 2003. On the formalisation of nanoethics, see Ashley Shew, "Nanotechnology's Future: Considerations for the Professional" in Fritz Allhoff and Patrick Lin (eds.), *Nanoethics: Emerging Debates* (Dordrecht: Springer, 2008)**.** This article is based on the first systematic attempt at a code of professional conduct for nanotechnologists – Shew's 2005 BA thesis at the University of South Carolina, Alfred Nordmann's US academic base.

> little public understanding of chemistry: what it is, what it does, and what it can do.

In short, we may be living in a time when Weaver's ambitions are being revisited to good effect by CT, albeit in the spirit of regaining lost advantage and perhaps even lost collective memory of that advantage, all historic spurs to entrepreneurship.[5]

Returning to the present: What is at stake in the difference between the US and EU stances on the CT agenda? In a nutshell, the US strategy aims to leverage short-term practical breakthroughs in nanotechnology into a long-term basic research agenda in which nanotechnology would enable revolutions in biotechnology, information technology and, most ambitiously, cognitive science. This is encapsulated as the 'NBIC' vision of CT.[6] Underwriting this vision is the idea that 'nano' (i.e. a billionth of a metre) is the smallest manipulable level of physical reality that does not incur quantum indeterminacy. Molecular interventions at this so-called 'edge of uncertainty' can be directed to, say, clear the arteries, repair nerves, etc. Seen in their own terms, as developments within chemistry, these interventions are merely incremental improvements. But what matters are the research opportunities these improvements open up in other fields once they are applied. The sense of 'convergence' in CT here clearly implicates a general history and philosophy of science in which developments in nanotechnology act as a tipping point for revolutionary change across all of science and technology.

In contrast, the EU strategy discusses CT in more modest terms, allowing for multiple convergences amongst different disciplines. Indeed, it is ultimately less concerned with the future direction of science than on what Joseph Schumpeter meant by 'innovation', that is, the conversion of an invention to a successful market product. The background assumption here is that the scientific community does not provide sufficient incentive to exploit the full social and economic benefit of its new ideas. Under the rubric of CT, the EU proposes incentives to break down cross-disciplinary barriers to enable new ideas to be brought to market more effectively. At the same time, the EU sees itself in a more regulatory role. Where the US initiative calls on both the state and business to reinforce already existing trends in nanotechnology, the EU initiative is much more explicitly about the reorientation of scientists' behaviour from their default patterns to what the 2004 EU report edited by philosopher Alfred Nordmann called 'shaping the future of human societies'.[7]

What might be called the 'dark side' of the idea of convergence consists of research alternatives that are implicitly eliminated – what economists call 'opportunity costs' – as research trajectories are encouraged to come together. Here too we see a difference between the US and EU approaches. There are two general ways of conceptualizing this progressive elimination of alternatives: one involving *positive*, and the other *negative*, feedback loops. While there are examples of both types of feedback loops in the interviews and the policy documents, generally speaking, the US CT strategy is

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[5] Reuven Brenner, *Rivalry: In Business, Science, Among Nations* (Cambridge University Press, 1987).
[6] The strategy of funding longer term CT-oriented projects on the back of shorter term nano-based developments in materials science and chemical engineering was explicitly raised by Max Lu, director of the Australian Research Council Centre for Functional Nanomaterials at the University of Queensland. Roco sits on his advisory board, where they have cordial relations.
[7] Alfred Nordmann, ed. (2004) *Converging Technologies – Shaping the Future of Human Societies*. Brussels: European Commission.

given more to positive feedback loops, and the EU CT strategy more to negative feedback loops. In a nutshell the difference is as follows:

- *Positive*: Only certain strands of research provide increasing returns on investment, which in turn attract subsequent resources into those established paths. Policymakers see themselves here as simply adding forward momentum to convergences that, however tentatively, are already taking place.[8]
- *Negative*: Research futures are conceptualized here as much more open, which means that policymakers play a greater role in steering researchers in the direction of various desirable convergences that might not otherwise take place, actively discouraging, say, more traditional mono-disciplinary research.

The difference between feedback loops reflects the extent to which CT policymakers see themselves as moving with or against the default patterns of scientific inquiry. In many instances, this difference may turn out to be more of rhetorical emphasis in the formulation of policy statements. However, matters of substance may also be at stake.

CT through Positive Feedback Loops:

The US CT stress on positive feedback occurs on two levels: in terms of (1) the strategy used to chart NBIC advances; (2) US responses to those developments. Let us take each in turn.

1. The US government, largely through the initiative of Ron Kostoff at the Office of Naval Research, has invested significantly in 'literature-assisted discovery', which uses bibliometrics to chart rapidly expanding fields in order to anticipate the next stage in a research trajectory, which oneself or one's competitors may be better positioned to make.[9] The impetus for this investment has been the rapid growth of China's involvement in nanotechnology, making it the world's leader in terms of sheer quantity of published research. However, the quality of the research is still in question, at least as measured by the quality of the journals where that research is published. But that too is improving, as Chinese authors form an expanding portion of those publishing in Western nanotech outlets.[10] The US strategy is to keep constant the goals of CT in terms of 'improving human performance' but remain open-minded about the exact means by which science will serve those goals – that is, by whatever research trajectories happen to bear fruit, which in turn can be used to leverage further basic research. Implied here is a very strong faith in science's capacity to turn up something that will be to humanity's benefit.
2. The US appears willing to let the Chinese strike out in many different nanotech directions, while the US develops 'pipelines' to take maximum advantage of whatever breakthroughs are made. Two pipelines promoted by Roco at the NSF are particularly relevant: (a) The *Integrative Graduate Education and Research Traineeship Program* (IGERT), whereby Ph.D. students are subsidized to work on CT-related projects to counter the department-based allocation of scholarships for doctoral training, perhaps ultimately breaking down the default disciplinary basis

[8] W. Brian Arthur (1994). *Increasing Returns and Path Dependence in the Economy*. Ann Arbor MI: University of Michigan Press.

[9] Ronald Kostoff, Systematic Acceleration of Radical Discovery and Innovation in Science and Technology. DTIC Technical Report Number ADA430720 (Defense Technical Information Center, Fort Belvoir , 2005.) Available at: www.dtic.mil/

[10] Ronald Kostoff, 'Structure and Infrastructure of Global Nanotechnology Literature' *Journal of Nanoparticle Research*. 8 (2006): 301-321.

for the reproduction of academic knowledge.[11] At a cognitive level, IGERT aims to enable students to think in terms of CT at the outset of their career rather than be forced to synthesize different disciplinary agendas later. A suggested consequence of IGERT is that the next generation of scientists will be more instinctively sensitive to market-driven concerns. (b) The *Industrial Research Initiative* (IRI), whereby US companies develop 'CT platforms', i.e. research capabilities that allow for speedy development of new NBIC-based products.[12] Roco contrasts this 'fast but focused' view of CT's future with that of the more 'science fictional' approach associated with Drexler and Kurzweil. For example, IBM and Intel are investing in CT to find cheaper substitutes for the current electron charge basis of information transmission

These pipelines are to be facilitated by increased national funding (perhaps with matching corporate sponsorship) for research designed to 'reverse engineer' the brain to enable the more efficient uptake of new knowledge by the appropriate sensori-motor modalities and cognitive faculties. Financial matters aside, the main obstacles to making advances in these areas may be more ethical than technical: i.e. potential so-called enhancement technologies will probably develop faster than public willingness to test and use them. But let us suppose the pipelines proceed as planned. One negative unintended consequence may be major short-term economic dislocation (i.e. unemployment, company closures, investment losses, loss of productivity), as nanotechnology becomes a 'general purpose technology' (GPT) whose innovative and improving cross-sector pervasiveness effectively restructures the entire economy. Such a system realignment occurred in the 1970s and 1980s as information technology became a GPT. However, at this point the evidence is inconclusive, especially since so much nanotechnology simply extends research in existing fields under a different rubric.[13]

CT through Negative Feedback Loops

On the negative feedback side, consider the European Commission communication, 'Nanosciences and Nanotechnologies: An action plan for Europe, 2005-2009' ('NN'), opens with the concern that European scientists are not sufficiently 'entrepreneurial' in the strict Schumpeterian sense of converting inventions to innovations, i.e. bringing their ideas to market. NN goes on to propose various measures to ease the commercialization of nanotech innovation, including the harmonization of patent standards and the monitoring and publication of innovation waves. NN also makes a

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[11] http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=12759. Israel and Australia have adapted to the IGERT scheme in contrasting fashion. On the one hand, Israel has wholeheartedly embraced the scheme by building entire universities around the CT agenda, and through the Talpiot scheme provide incentives for younger researchers to get involved in CT. On the other hand, Australia has taken a more nuanced line. Some CT-oriented interdisciplinary undergraduate and graduate programmes have been started but typically at typically lower ranked universities struggling with falling physics and chemistry enrolments, since the it is anticipated that students so trained will be best suited for the expanding labour market for lab technicians and research administrators, rather than front-line researchers.

[12] http://www.iriinc.org/. Roco remarked on a similar initiative in Nagoya, Japan.

[13] Jan Youtie, Maurizio Iacopetta, Stuart Graham, 'Assessing the nature of nanotechnology: can we uncover an emerging general purpose technology?' *Journal of Technology Transfer* (2008) 33:315–329. The original GPT study, based on IT, is Helpman, E., & Trajtenberg, M. (1994). 'A time to sow and a time to reap: Growth based on general purpose technologies'. *NBER Working Paper No. 4854*. Cambridge, MA: National Bureau of Economic Research.

larger and subtler move: It implicitly redefines 'scientific creativity' to mean the sort of mind that sees the commercial potential in new knowledge. Accompanying this definition is a general proposal for reforming science education to bring it closer to a business mentality that blurs the distinction between a university department and a corporate R&D division. While NN clearly aims to advance the CT agenda by counteracting scientists' default tendencies, some quite deep, it is unclear the extent to which these tendencies simply institutional or more personal.[14]

The original 2002 NSF report has had a demonstrable impact on the scholarly literature, decisively shifting the default meaning of the phrase 'converging technologies'.[15] The various EU responses, starting with Nordmann's 2004 report, have had much less impact, usually only as a critique of the original NSF report. A survey of the phrase in the titles, abstracts and keywords of publications included in the Web of Science and Google Scholar, revealed its pre-2002 occurrence mainly in two contexts. One was in the 'management information systems' and 'knowledge management' literatures, where CT pertained to the integration of information sources as a key to business efficiency in a time when an increasingly dispersed and mobile labour force made it harder for companies to retain the knowledge they had accumulated. The other context was multi-modal educational delivery systems that encouraged 'interactive' and 'distributed' learning regimes centred on student needs and interests. However, after 2002, the use of CT shifted to the scientific project envisaged in the NSF report, though often retaining some of the pre-2002 connotations. Thus, bioinformatics is now often highlighted as a knowledge management strategy for achieving CT, while CT-driven breakthroughs may enable more effective educational delivery systems that reflect and facilitate the brain's capacity to process information.[16]

Lurking beneath differences in formulation, the alternative US and EU versions of CT tap into radically different sensibilities that are somewhat occluded by euphemisms. In the US case, the phrase 'improving human performance' can be sharpened up to refer more explicitly to a project of enhancing individuals by making them – and their offspring – smarter, stronger, etc. This project presumes a sense of biological evolution that might be expedited to the overall benefit of the species by interventions at the level of individual species members. In the EU case, the phrase 'shaping future societies' suggests a more holistic and less invasive approach that focuses on enabling

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[14] Here too can see contrasting adaptations, in this case between Germany and India. On the one hand, very much in the spirit of NN has been Germany's Employee Discovery Law (2002). Formerly German academics were free to collaborate with industry, but afterward academics were treated as employees of the university, which formally owned the intellectual property. General acceptance of this shift in the legal status of the academic from civil servant to entrepreneur has been aided by a massive generational shift, as the '68ers' have made way for academics who have witnessed only increasing neo-liberalisation over the course of their careers. On the other hand, India recently adopted a version of the Bayh-Dole Act (see below in text) but in socio-political setting somewhat different from the US. By holding intellectual property rights, universities can increase their corporate autonomy not simply by becoming financially independent of the state but more importantly by laying claim to venture capitalist professors who currently take full advantage of their universities' resources while maintaining exclusive control over their profits.

[15] The most cited version of the report in the academic literature is Mihail Roco and William Sims Bainbridge, 'Converging technologies for improving human performance: Integrating from the nanoscale', *Journal of Nanoparticle Research*, 2002, **4**, 281-95.

[16] Albert Tzeng compiled the statistics on which my judgements are based. They are presented in **Annex …**

people to live more sustainable lives, where the state or some inter-state authority like the EU is seen as the protector of social equilibrium. In terms of contemporary ecological politics that I shall elaborate below, the US approach is *proactionary* and the EU approach *precautionary*.

However, both approaches contain ambiguities. In the US case these centre on the meaning of a term like 'improvement' or 'enhancement'. Is one referring here simply to systematically induced changes in, say, genetically controlled behaviour or neural circuitry, regardless of their results? Or does one also wish to imply that these changes are always, or even largely, beneficial? After all, a likely long-term consequence of a US-style improvement policy is an increase in people's willingness to make risky interventions at the genomic or neurophysiological level. But given the complexity of the contexts in which such interventions would play themselves out, their exact efficacy, let alone relative benefit vis-à-vis non-intervention, would be difficult to assess. Under the circumstances, an implicit goal of the US approach must be for people to see their bodies as sites of experimentation.

In the EU case, the ambiguities centre on its attitude towards 'marketisation'. On the one hand, the EU clearly wants to remove barriers to the promotion of CT-related innovations that have been erected within but also imposed on academic research. The former refers to the legitimation of inquiry on narrowly disciplinary terms, the latter to legal restrictions on the pursuit of intellectual property rights by public institutions. This is a problem that the US resolved by enacting the Bayh-Dole Act in 1980.[17] On the other hand, the EU clearly has a protective attitude towards the public destined to be exposed to the innovations unleashed in such a liberalised economic environment. It would seem then that increased openness to the marketing of innovative products is to be matched by increased monitoring and possibly control of their consumption. This is likely to result in conflicts in the legal system, as both producers and consumers each assert their enhanced sense of 'rights'. I shall suggest below that unlike the US, the EU retains a response mode characteristic of the first crisis of the welfare state as it tries to deal with the second one.

At the level of political economy, the CT agenda may be seen as a 'technological fix' for the second of two fiscal crises of the welfare state that has affected both sides of the Atlantic. The first fiscal crisis occurred in 1970s, with the increasing tax burden on individuals and businesses to finance wider state coverage of welfare needs. Because this problem was predicted to escalate as more countries reached the standards of living enjoyed by the developed world, calls were made to restrict population growth, via mass contraception and perhaps even some reintroduction of eugenics, especially in the developing world (though 'zero population growth' was portrayed as an ideal in the developed world). What is of interest here is that this technologically oriented solution diagnosed the problem, in Malthusian fashion, as one of *overconsumption*. However, in retrospect the end of the first fiscal crisis came

[17] The best account of the Bayh-Dole Act's origins and impacts on US academia is Daniel S. Greenberg, *Science for Sale: The Perils, Rewards, and Delusions of Campus Capitalism*. (Chicago: University of Chicago Press, 2007). Greenberg, perhaps the most venerable US science journalist, wonders why universities don't regard the products of their labour in a more commodified light – i.e. to their advantage as knowing best the value to place on their goods, given the opportunities open up by the Bayh-Dole Act.

not from the proposed technological fix but the weakening of welfare state coverage, in the name of 'neo-liberalism'.

The second fiscal crisis of the welfare state, dating from the 1990s, pertains to the anticipated financial burden on the pension system of people living longer after retirement. CT is relevant to this development, as it promises -- in both its US and EU guises -- a longer period of labour productivity, expanding the economy in general and deferring the need for individuals to draw on pensions. Note that this problem arises in the context of relatively stable, or stabilizing, population growth rates. This second fiscal crisis is diagnosed, in Ricardian fashion, as one of *underproduction*. This shift from overconsumption to underproduction is interestingly reflected in the role played by ecological considerations in each: In the former case, nature provides an ultimate irreversible barrier, resulting in a *precautionary* principle; in the latter, nature is a constraint that can be strategically manipulated, resulting in a *proactionary* principle.[18] Indicative of the latter position is the prospect that nano-machines might someday, and perhaps regularly, reverse the effects of industrial pollution in a 'cake and eat it' scenario. This helps to explain the attraction of the CT agenda in the rapidly industrializing economies of India and China.[19]

2. Defining 'Convergence' in Converging Technologies: Ontological Levelling

For technologies to converge, they must do something more than simply engage in 'synergy' or 'multi-', 'inter-' or even 'transdisciplinarity'. And while the convergence of technologies may produce 'emergent technologies', in the sense of innovations that could not have arisen without the convergence, technologies may also 'emerge' as by-products of the normal development of a single technology. In terms of these nuances, US policy documents are much more explicitly committed to convergence than the EU documents. In the EU context, extended collaboration between two disciplines counts as 'convergence'.[20] In particular, BIO + INFO and, more recently, NANO + BIO tend to be targeted as the pairs with the most research and development potential.[21] However, again unlike the US case, there is little talk of forward momentum towards a convergence of many disciplines in the promotion of some overarching goal. Instead the EU model seems to be based on a modified

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[18] On the proactionary principle, see Max More (2005). "The Proactionary Principle." http://www.maxmore.com/proactionary.htm. The idea is stronger than the Popperian reversibility of piecemeal social engineering because the idea is not merely to reverse a course of action that has already generated negative consequences but to undo those very consequences.

[19] This justified the widespread public enthusiasm for nanotechnology in India, a nation where 75% of the inhabitants still lack clean water and sanitation. However, if one regards anthropogenic industrial pollution as an eco-level disease, then nanobot-based solutions simply create the equivalent of a drug dependency. It also came up in the Austria interviews but with concerns about long-term side effects that will need to be closely monitored, like ambient radiation from nuclear reactors. See also Ronald Kostoff, et al., 'Assessment of China's and India's science and technology literature – introduction, background, and approach'. *Technological Forecasting and Social Change* 74 (2007): 1519-38.

[20] See, e.g. Wilhelm Bibel (ed.), 'Converging Technologies and the Natural, Social and Cultural World', Special Interest Group Report for the European Commission via an Expert Group on 'Foresighting the New Technology Wave' (26 July 2004), ftp://ftp.cordis.europa.eu/pub/foresight/docs/ntw_sig4_en.pdf

[21] In the case of India, it's just INFO + anything. See the report of the National Knowledge Commission: http://knowledgecommission.gov.in/recommendations/default.asp. In Israel, there is INFO + COGNO via linguistics.

'finalizationist' model, which presupposes that disciplines have reached a certain level of maturity that enables them to be steered toward collaboration for socially beneficial purposes.[22]

At the most basic level, the idea of converging technologies presupposes that multiple technologies are coming into increasing but also more focused interaction. The idea stops short of presupposing a specific target but it does contain the idea of an outer limit that somehow shapes the interaction. This point of definition is illustrated in three cases where 'convergence' has a specific meaning in the arts and sciences:

- In art history, linear perspective is defined as convergence in lines of composition towards a vanishing point on the horizon. The result is to give a sense of closure to a pictorial image that would otherwise appear open-ended and disorienting.[23]
- In the philosophy of nature, there is a theory of 'convergent evolution', derived from Jean-Baptiste Lamarck and associated with the heretical Jesuit paleontologist, Pierre Teilhard de Chardin. He predicted that, through increased interbreeding and other forms of communicative interaction, human biological differences would be overcome and we would end up turning the earth into a single 'hominised substance'.[24]
- In the philosophy of science, there is a theory of 'convergent scientific realism' associated with the US pragmatist Charles Sanders Peirce. His idea was that through a fallible process of successive approximation, scientists starting with disparate theories eventually arrive at an account of reality that commands the widest possible assent over the widest range of propositions.[25]

As the above examples illustrate, 'convergence' implies that formerly distinct lineages come to lose some, if not all, their differences in a moment of synthesis. This is much stronger than the simple idea that different disciplines share some things in common. For convergence, such commonality must also cause the disciplines to see their interests as more closely aligned, so that they come to orient their patterns of work to each other.

The recent history of the sciences most closely connected with the CT agenda offers some templates for the move to convergence.

- The development of X-ray crystallography in the 1940s first enabled the mass migration of physicists and chemists to biology, eventuating in the revolution in molecular biology associated with the discovery of DNA. The value of this technique was the clear visualization of phenomena it afforded, most popularly in the double helix structure of DNA. This in turn decisively shifted biology's intellectual center of gravity from the field to the laboratory, drawing together biology's disciplinary horizons with those of the physical

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[22] See Bibel, especially General Recommendation 6. On the original phase of finalization (basically the directed convergence of several fields in the state of advanced Kuhnian normal science towards the needs of the welfare state), see W. Schaefer, ed. *Finalization in Science* (Dordrecht: Reidel, 1983).
[23] On the difference that linear (vis-à-vis hyperbolic) visual pespective has made to the history of science, see Patrick Heelan, *Space-Perception and the Philosophy of Science* (Berkeley: University of California Press, 1983); Paul Feyerabend, *The Conquest of Abundance* (Chicago: University of Chicago Press, 1999).
[24] Pierre Teilhard de Chardin, *The Phenomenon of Man*, Harper & Row, 1961, pp. 238-42.
[25] On the history of this theory, see Larry Laudan, *Science and Hypothesis* (Dordrecht: Kluwer, 1981), chap. 14.

sciences. The physical scientists most attracted by this move also tended to be undeterred by the 'randomness' of nature, be it in the sense of quantum mechanics or genetic variation. [26] They treated life as essentially an engineering project. CT arguably attempts to repeat this movement by enabling people trained in physics and chemistry, fields now subject to declining enrolments and research funding, to migrate to 'nano-bio' fields.

- In the 1950s, a similar development occurred with respect to linguistics, formerly also an archive- and field-based subject based in philology and anthropology. Once a critical mass of data had been gathered on the world's languages, people trained in mathematics and the nascent field of computer science (often under the guise of 'information and communication theory') analysed the sound patterns and grammatical structure of utterances, first in purely statistical terms but later in the attempt to identify 'universal' formal properties. The seminal convergence moment here occurred when Noam Chomsky, one such a mathematically trained (and philosophically informed) linguist, turned the tables on his teacher Zellig Harris by arguing that mathematics could go beyond providing an analytic tool to reveal the 'deep structure' of language, the so-called universal grammar that by the late 1960s came to be associated with the still larger convergence of 'cognitive science'.[27]
- In the past half-century, computer simulation has become a lingua franca for an increasing number of scientific disciplines, enabling the translation and integration of phenomena gathered from disparate sources into a common 'virtual reality' that is projectible and manipulable along several spatial and temporal dimensions.[28] Perhaps the most notable site of convergence here has been bioinformatics, whose innovations in information storage and retrieval allow researchers to pool and share results relating to the testing of various molecular combinations for their biomedically relevant consequences. In this context, genetic information is treated as literally, not metaphorically, digital.[29]

All of these developments have served to remove traditionally discipline-based barriers to scientific communication. In that respect, they provide for one of the preconditions for convergence, namely, the intensification of researcher interaction. But they also point to a deeper sense of convergence: namely, disciplines are regarded more in discursive than ontological terms. In other words, they are distinguished more

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[26] Historians have argued that this migration represented the vestiges of 'biophysics', an ideal still represented in Erwin Schrödinger,'s 1943 Dublin Lectures, *What is Life? The Physical Aspects of the Living Cell* (Cambridge UK: Cambridge University Press, 1955); also Nicolas Rasmussen, 'The Mid-century Biophysics Bubble: Hiroshima and the Biological Revolution in America, Revisited.' *History of Science* 35 (1997): 245-91.

[27] Of the NBIC disciplines associated with CT, cognitive science has explicitly aspired to convergence amongst the various field-, archive-, lab- and computer-based disciplines associated with the study of thinking. However, it was also admitted by most interviewees to be farthest from convergence with the other disciplines.

[28] This use of the computer simulation as 'trading zone' for the interaction of different disciplines originated with the Monte Carlo simulations used in the design of the original atomic bombs. See Peter Galison, *Image and Logic* (Chicago: University of Chicago Press, 1987). For a knowing analysis of the political consequences of this development, see Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge UK: Cambridge University Press, 2002), pp. 351-355.

[29] See my Anders Sandberg interview; Robert J. Robbins, 'Information Management as Key to Human Genome Project' (1996), http://www.esp.org/rjr/cthsl.pdf

by the language they use than the reality they access. Thus, in various cases, the distinction between literal and metaphorical language falls by the wayside: On the one hand, the carbon-based molecular structure of bionic computers enables the solution to problems that have eluded traditional silicon-based computers.[30] On the other hand, the structure of DNA itself has been used as the template for the computer architecture.[31]

Generally reflective of this blurred distinction between the model and the modeled has been the field of *artificial life*, which has shifted its research project over the past ten years from *simulating* to *instantiating* life. The implication here is that carbon-based 'wetware' of flesh-and-blood organisms is no longer regarded as the 'real' or 'natural' form of life that 'software' (i.e. computer programs) and 'hardware' (i.e. robots) simulate to varying degrees. Rather, life is defined in terms that are completely abstracted from its mode of realization so that wetware, software and hardware all instantiate 'life' in exactly the same sense.[32]

The language of 'instantiation' derives from theological discourses of the Christian deity's triune nature, that is, the idea that God is subject to three equally divine manifestations: Father, Son and Holy Spirit. These theological roots go beyond historical curiosity to a general principle of Biblical interpretation that provides a precedent for reducing, if not erasing, the difference between processes, entities and interventions of 'artificial' and 'natural' origin. This principle, associated with what the 14th century scholastic John Duns Scotus called the 'univocity of being', takes humanity's creation 'in the image and likeness of God' rather literally, such that human differs from divine creation only in degree not kind: God may be infinitely more powerful than us but he works in largely the same way, i.e. by adhering to the same principles. The centrality of this idea to the 17th century Scientific Revolution is very well documented, and helps to explain why the revolutionaries tended to be Protestants rather than Catholics (unless heretics like Galileo).[33] Catholics followed Aquinas in promoting a less literal reading of the Bible, in which accounts of God's creative power are to be taken as mere metaphors for something we are incapable of grasping in its totality. This old Christian schism surfaced at one point in the interviews, when a French computer scientist associated the US CT agenda with a 'Protestant' vision of the world in which 'playing God' is seen as a human entitlement.[34]

When 'life' is treated as an abstract entity subject to multiple instantiations, it is sometimes defined in *functional* terms, such that an artificial entity counts as living if it can pass for a natural life form, as in a Turing Test. However, increasingly the terms in which life is defined are purely *formal*, as in entities that through self-organizing

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[30] L.M. Adleman. 'Molecular Computation of Solutions to Combinatorial Problem'. *Science* 266 (1994):1021–1024.This research

[31] K. Chang. 'Smaller Computer Chips Built Using DNA as Template'. *New York Times*, Nov 21, 2003.

[32] Martyn Amos, *Genesis Machines: The New Science of Biocomputing* (London: Atlantic Books, 2006).

[33] Peter Harrison, *The Bible, Protestantism and the Rise of Natural Science*. (Cambridge UK: Cambridge University Press, 1998).

[34] See interview with Bernard Espiau. A highly recommended critical history of this Christian sensibility is David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention* (Harmondsworth UK: Penguin, 1997).

means evolve to a certain level of complexity and stability, even if this happens entirely in virtual reality.

A good example of this purely formalist conception of life that played a remarkable role in a legal setting is Avida, a computer program designed to generate 'digital organisms' (aka computer viruses) according to parameters for self-replication and mutation that approximate those postulated by Darwinian natural selection.[35] That after a reasonable number of generations Avida generates stable complex organisms comparable to those in the natural world was offered as evidence for the existence of natural selection in *Kitzmiller v. Dover Area School District*. The defendants in this US circuit court case had offered intelligent design (ID) as an alternative to Darwinian natural selection, which they regarded as no more than a 'theory' of the origins and maintenance of life on earth.

In this context, it is striking that the Judge who ruled against the defendants took at face value the claim that Avida *instantiates* natural selection, thereby obviating the need for alternative theories to be taught (especially given ID's transparently religious inspiration). Thus, even if the exact role of natural selection (vis-à-vis other evolutionary mechanisms like random genetic drift and orthogenesis) in the history of natural organisms remains an open question, its general biological validity has been secured by a computer program that demonstrates the efficacy of natural selection on digital organisms. Perhaps without realizing it, the judge had contributed to the CT agenda by granting the same evidentiary status to evolution happening to carbon and silicon based life forms.[36]

But the issue of convergence goes beyond accepting different bodies of evidence in support of a common theory. It would be easy to imagine an Avida-like program interfacing with other programs responsible for regulating natural organisms to produce a more authentically Darwinian sense of natural selection. I have in mind here the ever-present threat of computer viruses capable of paralyzing society's information and communication infrastructure, thereby jeopardizing people's livelihoods and even lives. The turn to artificial life invites us to think of this prospect as akin to releasing organic waste from labs and factories into public water supplies and sewage systems. In this respect, the products of computer simulations are not only just as abstract from natural phenomena but also just as real as those of laboratory experiments. One advocate of a strong CT agenda, Ray Kurzweil, has pressed points of this kind to the US Congress as part of a renewed national security strategy.[37]

The potential policy implications of this suggested ontological convergence are enormous.[38] But do they imply that the CT agenda is either 'reductionist' or 'holist'? Some commentators clearly see CT as constituting a revival of the reductionist

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[35] Lenski, R., Ofria, C., Pennock, R., Adami, C. (2003). "The Evolutionary Origin of Complex Features," *Nature* 423: 139-44.

[36] The expert testimony that found favour with the judge was Robert Pennock, *Kitzmiller v. Dover Area School District*, Transcript Day 3, 28 September 2005, pp. 91-2.

[37] Ray Kurzweil, 'Nanotechnology dangers and defences', *Nanotechnology Perceptions* **2** (2006) 7–13. However, Roco (in interview) observes that while post-9/11 national security interests initially led DARPA to support the CT agenda, Congress stopped DARPA-related CT in 2003, which Kurzweil's testimony attempted to revive – though *not* with Roco's blessing.

[38] E.g. animal and android rights, especially in light of cyborganization that makes it difficult to distinguish where the 'human' ends and the 'non-human' begins.

scientific research programme that would portray all the objects of science as some complex extension of the fundamental particles and forces studied by physics. These commentators tend to stress the particular emphasis that CT, especially in its US guise, places on the nano-level of reality, stressing its drive towards miniaturization. In that respect, CT appears to be about 'converging downward' to some ultimate constituents of matter. In contrast, support for the holism of the CT agenda rests on its aspirations to create an interdisciplinary or even transdisciplinary science base that addresses questions concerning the enhancement of human performance (US) or welfare (EU) that are not adequately addressed by the individual sciences on the CT agenda. This is, so to speak, a 'converging upward', which is indeed how CT is frequently depicted in the founding policy documents.[39]

However, neither reductionism nor holism adequately captures the distinctiveness of the CT agenda.[40] In particular, it would be a mistake to regard CT as simply a high-tech repetition of the issues classically raised by physical reductionism, in which all of reality is seen as a hierarchy of increasingly complex molecular structures, ranging from subatomic particles to entire ecosystems. Indeed, the *verticalist* imagery of 'top-down' and 'bottom-up' may be itself profoundly misleading as a basis for conceptualizing the policy implications of CT. For example, the sorts of hybrid entities generated by processes associated with CT, such as genetic modification, xenotransplantation, computerisation, while generally quite strategic and deliberate (and hence not 'bottom-up' in the traditional sense of 'unintended' and 'emergent') are without any overarching sense of plan that these interventions are meant to serve (and hence not 'top-down' in the traditional sense of 'holistic' and 'preordained').

This feature of CT may be seen as characteristic of a trial-and-error 'bioprospecting' mentality that was anticipated nearly two decades ago by Harvard's professor of molecular biology, who was concerned for the intellectual future of his field, as researchers seemed to be content with testing out molecular combinations for their consequences, especially their biomedical uses, but nothing more theoretically interesting.[41] This implies a *horizontalist* imagery, whereby disciplines are linked by common methods – broadly defined as 'modeling techniques' – that in the long run break down disciplinary differences, while reifying the methods as a shared reality. Thus, bioinformatics, originally a tool of molecular biology, becomes the thing of which molecular biology is itself an application.

In this respect, both the US and EU policy documents relating to CT may be seen as providing a focus that tries to reinvent a verticalist perspective to provide an easier basis for governance. Admittedly, the focus in the US and EU documents is defined somewhat differently: 'enhancement of human performance' (US) *versus* 'improving

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[39] One scholar who stresses this contrast in convergences is Jan C. Schmidt,'Knowledge Politics of Interdisciplinarity: Specifying the type of interdisciplinarity in the NSF's NBIC scenario' *Innovation*, 20 (2007): 313-327.

[40] One of the few who recognises that the CT agenda transcends the standard reductionism/holism binary is George Khushf, 'A Hierarchical Architecture for Nano-scale Science and Technology: Taking Stock of the Claims About Science Made By Advocates of NBIC Convergence' in D. Baird, A. Nordmann & J. Schummer (eds.), *Discovering the Nanoscale*, (Amsterdam: IOS Press, 2004), pp. 21-33. However, Khushf sees the matter still in verticalist terms but he envisages NBIC as encouraging reciprocal feedback relations between top-down and bottom-up organizations of matter. He misses the strategic character of a theory designed to just interventions specifically at the nano-level of reality.

[41] See Walter Gilbert (1991). "Towards a Paradigm Shift in Biology." *Nature*. 10 January 349: 99.

human welfare' (EU). However, both introduce an overarching sense of convergence on *the human* that need not otherwise result from the default pattern of convergences taking place in contemporary science and technology. Indeed, conserving humanity's integrity in the face of various induced convergences has become an explicit policy goal, especially amongst EU policymakers, who create distance from US CT initiatives by accusing them of promoting 'transhumanism', which of course the US adamantly, and with *some* justification, denies.[42]

Indicative of such countervailing tensions placed on the concept of the human by the CT agenda is a set of neologisms introduced by Nikolas Rose, the sociologist who coordinates the European Science Foundation's 'Neuroscience and Society' network from the London School of Economics:[43]

1. *Biological citizenship* concerns the new ways in which we are coming to relate to each other by virtue of possessing overlapping genomes that are subject to common regimes. Contrary to an earlier ideology of biological determinism associated with the eugenics movement, we are now entering an age in which people will be expected to know, and hence held responsible for, their genetic constitution.
2. *Neurochemical self* refers to the ways in which the parameters of human identity, including our most intimate thoughts and feelings, are coming to be defined in terms of states that are increasingly manipulable by pharmacological or surgical means. This is not quite reductionism because these developments occur at multiple levels of intervention that do not reflect a consistent ontological framework.
3. *Somatic expertise* is a form of knowledge that has emerged to mediate biological citizenship and the neurochemical self by extending regimes of self-management from diet, exercise and regular medical check-ups to periodic cognitive and physical 'upgrades' by means of drugs or surgery. In this context, genetic counselling is an emerging field that envisages our bodies as long-term investment prospects.
4. *Biocapital* captures at once the radical functionalisation and commercialisation of our bodies, which has been greatly facilitated by the biological and technological feasibility of 'xenotransplantation', that is, the successful transfer of organic material – often genetic – from one species to another. The free mobility of biocapital serves to undermine the norm of bodily, and even species, integrity in ways comparable to the role that free trade policies have played in eroding the legitimacy of the nation-state.

I shall return to the transhumanist challenge in section five of this report.

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[42] Of the two main authors of the original NSF document, Bainbridge is clearly the transhumanist. His solo articles veer towards matters of 'cyberimmortality', whereas Roco's tend to focus on the reorganization of the scientific labour force. Contrast W.S.Bainbridge, 'The Transhuman Heresy', *Journal of Evolution and Technology* 14 (2): August 2005, http://jetpress.org/volume14/bainbridge.html; M.C. Roco, 'Coherence and Divergence in Megatrends in Science and Engineering', *Journal of Nanoparticle Research* **4:** 9–19, 2002.

[43] For an elaboration, see Nikolas Rose, *The Politics of Life Itself: Biomedicine, Power, and Subjectivity in the Twenty-First Century*. Princeton: Princeton University Press, 2007. The book is to be recommended mainly for its survey of emerging trends rather than any clear normative guidance, which is mired in the usual Foucauldian ambivalence.

3. CT's fixation on nanotechnology: The Resurgence of the Chemical Worldview.

CT's fixation on nanotechnology is best seen in terms of the quest for the most finely grained level of reality at which humans can strategically intervene to re-engineer themselves and their environments. A historical frame of reference is provided by the medieval alchemists, who spoke of '*minima materia'*, which is sometimes mistranslated as atoms, or ultimate units of matter. In fact, the alchemists were seeking the smallest bits of matter *that retain their functional properties* – largely in the context of medical practice. Homoeopathy continues this tradition, especially if one thinks of the serial dilution of toxic materials as a crude prototype of the scaling down of somatic interventions to the nano-level.

However, as one might imagine, precedents from alchemy and homoeopathy did not bode well for nanotechnology's early acceptance. The April 1996 issue of *Scientific American* debunked nanotechnology as the latest science hype for promising self-cleaning surfaces, etc., capable of undoing with artifice all the effects that nature had wrought over many years, perhaps even millennia.[44] In a debate initiated by *Wired* magazine in response to this article in November 1997, Brad Cox, a computer scientist who popularised the idea of 'superdistribution' (i.e. a peer-to-peer tracking system for the spread of digital goods without overarching copyright protection), defined nanotechnology as a 'faith' defined by the premise, 'whatever evolution can do, design can do better'.[45] He elaborated the point as follows:

> The spontaneous orders emerging from evolutionary interaction of autonomous distributed agents with their environment can be improved on by that centrally planned activity the engineering community calls design.

Cox argued that the nanotech faith was the death rattle of the 19th century mechanistic world-view, which was inclined to take its models literally, and hence viewed the formation of molecules as akin to the gluing of billiard balls, all in defiance of 20th century knowledge about quantum mechanical effects.

At a more general level, argued Cox, the nanotech engineer mistakenly locates himself outside system he is trying to design, thereby falling foul of evolutionary biology's insights into sustainable environments. Cox himself backed the briefly fashionable 'bionomics' movement, which viewed the economy as an ecosystem that mimics the natural world in a sense aligned to the 'social construction of reality', where 'social' is understood in the distributed micro-sense favoured by phenomenological sociology and Austrian economics.[46] Bionomics-related research was seen as being conducted by the simulations of 'complex adaptive systems' performed by the Santa Fe Institute.

This early critique cast the enthusiasm for nanotechnology – which at the time was more strongly supported by applied than basic scientists – in terms of the ideology of 'central planning' so favoured by social engineers in the past. Thus, the 1990 book *Bionomics* was largely devoted to evolutionary arguments that undermined Keynes-inspired metaphors for the acting on the economy as 'pump priming', 'cooling down',

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[44] G. Stix (1996). Trends in Nanotechnology: Waiting for breakthroughs. *Scientific American* (April): 94-99.
[45] HotWired BrainTennis Debate, Nov 97, http://virtualschool.edu/cox/pub/97WiredBrainTennis/
[46] P. Berger & T. Luckmann, *The Social Construction of Reality*, 1968; back to Alfred Schutz, F. A. Hayek.

'putting on the brakes' and (in the case of corporations) 're-engineering', as if a central planner could do such things without generating long-term, potentially negative unintended effects as well – the economic equivalents of waste and pollution.[47]

However, the prospect of resurrecting the idea of the planned economy, symbolically killed off with the fall of the Berlin Wall in 1989, was not the only target of this assault on nanotechnology. Perhaps more strongly implicated was the proposal put forward from within the free-market capitalist camp by George Gilder, an economist and Republican Party speech writer who originated 'Reaganomics'. In 1989 he published the best-seller *Quantum Economics*, pointing to nanotechnology as capitalism's final frontier, now that we are (allegedly) on the verge of acquiring God-like mastery over the fundamental forces of nature. Gilder thus predicted a nano-cornucopia whereby we could finally realize humanity's biblical entitlement to bring order and prosperity to Earth.

Gilder had in mind this often-cited quote from Eric Drexler's *Engines of Creation* (1986): "Coal and diamonds, sand and computer chips, cancer and healthy tissue; throughout history, variations in the arrangement of atoms have distinguished the cheap from the cherished, the diseased from the healthy. Arranged one way, atoms make up soil, air, and water; arranged another, they make up ripe strawberries. Arranged one way, they make up homes and fresh air; arranged another, they make up ash and smoke." Partly from the proceeds of *Quantum Economics*, Gilder soon thereafter co-founded Seattle's Discovery Institute, which most notoriously promotes intelligent design as an alternative to Darwinian evolution but has been more practically engaged with the provision of alternative energy solutions for the Pacific Northwest. Gilder himself remains very interested in NBIC-style CT, having played host to Ray Kurzweil at the Discovery Institute where he gathered intelligent design theorists to discuss Kurzweil's proposition that we are 'spiritual machines'.[48]

Note that nanotechnology's stress on the 'functional' is an anthropocentric concept that presumes an understanding of the arrangement and movement of matter in terms of their instrumentality in bringing about humanly relevant ends. Because the general history of science tends to be told through the history of physics, it is common to treat scientists who persisted in the modern era to regard relations of Newtonian mass and force in purely functional terms – say, as 'energy' – as having been conceptually mistaken. Thus, Joseph Priestley, the polymath chemist who first experimentally isolated oxygen in the 1770s is not normally credited with its discovery because he thought he had invented a technique for purifying air and water (which of course oxygen does), not a fundamental element of nature. Indeed, a convenient way to distinguish the histories of physics and chemistry in the 19th and 20th centuries is that chemistry retained this concern for *minima materia*, whereas physics gave it up in favour of a search for ultimate units as such, regardless of their functional character. Indeed, the rise of the Copenhagen Interpretation of quantum mechanics in the 1920s suggested that ultimate physical reality eludes any ordinary sense of causation. To be sure, nuclear fission, an outcome of physics' search for the ultimate units of matter, proved an innovative basis for both maintaining and destroying civilised life by

[47] Michael Rothschild, *Bionomics: The Inevitability of Capitalism* (Henry Holt, 1990).
[48] Richards, J., ed. (2002). *Are We Spiritual Machines?* Seattle: Discovery Institute.

exploiting properties of matter that can only be called, respectively, 'pre-' and 'anti-' functional. In contrast, CT aims to return science squarely to the functionalist fold.

In the first section, I observed that much has been made of the emergence of nanotechnology as a re-branding exercise for chemistry. This discipline first lost ontological status at the start of the 20th century, after having been reduced to atomic physics, and which by the end of the 21st century had lost its sociological status – albeit this time alongside physics -- as enrolments dropped and departments closed in the first world. At the dawn of the 20th century, the two disciplines were on equal epistemological and ethical footing as sources of general natural-philosophical worldviews. At the public level, the differences between physicists and chemists appeared incommensurable: the former concerned with the pure and the latter the practical. However, they also conducted a protracted battle over the reality of atoms, which the chemists denied (except as a theoretical fiction) but the physicists eventually proved, with Einstein's explanation of Brownian motion. After that 1905 discovery, chemistry was increasingly seen as the branch of physics that deals with complex molecules and their applications.

The difference between the physical and chemical world-views may be summarized in the following chart:[49]

WORLD VIEW	**PHYSICAL**	**CHEMICAL**
AIM OF SCIENCE	Discover the ultimate nature of things	Construct the most efficient means to our ends
EPISTEMOLOGY OF SCIENCE	Realist	Instrumentalist
IDEOLOGY OF SCIENCE	Professional	Industrial
THEORY OF MATTER	Atomic	Energetic
THEOLOGICAL HORIZON	Divine design	Faustian potential

The physical and chemical worldviews can be regarded as complementary, especially from a theological standpoint.[50] The physical world-view draws a strong distinction between God and humans, such that there are final barriers to our ability to predict and control nature. We aim to discover that beyond which we cannot turn to our own advantage. In contrast, the chemical world-view, much more heretically, imagines humans playing, if not replacing, the divine creator. Here matter is treated not as an insuperable barrier but raw material to be moulded – with more or less difficulty – to serve human needs. What matters is not the ultimacy of matter *per se* but its moment of ultimate plasticity, the so-called edge of uncertainty that the nano-scale promises to provide.

This shift from the physical to the chemical world-view has profound metaphysical implications. Before the 20th century, it was common to distinguish 'natural' and

[49] For a more systematic characterisation of the two worldviews, see Steve Fuller, *Thomas Kuhn: A Philosophical History for Our Times (*Chicago: University of Chicago Press, 2000), chap. 2. In this context, I show that Kuhn's theory equates science as such with the physical worldview.
[50] The theological standpoint tends to matter more the more removed the scientist is from the direct study of life in its natural habitats, where a more inductive methodology naturally prevails.

'nominal' kinds, i.e. things identified in terms of what they are *vs*. what we name them, a Biblical distinction that in its modern form is due to John Locke's adaptation of Thomas Aquinas. 'Nominal kinds' were said to be arbitrary because the things assigned the same names would not necessarily share anything deeper (or 'essential') than our interest in treating them the same. In that sense, all kinds are at least nominal and the question is whether they are natural as well. (Locke shifted the burden of proof to those who claimed to have named natural kinds.) However, by the end of the 20th century, this rather sharp distinction between natural and nominal kinds yielded to more fluid distinctions based on the degree to which we can bend things to our will. Hence, Roy Bhaskar wrote of the difference between 'transitive' and 'intransitive' dimensions of reality, and Ian Hacking of 'interactive' versus 'indifferent' kinds, which in both cases roughly corresponded to the objects of the human *vs*. the natural sciences.[51]

Now, however, it may be more appropriate to distinguish between *virtual* and *real* kinds, the latter understood as multiple realizations of the former.[52] This marks a radical shift in the ontological focus of scientific inquiry. In particular, 'nature' is cast as only a subset of all possible realizations (i.e. only *part* of the 'real'), as opposed to something inherently 'other' or 'independent' of whatever humans might name or construct. Once again this perspective is familiar from the chemical world-view, in which, say, the difference between 'natural' and 'synthetic' fibres lies entirely in the history of their production and their functional properties, but not in terms of the metaphysical priority of one to the other, since both the 'natural' and the 'synthetic' are composed of the same fundamental stuff – and the latter may indeed count as an *improvement* over former. By extension, 'mind' and 'life' lose the metaphysical mystique associated with their natural origins and come to be assessed simply in terms of the properties possessed by their realizations – be they human, carbon-based, silicon-based or some cyborgian mixture. I shall pick up this point in **section 6's** discussion of 'ableism'.

Starkly put, in this third metaphysical phase, a thing's identity is no longer constrained by its history, not even its Darwinian evolutionary history. Thus, as we get better at pharmaceutically manipulating genetic expression and neural circuitry with an eye to long-term improvements – be it through direct incorporation into the next generation's genetic potential or less directly through regular corrective medical interventions (cf. vaccinations) – the more hollow the following concern will seem:

> **Human enhancement beyond evolution**
>
> *"If it is such a good idea, why has evolution not built us that way?" That is the question two philosophers say we must ask before we attempt to enhance our human capabilities.*
>
> We already augment our minds with drugs such as Ritalin and modafinil, our sexual performance with Viagra and our immune systems with vaccines. These are nothing

[51] Roy Bhaskar, *A Realist Theory of Science* (Brighton UK: Harvester 1975); Ian Hacking, *The Social Construction of What* (Cambridge MA: Harvard University Press, 1998).

[52] The most obvious philosophical precedent here is Gilles Deleuze, who in turn drew on the work of Gilbert Simondon, who held the chair in psychology at the Sorbonne in the 1960s, when Deleuze wrote *Difference and Repetition*. Simondon theorised individuation (i.e. the process of by which one becomes an individual) as products of epigenesis (i.e the process by which an organism's generic potential is realized in environmentally specific ways, thereby accounting for how, genetically speaking, near-identical members of a given species can come to live such different lives).

> compared with what might be on the way, from brain implants for a better memory to genetic modifications for sports performance (*New Scientist*, 13 May 2006, p 32).
>
> Before we consider forging ahead with these technologies, we need to consider why we haven't already evolved that way, say Nick Bostrom and Anders Sandberg of the Future of Humanity Institute at the University of Oxford. This will allow us to identify when it is feasible for us to outdo nature, they say, and when it is not.
>
> Before anyone considers giving humans greater brain power, for example, they should first show that the only reason we don't already have more mental capacity is that the resulting energy demands would have been a disadvantage for our hunter-gatherer ancestors when food was scarce. Now food is more plentiful, it might be OK to forge ahead, but if there is no convincing guarantee that this enhancement no longer poses a problem, it might be wiser to steer clear of it. "The human organism is enormously complex," says Bostrom. "If we go in blindly and change things at random, we are likely to mess up." He presented the idea last week at the Transvision conference in Helsinki, Finland.

I highlight this short article, which appeared in the *New Scientist* in 2006, because caution with respect to human enhancement policies is being urged on evolutionary grounds from a most unlikely source, namely, two intellectual leaders of the transhumanist movement.[53] It would seem that even transhumanists – at least the academically respectable ones -- continue to trade on an old rhetoric of evolutionary 'anchoring' that harks back to a time – from the late 19th to the late 20th centuries – when the ancient ancestry of our genetic traits (e.g. vestiges of the 'reptilian' or 'primate' brain) was associated with their relatively strategic impermeability.[54]

But as a matter of fact, as transhumanists would be the first to point out, we are gradually discovering ways of re-engineering processes and properties that originally developed over millions of years. Even from an evolutionary standpoint, there is no reason why biological traits that have been around for aeons cannot be successfully changed overnight, provided the presence of environments where individuals possessing the new traits prove 'adaptive' (i.e. reproduce themselves). To be sure, this is much easier said than done. Indeed, the extreme prospects of genetic and neural re-engineering – both in terms of risks and benefits – revisit the classic questions of social engineering. However, addressing them adequately has less to do with respecting the deep past than with reconstructing today's socio-technical world to render it hospitable for any such biologically modified beings. The nostalgic appeal to an evolutionary naturalism simply obscures what is, in effect, a straightforward political decision about the care with which we project future generations.[55]

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[53] From issue 2566 of *New Scientist,* 26 August 2006, page 25.

[54] In the philosophy of biology, this perspective is associated with the 'Weismann Doctrine', named for the German embryologist normally credited with experimentally demonstrating the lack of interaction between 'somatic' and 'germ' cells (i.e. changes to an organism's physiology during its lifetime vis-à-vis comparable changes in its offspring's physiology). Of course, by the early 20th century, it was generally granted that irradiation, strictly speaking, violated the Weismann Doctrine but not in a strategically tractable way, as, say, followers of Lamarck would have liked. However, CT precisely revisits the Lamarckian dream with better science.

[55] Letters to the editor on this article reflected critically on the transhumanists' continued normative reliance on evolution. One observed, quite properly, 'Evolution didn't "build" us at all. It can only play the hand mutation deals it. If no mutation occurs giving rise to a particular characteristic, no matter how much of a "good idea" that characteristic is, it will not arise. We, however, have the capacity for foresight and so can fine-tune some of evolution's less elegant solutions.'

A good way to encapsulate the foregoing three-stage metaphysical transformation in what kinds of things there are is to correspond them to the three main phases in the history of genetics, with CT bringing the final stage to fruition:

	METAPHYSICAL DISTINCTION	**GENETIC ORIENTATION**	**CAPACITY FOR INTERVENTION IN LIFE PROCESSES**
Before 20th century	Natural v. Nominal kinds	Linnaean species creation	Minimal: Fundamental life processes out of human hands
20th century	Intransitive v. Transitive kinds	Mendelian population genetics	Selective breeding can affect later generations
After 20th century	Virtual v. Real kinds	CT nano-bioengineering	Alternative realizations of genetic potential possible in same generation.

4. Biology as a Vehicle for Human Enhancement – Social Science's (Relatively) Hidden History and Possible Future[56]

Despite considerable controversy surrounding the term 'human enhancement' as a goal of CT, with the EU in equal measures suspicious and skeptical of US aspirations, nevertheless such disagreements are less over the desirability of enhancement *per se* than the form it takes. As we have seen, 'enhancement' promises that individuals will enjoy greater consumer choice but also longer economic productivity, thereby enabling lessening state welfare burdens. It would seem, then, that there is something for everyone across the political-economic spectrum.

There is a long history of treating genetic variability in competitive terms, as played out over successive generations of socially delineated 'races', 'clans' and 'families'. The interest in enhancing human performance is ultimately rooted in the palpable differences in achievement that emerge from examining these various lines of human descent. In particular, those from modest origins often pick themselves up but never reach the top without violence, and then only temporarily, whereas those who start on top often regress to a position of mediocrity if not outright degeneracy, unless they prove to be of sufficiently strong 'character'. However, it has been long thought that some targeted intervention might be able to alter both these tendencies – notably the first major work of Western political philosophy, Plato's *Republic*.

While most subsequent theories of politics have concentrated on preventing the rot from setting in (e.g. through constitutional checks and balances and various incentives to prevent corruption), Plato was distinctive in trying to raise the bottom by identifying promising offspring from all classes and subjecting them to special training over the course of several decades to enhance their latent potential for

[56] This strand of the history of science-society relations has yet to be told in its entirety. The standard point of departure in English, Daniel Kevles, *In the Name of Eugenics* (Cambridge MA: Harvard University Press, 1985), regularly updated and now in several editions.

leadership. If Freud held that a child's future was sealed by age five, Plato held that it was around that age that the child's nascent responses to the world could be channeled for maximum social benefit.

Though lacking anything like a modern theory of genetics but possessing a keen sense of Greek history, Plato was struck by the unreliability of family background as a predictor of desirable qualities like leadership. Nevertheless, he believed that a stable social order requires just such a belief in the heritability of achievement. The value of heritability lay in the security one feels from anticipating what people are likely to do under normal circumstances, given their past, which then allows for their acts to be encouraged or prevented. Plato spoke of this as a 'noble lie', the so-called 'myth of the metals', the quasi-racist, caste-like basis of a stable social order, which justified segregating the best from the rest. However, this folk theory needed to be supplemented by a more esoteric theory that recognized the inevitable uncertainties that resulted from people of perhaps a fixed genetic make-up encountering circumstances, themselves perhaps separately predictable, but beyond the control of those encountering them.

The big difference between how Plato and we think about the prospects for human enhancement is that unlike Plato, who conceptualized the issue in terms of decisions taken about individual lives, the CT agenda operates at two steps removed, selecting research trajectories likely to result in enhancement innovations that, at least in principle, would be available to the full range of inhabitants of the nations promoting the CT agenda. To be sure, which particular individuals end up benefiting from these innovations is left open in a way Plato would not approve. To a large extent, this difference in approach reflects Plato's greater certainty about the consequences of his decisions. He believed that the requisite knowledge was already available but that people were normally too self-interested to be trusted to make the right decisions. Thus, Plato established the Academy as a school for aspirant philosopher-kings, who would be trained to adopt the universal standpoint as their own default basis for taking decisions. To be sure, Plato regarded this as a difficult task, requiring several decades of matriculation – but *not* the commission of specialized research.

Plato's folk theory of the heritability of achievement, the 'myth of the metals', was revisited with new empirical vigor in the late 19th century by Darwin's cousin, Francis Galton, who coined the term 'eugenics' for the project of tracing family lineages in order to identify, and cultivate, lines of achievement. This project was politically attractive to an emerging liberal-socialist sensibility, associated with the Fabian Society in the UK, that on the one hand was keen to remove the hereditary privilege of the House of Lords, which typically rested on the achievement of one ancient ancestor who turned out to have been an exception in a family history whose members have regressed over successive generations; and on the other hand, feared that the advent of majoritarian democracy would swamp the efforts and aspirations of the talented unless they reproduced themselves in sufficient numbers.

Although the underlying theory of genetics changed radically over the 80 or so years that saw the likes of Galton, Karl Pearson, Ronald Fisher and Julian Huxley advance versions of what is often called 'positive eugenics' (as opposed to the 'negative eugenics' associated primarily with culling, as practiced *in extremis* by the Nazis), they all agreed that not everything was worth preserving in the human gene pool

simply because the gene pool was 'human'. In this respect, these thinkers accepted the premise of all versions of modern evolutionary theory, namely, that species are not fixed essences (e.g. specially created by God) but mutable sites for the collection and transmission of genetic material.

The history of eugenics is relevant to the project of human enhancement because it establishes the point-of-view from which one is to regard human beings: namely, not as ends in themselves but as means for the production of benefits, be it to the economy or to 'society' more diffusely understood. The Abrahamic or Kantian idea of humanity as a species-being in possession of its own unique integrity and autonomy (aka 'dignity') is largely relegated to ethical 'side constraints' for the conduct of research and 'precautions' related to anticipated negative consequences of such research and its applications.[57] The shift strongly resembles the one that occurred to the idea of *producer* in classical political economy. In authors from Aquinas to Locke, a 'producer' was the worker through whose creative transformation value was given to nature. It was associated with humanity's spark of divinity. However, by the early 19th century, 'producer' had come to name the workplace manager whose organization of workers enabled the efficient flow of goods and services. In other words, a producer became a human whose job was to transform other humans, as if they too were simply part of nature. An awareness of this semantic transformation lay behind Marx's early critique of capitalism, especially in terms of the alienation of the worker from his labor as the abstract factor of 'productivity' that requires the supplementation, if not outright replacement, of people with machines and other artificial arrangements.[58]

The CT agenda, especially in the NBIC form promoted by 2002 NSF document, harks back to this early understanding of social science, one that predates the field's separation into distinct disciplines or, for that matter, its clear differentiation from the natural sciences. It is a vision most recognizable as Auguste Comte's original version of 'sociology' as the overall development of science brought to self-consciousness, as humans are finally incorporated as proper objects of scientific inquiry, thereby providing the site for the integration and collective self-governance of the all the sciences. Convergence on the ideal social order on a global scale would presumably soon follow. A slightly less grandiose, less theoretically freighted and more policy-oriented precedent of this vision actually came close to the horizons of today's CT agendas. I have in mind the 1814 proposal of Comte's mentor, Count Henri de Saint-Simon, *The Reorganization of European Society*. Saint-Simon held that regardless of Napoleon's personal fate, he had succeeded in consolidating Europe as an idea that could be taken forward (by others) as one grand corporate entity, to be managed by a

[57] See the Austrian interview with FS on nanotoxicity. It is worth stressing that this nascent posthumanist sensibility is actually the view of those who see themselves as 'socially conscious' but in a sense that treats the ecology as providing society's parameters. For humanist counterpoint, see Jürgen Habermas, *The Future of Human Nature* (Cambridge UK: Polity, 2002).

[58] This self-alienation of the mental and physical parts of production was crystallised in the 20th century through various theorisations of an intellectually driven 'managerial class' that would run a firm like an army – from 'the top'. See Karl Mannheim, James Burnham, etc. The model had been already provided in the specialist training of the French *Grandes Ecoles*, which Friedrich Hayek held responsible for all perverse modern applications of science as a technology of radical social transformation. See Hayek, *Counter-Revolution of Science* (New York: Free Press 1952).

scientifically trained cadre, modeled on the civil engineers trained in the *Ecole Polytechnique*.[59]

A striking feature of Saint-Simon's vision, relevant for our purposes, is his generalization of Adam Smith's hostility to the barriers that owners, and laws governing ownership, placed to the productive use of capital. The form of capital Smith mainly had in mind was land, whose owners could derive income by charging rents for simple occupancy. Saint-Simon's CT-relevant innovation was to propose that *ownership of one's body* was the main barrier to increased productivity – what is now euphemistically called 'underutilised human capital'. By analogy, Saint-Simon objected to the idea that individuals, simply by virtue of self-possession were entitled to certain basic goods. To be sure, by the late 18th century, ideas of liberty as an 'inalienable' right premised on the 'dignity' of the person had become the standard by which political regimes were judged, on the basis of which the American and French Revolutions were justified. And in this respect, Saint-Simon was a 'counter-revolutionary' thinker. However, from the standpoint of CT, he was ahead of his time.

The radical assumption behind Saint-Simon's proposal was that possession does not entail competence. Property ownership had been traditionally required for political participation because it was presumed that owners must be able to manage their holdings effectively in order to thrive: i.e. they displayed on a small scale the sort of judgment required on a large scale. This line of reasoning was extended to self-ownership in the late 18th century to incorporate tradesmen and professionals who may not be landholders but whose gainful self-employment revealed their competence. Saint-Simon's proposal gave a perverse spin to this development by shifting personal competence from an 'input' to an 'output' measure – i.e. from presumptive possession to revealed productivity. In short, Saint-Simon legitimized the idea that, on a show of competence, not only might political power be granted to those who previously lacked it (such as tradesmen and professionals) but also the converse applied, such that delinquent landholders might lose the right to dispose freely of their property. He notoriously made the point by arguing that France would lose its civilization and prosperity if it lost its scientists and artists, but nothing would change if it lost its priests and aristocrats. It was this assessment that led Marx to deride the *rentier* class for its promotion of 'rural idiocy'.

The 19th century made the shift to Saint-Simon's perspective increasingly plausible as the state came to represent society as a corporate 'national' entity with a life and purpose above and beyond those of its constitutive individuals. The administration of this corporate entity was entrusted to a bureaucracy – whom Saint-Simon envisaged as consisting of industrialists and technocrats -- with the power to redistribute the nation's wealth so as to ensure maximum productivity. Recall, once again, that 1814 was before the natural and social sciences were clearly distinguished. This bears on what 'redistribution' might have meant. It is now easy to imagine Saint-Simon as having been concerned with redistribution *only* at the level of material wealth, i.e. with the state's ability to tax and spend. However, he was also interested in the redistribution of 'sentiment', largely through changes in what, after Claude Bernard, came to be called the 'internal' (i.e. the organism's physiology) and 'external'

[59] See Hayek, *Counter-Revolution*, chaps. 12-16

environments responsible for their generation and maintenance. As we shall see below, this aspiration establishes his relevance to the 2002 NSF report.

Saint-Simon – and certainly Comte and sociology's academic founder, Emile Durkheim – saw the matter in terms of 'moral education', which in practice meant a reprogramming of each generation's brains to undo the misconceptions (or 'ideology') instilled by religious instruction, not least the idea of a mental life independent of both the natural and social order, the so-called seat of the soul, the pseudoscience of which was 'psychology'. While these thinkers thought of reorienting brains to society largely in terms of altering the 'external environment;' they certainly aspired to intervene more directly in the brain. Indeed, an often neglected feature of 19th century debates over the foundations of the social sciences – then often called the 'moral sciences' – is the enthusiasm for a positivistically upgraded science of *medicine* to become the basis for a unified policy science that might pass for 'sociology'. CT, especially in its NSF guise, should be seen as revisiting this prospect at a time when the differences between the natural and social sciences – not least the biology/sociology interface – have begun to lose their institutional and intellectual salience.[60]

Here it is worth observing that the biology/sociology interface remained porous as long as the so-called the Weismann Doctrine was not in effect.[61] In other words, as long as biologists found no reason to think that physical changes to a current generation of organisms would have long-term effect on offspring, it became convenient to distinguish biology from sociology in terms of a focus on genotypic v. phenotypic changes – the former change bearing on the latter, but not vice versa. To be sure, the Weismann Doctrine is alive and well amongst evolutionary psychologists who explain the limited variance of human socio-cultural responses to their physical environment in terms of genotypic anchoring. However, the promise of CT's capacity to switch genes on and off and otherwise produce permanent effects on the genome in a single generation suggests the resurgence of a sensibility closer to Saint-Simon and Comte, both of whom were sympathetic to Lamarckian views of evolution.[62]

In its pre-scientific 'therapeutic' mode, medicine was largely concerned with preparing 'patients'-- literally passive beings -- as they pass through the natural course of their lives. However, the 19th century came to see infirmity and death as enemies of the body politic to be overcome through regular and systematic medical treatment, functioning as a kind of micro-level national security system. This change in

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[60] For more on the implications of this development, see Steve Fuller, *The New Sociological Imagination* (London: Sage 2006).

[61] On the Weismann Doctrine, see **footnote 54** above.

[62] Following recent analytic philosophy of mind, we may distinguish four modes in which sociology might relate with neurophysiology: (1) *dualism* – they describe two relatively autonomous domains, perhaps because of the Weismann Doctrine (this has been sociology's default position for most of the 20th century, but CT-driven prospects of neuro- and even geno-plasticity increasingly make this option untenable); (2) *eliminativism* – the position of the French positivists, whereby 'psychology' is just a false religiously inspired theory of how brain-society interactions work; (3) *reductionism* – different states of social being (e.g. a secular ideology and a religious belief) are reducible to common brain patterns; (4) *functionalism* – different brain patterns converge on a common state of social being (e.g. multiple constituencies for a political party or multiple markets for a product). The most interesting sociologist on the neuro-social interface is Stephen Turner. See Turner, 'Social theory as cognitive neursocience', *European Journal of Social Theory* 10 (2007): 357-74.

sensibility is normally attributed to the late 18th century physiologist Xavier Bichat,[63] who figured as a major saint in Comte's positivist revision of the holy calendar. As mediated by the founder of French experimental medicine, Claude Bernard, Bichat's idea passed into the work of Durkheim, who quite explicitly treated deviance as moral pathology.[64]

Moreover, this view was by means restricted to France. In Germany, Rudolf Virchow as early as 1855 argued for medicine as the scientific basis of the law, calling for medical doctors to function in a proactive capacity, akin to the newly established legal institution of the police. According to this line of thought, warding off disease (especially epidemics) is like warding off crime: Both rob society of its productivity but they differ over the physical level at which the infractions occur, with medical doctors operating at a finer-grained level than the police.[65] While not sufficient to enable the convergence of the disciplines of medicine and law, strands of this line of thought have continued as, say, the basis for child vaccination campaigns, in which negligent parents can become subject to prosecution. And now we might not be far from the day when the right to give birth requires prior consultation with a genetic counselor who apprises the pregnant woman of both her options and her liabilities for their consequences.[66]

In short, were he teleported across the two centuries that divide him from us, Saint-Simon could recognize the following slogan, taken from the NSF document, as a more advanced version of what he had advocated. I have supplied a chart of the relevant translations:

> If the Cognitive Scientists can think it,
> the Nano people can build it,
> the Bio people can implement it,
> and the IT people can monitor and control it.[67]

SAINT-SIMON (early 19th century)	**ROCO & BAINBRIDGE (early 21st century)**	**SHIFT OF FOCUS?**
Social Science	Cognitive Science	From institution to individual
Carceral Institutions and Urban/Regional Planning	Nanotechnology	From external to internal environment
Medicine (Both and Forensic and Corrective)	Biotechnology	More intensive interventions
Vital Statistics (Administrative Sciences)	Information Technology	More extensive data gathering

[63] Bichat, ironically, was himself dead by age 30.
[64] Paul Hirst, (1975). *Durkheim, Bernard, and Epistemology,* London: Routledge & Kegan Paul**.**
[65] Saracci, R. (2001). 'Introducing the history of epidemiology', in J. Orsen et al. (eds.) *Teaching Epidemiology*. Oxford: Oxford University Press. Carried to its logical extreme, this line of thought justifies state funding for a substantial standing army, given a 'permanent state of emergency' from foreign foes. It is usually attributed to Bismarck's chief military officer, Baron von Moltke, but it received its most significant theoretical expression in the Weimar jurist and Nazi sympathiser, Carl Schmitt.
[66] Nikolas Rose (2007), chap. 4.
[67] Roco and Bainbridge (2002), p. 13

The applied epistemologist Jean-Pierre Dupuy has argued that a unique feature of the nano-driven character of the CT agenda is that proposals have been made for the normative regulation of scientific research – sometimes resulting in explicit guidelines – long before such research actually exists, let alone has borne socially relevant fruit.[68] Indeed, such an 'anticipatory governance' orientation has become the main framing concept of the largest social science initiative associated with the US CT agenda, the 'Nanotechnology in Society' network centred in Arizona State University, under the leadership of David Guston and Daniel Sarewitz. It would seem natural to translate a concept like anticipatory governance into the language of ethics, perhaps as an extension of the 'precautionary principle' used in ecological discourses. However, this fails to capture the proactive character of the lines of inquiry pursued under the concept, which more strongly resembles public relations or even marketing.

Two aspects of these 'anticipatory' activities are relevant here, one from the science side and the other from the public side. First, practitioners of certain branches of materials science and chemical engineering – if not chemistry more generally – have increasingly identified their field of research as 'nanotechnology'. This has enhanced the sense of forward momentum to nano-driven fields in citation indexes that depend on self-characterisation for their keywords.[69] Second, social scientists in both the US and EU have been interested in not only surveying public opinion on current developments in nanotechnology but also anticipating the reception of future nano-based products.[70] The latter, intentionally or not, serves to acclimatise citizens, in the company of their peers, to whatever nano-driven changes might be on the horizon.

These 'nano-futures', which are presented both live in 'science cafés' (i.e. the American version of the 'café scientifique') and in cyberspace through wiki-media.

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[68] Jean-Pierre Dupuy, 'Complexity and Uncertainty: A Prudential Approach to Nanotechnology', A contribution to 'Foresighting the New Technology Wave'. High Level Expert Goup, European Commission, Brussels. March 2004. http://portal.unesco.org/ci/en/files/20003/11272944951Dupuy2.pdf/Dupuy2.pdf. Dupuy's claim is strictly speaking false. An important earlier precedent is the 'anticipatory governance' of alchemy by the Roman Catholic Church, especially after the Papal Bull of 1317, which prohibited the project of transmuting base metals into gold on both moral and economic grounds: morally, it arrogated to humans what properly belonged to nature, and economically, it threatened to upset the exchange value of precious metals. Analogous concerns about the destabilisation of nature and the economy are raised today about nanotechnology, especially in light of the claims of its more zealous advocates like Drexler and Kurzweil. However, the trick has been to create an assembler at the nano-level that can then assemble other nano-molecules. This is an updated version of the alchemist's "philosopher's stone". The point to underscore is that the Papal Bull was announced without any evidence that the more ambitious elements of the alchemical project were even close to realisation, this despite the hype generated by the Oxford Franciscan Roger Bacon, the medieval answer to Drexler, who believed the alchemy is part of humanity's Biblical entitlement as having been created in *imago dei*. See David Noble, *The Religion of Technology*.

[69] Alan Porter, Jan Youtie, Philip Shapira, 'Refining search terms for nanotechnology: Briefing Paper', http://cns.asu.edu/cns-library/documents/Porter-Shapira%20Nano%20Search%20Briefing%20Paper.pdf

[70] An account of these nano-futures is provided by Cynthia Selin of Arizona State University: http://asdn.net/ngc2007/presentations/selin.pdf. She discusses the concept of nano-futures in light of science and technology studies in 'Expectations and the Emergence of Nanotechnology', *Science, Technology and Human Values* 32 (2007): 196-220. The potentially self-fulfilling character of nano-futures (at least in terms of acclimatising people to any new nano-based developments) was remarked by participants in the 'cyberchat' that accompanied the 'Converging Science and Technologies: Research Trajectories and Institutional Settings' conference associated with this project, held in Vienna 14-15 May 2007. http://www.converging-technologies.org/cyberconference/Chat/tabid/55/Default.aspx

The scenarios are initially vetted by the relevant scientists so as to be sufficiently plausible for people to take seriously. In social psychology, this strategy is often dubbed 'inoculation', the suggestion being that by allowing people to spend time thinking and talking about extreme or pure cases of some potential threat, you have laid the groundwork for the acceptance for a less virulent version. At the very least, you have normalised the idea in their minds. Of course, at the same time such scenarios lower one's guard to the potential harms caused by nanotechnology, they also raise one's expectations that its social benefits are forthcoming. But this too may be interpreted along Janus-faced lines: The anticipatory acceptance of nanotechnology may lead, on the one hand, to an anti-science backlash if sufficient benefits are not forthcoming or, on the other, to a willingness to interpret all manner of marginal nano-driven improvements as indicative of greater things to come.

For Dupuy, these nano-futures are high-tech versions of the performative, or 'self-fulfilling', character of prophecy, whereby a notional preference for a certain future, which the prophet channels as the voice of God or the scenario elicits from the participants, serves as a groundwork for what in retrospect will enable people to say that they were prepared for what eventually happened. Of course, strictly speaking, self-fulfilling prophecies need not turn out to be true but the import of taking the prophecy seriously is to think in terms of tendencies in the present that would indeed be responsible for the prophecy coming true, were it to come true. Similarly, as people become accustomed to thinking in terms of nano-futures, while the relevant scientific breakthroughs that would turn these scenarios into realities may not happen any more quickly, people will be primed – and inclined to provide further groundwork (in terms of funding, 'anticipatory governance' regimes, etc.) -- to recognize and incorporate the realization of the nano-futures when (and if) they happen.

One feature of this 'priming' of the future is worth highlighting, as it bears on the transhumanist futures that, as we shall see in the next section, some enthusiastic bioethicists have begun to project. The historic appeal of Lamarck's theory of evolution lay in the prospect of improving oneself through deliberate effort, the results of which would have continuing genetic consequences. The panoply of proposed CT-based enhancement strategies promise to deliver on at least this part of Lamarck's vision. However, the justifiability of this optimism depends on how one identifies the nature of the relevant interventions.

Bioethicists and others hoping for a Neo-Lamarckian revival tend to talk about genes as a population geneticist would, namely, as bearers of socially significant traits – as if that captured the character of our interventions in the genome. Thus, thought experiments to test our intuitions about the morality of enhancement typically go like this: "Suppose a treatment was available to switch on a gene that would enable your child to cognitively mature at such a rate that he could avoid primary school altogether…." The problem with this scenario is *not* that no one currently faces such a problem but rather that progress in our ability to intervene at the nano-level of life – and to monitor the relevant consequences – is best understood in terms of how molecular biology thinks about the gene, which has to do with the propensities of various protein configurations in a given biotic environment, such as the human body. As the leading historian of the field put the matter:

> How is gene defined: population geneticists follow traits, whereas molecular biologists follow protein: 'for the molecular biologist, a gene is a fragment of

> DNA that codes for a protein. For a population geneticist, it is a factor transmitted from generation to generation, which by its variations can confer selective advantage (positive or negative) on the individuals carrying it'.[71]

So, sure, we're getting better at, say, gene switching or brain boosting but our social categories do not naturally map on either the causes or the consequences of such interventions. We are basically just learning how to manipulate our proteins better. In this respect, a society that encourages the study and application of CT-oriented research is forced to conceive of the activity as an opportunity to use our own bodies as sites for biomedical experimentation and bioprospecting. I say this not to discredit the transhumanist ambitions but to alert people to the attendant changes in the sense of self, as well as our relationship to others, in what amounts to a scientific license for risk-seeking behavior of the most fundamental order. My guess is that transhumanists routinely commit this category mistake because they are so keen to demonstrate the feasibility of overcoming traditional 'natural' boundaries by artificial means – even, so it seems, these means are sociologically speaking either irrelevant or deleterious.

5. 'Enhancing Evolution': The Unspoken Normative Dimension of the CT Agenda

John Harris, editor of the *Journal of Medical Ethics* and Professor of Bioethics at the University of Manchester School of Law, is probably the most intellectually challenging moral philosopher writing in Britain today. He has recently published *Enhancing Evolution*, based on a series of lectures given at Oxford's James Martin Institute for Science and Civilization in 2006, presents the most systematic case to date for the value of artificially enhancing the human condition along broadly CT lines.[72] Although Harris does not explicitly endorse a 'transhumanist' ideology, he admits that the liberal policies he supports on enhancement may eventually result in a

[71] Michel Morange, *A History of Molecular Biology*. (Cambridge MA: Harvard University Press, 1998), p. 249. A good historical and philosophical account of the related distinction of the P-gene (i.e. preformationist – a gene for a specific trait) and the D-gene (i.e. developmentalist – a gene as a potential that can be actualised in many different ways), see Lenny Moss, *What Genes Can't Do* (MIT, 2003). A similar dichotomy arose between the more cautious Max Delbruck and his intellectually more adventurous mentor Erwin Schrodinger, both of whom midwived a generation of physicists and chemists to enter the field that became molecular biology. See especially Robert Rosen, *Essays on Life Itself* (Columbia University Press 1999), chap. 1, 'The Schrodinger Question'. The distinction between the two views may be summarised in the following chart, which I hope to unpack on another occasion:

DELBRÜCK	SCHRÖDINGER
Mendelian reductionism	Monodian reductionism
Gene is force-like	Gene is mass-like
Trait-led	Protein-led
Preformation	Epigenesis
P-gene	D-gene

[72] John Harris, *Enhancing Evolution: The Ethical Case for Making Better People*. Princeton: Princeton University Press, 2007. The 2008 Warwick annual sociology debate (19 May) will pit Harris against me over the proposition, 'There is no scientific basis to the concept of humanity'. Harrris will defend, I will oppose.

species-change that might be properly called 'transhumanist'.[73] One is reminded here of the back-door route to socialism from capitalism through an enlightened sense of self-interest that recognises the long-term benefit of a progressive income tax regime to productivity and hence prosperity. Like socialism, transhumanism retains an air of political incorrectness that requires its ends to be achieved by (at least verbally) indirect means.

Some other caveats need to be issued about Harris' argument at the outset. Harris defends 'enhancing evolution' on Neo-Darwinian and utilitarian grounds. However, one might start from Neo-Darwinian and utilitarian premises and project a rather different future from Harris'. In this respect, a conspicuous omission from his otherwise wide-ranging treatment of actual and potential opponents is Peter Singer, the only philosopher whose global influence exceeds Harris' on bioethical matters. Singer shares Harris' starting point but reaches significantly different conclusions. Much more than Singer, Harris takes a liberal-individualist stance towards utilitarianism, as if Bentham were simply a natural extension of Locke. He interprets the utilitarian maxim 'the greatest good for the greatest number' as something for everyone to decide for themselves as long as it does not prevent others from doing the same. An alternative reading of the utilitarian maxim, one closer to Singer and more in the original spirit of Bentham's maxim, would deal with matters in a more aggregate fashion, in which case one might query the benefit-to-cost ratio of regularly enhancing a deficient individual vis-à-vis simply transplanting that individual's remaining functional parts to others who might make better use of them. After all, utilitarianism is, strictly speaking, a philosophy dedicated to the maximisation of *social* welfare, and hence not *a priori* committed to the bodily integrity – let alone indefinite enhancement -- of *individuals*, whose value is mainly as sites for registering society's pleasures and pains.

This subtle but important point was brilliantly satirised a decade ago by the political theorist Steven Lukes in the novel, *The Curious Enlightenment of Professor Caritat*.[74] Lukes envisaged a utopia called 'Utilitaria' a land whose motto was 'From Welfare to Farewell', as citizens came to think of their legacy in terms of the body parts they could bequeath to fitter specimens, once their own bodies exhibited diminishing productivity returns on biomedical investments. It is easy to ridicule such a sensibility, but it actually captures a world in which people have come to realize that they are all made of the same stuff, given some largely accidental marginal differences.

If anything, from a Neo-Darwinian standpoint, Lukes' Utilitaria is much too tame. One could further argue that its regime needs to be extended to all animals, whose genomes after all differ from human ones by no more than 5%. At that point, we enter into Peter Singer's bioethical paradise, which would turn the welfare state into a guarantor of the efficient transfer of genetic material to enable the maximal productivity of the widest range of species.[75] This would amount to treating genes as

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[73]Harris, *Enhancing Evolution*, p. 37-8.

[74] S. Lukes, *The Curious Enlightenment of Professor Caritat (*Verso, London, 1996). According to Rawls, utilitarianism founders on personal integrity but is this really any different from species integrity: i.e. we're all samples of the same gene pool. Our humanity is that we set boundaries, categories, whereas nature by itself would be entirely indeterminate.

[75] Peter Singer, *Practical Ethics* (Cambridge UK: Cambridge University Press, 1993).

pure capital (or 'biocapital', to use Nikolas Rose's term) in search of greater mobility, with humans as just one of its many transient species bearers. (Imagine Richard Dawkins 'selfish gene' vision of evolution implemented as an extension of free trade policy.)[76] The nightmare scenario, then, would be not the Marxist one that humans might be replaced by technology once their productivity flags, but rather the Darwinist one that particular humans might need to be culled to ensure an efficient division of labour amongst species (aka symbiosis) in a sustainable ecology. Nazi Germany was the first society that claimed to act on the basis of this principle, which eventuated in the 'culling' of millions of Jews.[77]

Harris disappointingly fails to come to grips with this alternative future that could easily follow from his own Neo-Darwinian and utilitarian premises. He avoids discussing not only Singer but also more generally animal rights, android rights or, for that matter, any broader ecological orientation -- including the physical side-effects of nano-based biotechnologies that in the future may be used, say, to regenerate our organs or cleanse our bloodstream. Harris' ethical universe is resolutely anthropocentric and relatively innocent of concerns about cyborgs or any other witting or unwitting hybridisation of the human condition. However, the most touching feature of Harris' naivete is his reliance on Darwin's authority.

What makes Harris' faith in Darwin touching is that he retains so much of the unfounded humanist sensibility of Darwin's early followers. Like them, Harris cautiously welcomes transhumanism as humanism brought to self-realisation – not as a fundamental discarding of the human as an altogether inferior form of life. For a glimpse into the limits to Harris' imagination, consider this bland statement:

> It is difficult, for me at least, to see any powerful principled reasons to remain human if we can create creatures, or evolve into creatures, fundamentally "better" than ourselves. It is salutary to remember that we humans are the products of an evolutionary process that has fundamentally changed "our" nature.[78]

Of course, it is difficult -- especially if you cannot imagine that those future creatures might *lack* features that are now core to human identity. Here I don't mean creatures lacking in such historically deep human capacities as cognitive abstraction or moral reflection. I mean something much more basic. If the worst scenarios of global

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[76] In this respect, the molecular revolution has enabled biology to advance more swiftly along the trajectory charted in the 19th century in political economy, during which 'value' came no longer to be seen as ultimately grounded in land or even labour but inclusive of anything that could be exchanged at a price. Similarly, nowadays 'life' is not restricted to naturally evolved life-forms but extended to artificial entities that can function in a life-like fashion, i.e. bearers of biocapital. Given the closeness of natural history and political economy in the 18th century, with figures such as Linnaeus and Buffon having contributed to both fields (the idea of 'ecology' as nature's economy is a remnant of that era), it is striking just how *long* it has taken for life to become fully absorbed into the processes of commodification. Generally speaking, until the mid-20th century's consolidation of the Neo-Darwinian synthesis, biological thought held on to a strong distinction between 'natural' and 'artificial' that political economy had abandoned at least a century earlier.

[77] This precedent, including the likelihood that a similar 'culling' might occur in the future diffusely through the aggregation of individual choices in a 'bioliberal' regimes, is discussed in Steve Fuller, *The New Sociological Imagination* (Sage, 2006), chap. 14. Moreover, as in the case of Utilitaria, another distinguishing feature of any such diffusely executed culling in the future is that organs and other biomatter would be farmed and harvested from the victims, as already happens (at least from a natural law standpoint) during some forms of stem cell research.

[78] Harris, *Enhancing Evolution*, p. 40.

warming advocates turn out to be true, then our evolutionary successors might be best adapted to live in a restricted sensorimotor environment, so as to ensure minimal disturbance to the ecosystem. In that case, those whom we now call the 'disabled' may well constitute mutational vanguard of this posthuman species. Their advanced intellects would not be enhanced by capacities to intervene far beyond their physical location. (Think Steven Hawking.) From a strictly Darwinian standpoint, such a prospect must be taken seriously: After all, consider the downsized version of reptilian life that has descended from its dinosaur heyday.

In contrast, Harris, like many of today's so-called secular humanists, still harbours late 19th century hopes that evolution ultimately converges upon humanity's utopian fantasies. Yet, any substantial realization of those fantasies requires *deviating* from the default trajectory of evolution, at least as conceptualised in Darwinian terms, namely, a process lacking both knowledge and hope of the sort of fine-grained understanding of heredity that now provides *prima facie* plausibility to Harris' arguments for enhancement.[79] We tend to forget that, unlike Gregor Mendel, Darwin's belatedly recognised contemporary and the founder of modern genetics, Darwin himself stressed the *disanalogy* between the workings of natural selection and 'artificial selection', that is, the collected practises of animal and plant breeding that have informed agricultural progress over the centuries. Because Darwin believed that natural selection would always trump our best efforts at artificial selection, he was relatively pessimistic about humanity's capacity to relieve the more miserable aspects of our collective existence, other than by inhibiting the reproduction of those suffering from demonstrable genetic deficiency. Harris thus fails to realize that Darwin's true descendants are to be found amongst defenders of the precautionary principle, whom he humorously dismisses for their extreme risk-averse policy perspective.[80]

Harris' naive confidence in Darwin's support is exemplified in the 'retro-futurist' image that graces the cover of *Enhancing Evolution*, namely, the flexed arm muscle of a comic book Superman. In the mid-20th century, the phrase 'making better people' did indeed conjure up the idea of beings that were excellent versions of our current selves, as in the case of Superman, whose irradiated body expedited genetic change in generally desirable directions.[81] But nowadays transhumanism's normative horizons

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[79] In this respect, Lamarck is a surer guide than Darwin – especially in terms of the debates that normatively matter. The difference between Lamarck and Darwin is usually conceptualised in terms of how one explains adaptive variation in nature, with Lamarck allowing for a much greater amount of genetically transmitted learning than Darwin. However, the truly significant difference lies in their alternative conceptualisation of the evolutionary process. Whereas Darwin envisaged the origins of all species in terms of lines of common descent, Lamarck postulated that life was being created from scratch all the time, yet all creatures evolved towards some superior version of humanity. Thus, Lamarck is much less beholden than Darwin to species' physical morphology as a guide to what they might ultimately become.

[80] Harris, *Enhancing Evolution*, pp. 34-5.

[81] Much of this popular imagery was based on the work of Hermann J. Muller, a pro-Soviet US geneticist who won the 1946 Nobel Prize in Physiology or Medicine for discovering X-ray mutagenesis in fruit flies. However, Muller's own considered view was that irradiation usually produced lethal mutations that expedited death not evolution. Nevertheless, this line of thought must be considered as part of the tradition interested in simulating Lamarckian effects by Darwinian means. (One of Muller's fellow-travellers was Conrad Waddington, who housed Muller at the University of Edinburgh's Institute of Genetics in the early days of World War II, once Stalin's repressive policies made even Muller's eugenics-friendly research unfeasible.) While Muller avoided the transhumanist obsession with expediting evolution, he pioneered the movement's obsession with preserving (nowadays

veer towards what has been called *ableism* (i.e. able-ism), which aims for the indefinite promotion of various abilities, regardless of the species identity of their possessors.[82]

Ableists know enough about modern biology to realize that, left to its own devices, an accelerated version of natural selection is unlikely to result in creatures that we would be proud to call our own successor species. While evidence of common descent would no doubt remain in the genetic make-up and even the morphology of these later creatures, abilities valued in the earlier creatures might well have been eliminated because of intervening changes to the selection environment. Again, consider the relationship between extant reptiles and extinct dinosaurs: The mighty Tyrannosaurus would admit only with embarrassment its genetic responsibility for today's puny lizard.

In other words, for a pro-enhancement policy not to appear Sisyphean, one must believe that Mendel trumps Darwin – that artificial selection *can* beat natural selection. A consequence of this belief is that one might continue to value the indefinite promotion of, say, cognitive ability but come to realize, given changes to the natural world, that cognitive ability is best conveyed by creatures that significantly differ from our own biological make-up but whose creation is nevertheless within the range of our technological powers. One might regard such 'enhancements' in ontologically modest terms so that our cognitively superior successors look like us, or at least share the same material substratum – that is, they are carbon-based. The prospects for horizontal gene transfer, which revisits the Lamarckian idea that our offspring might be decisively affected by physical changes in our own lifetimes, would likely prove a first step in that direction.[83] For example, to enhance cognitive ability in an oxygen-deprived environment (assuming massive air pollution), the solution may be gene therapy based on some non-human species already able to get around this problem, from which then our offspring might also benefit.[84]

But of course, given more radical changes in the physical environment, the relevant sense of enhancement might move away from a carbon material substratum altogether to a more resilient silicon one that enables consciousness to be downloaded into computer androids. Put bluntly, Harris fails to see that a natural extension of his

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cryogenically) superior genetic stock by stressing how environmental pollution (not least from ambient radiation) was bound to deteriorate the human gene pool. Muller's career, which deserves close study today, highlights the Sisyphean dimension of transhumanism – i.e. unless continually proactive measures are taken, humanity's positive features will be undermined in the long term.

[82] A cynic might say that ableism marks the revenge of the disabled, since it would render normally abled people 'always already disabled'. Not surprisingly, then, the leading scholar-activist of ableism is Gregor Wolbring of the University of Calgary, who describes himself on his website as 'a thalidomider and a wheelchair user'. On the specific topic of this report, see the following article from Wolbring's very interesting and informative on-line article series: 'Ableism and NBICS', http://www.innovationwatch.com/choiceisyours/choiceisyours.2006.08.15.htm, 15 August 2006.

[83] See Freeman Dyson, 'Our Biotech Future', *The New York Review of Books*, vol. 54, no. 12, 2007. Dyson draws heavily on the work of the University of Illinois microbiologist Carl Woese.

[84] Ableism is a natural ally of the so-called adaptationist perspective on global climate change, which argues that rather than trying to deny or even stop climate change, the best course of action is to 'adapt', which may of course entail adapting our bodies as well as our external socio-economic systems. See Nico Stehr and Hans von Storch, 'Editorial: Introduction to papers on mitigation and adaptation strategies for climate change: protecting nature from society or protecting society from nature?' *Environmental Science & Policy* 8 (2005) 537–540.

argument is a license to write us out of existence by disaggregating 'the human' into a set of capacities, each of which can be assessed and extended separately without the others that have been associated in evolutionary history with the human condition. Thus, the ableist aims to make good on an assertion that was originally treated as highly controversial when the UK bioethicist Jonathan Glover uttered it a quarter-century ago: "Not just any aspect of present human nature is worth preserving."[85]

At the very least, under the abelist regime Harris countenances, the distinction between 'abled' and 'disabled' would be both relativised and modularised. This, in turn, would tend to expand the definition of 'disabled' from its traditional meaning (i.e. physical disability) to include a broader but vaguer category like 'disadvantaged' (aka 'non-competitive' or 'non-adaptive'), into which individuals may fall not because of any change to their bodies but, on the contrary, simply because their bodies fail to change in accordance with the norms of what Nikolas Rose calls 'somatic expertise'. Thus, people may come to think of themselves as 'always already disabled', that is, on the verge of falling behind in a social world where regular neurochemical upgradings are expected as a precondition for adequate performance.[86] The first stirrings of this general problem have already entered public view in controversies concerning the use of drugs to enhance competitive athletic and academic performance. The political responses so far suggest that this feature of the ableist agenda may well be subject to considerable regulation but it is very unlikely that its advance will be stopped altogether.[87]

Why is Harris blind to the prospect of enhancement? Despite his progressive rhetoric, Harris shares with his opponents – including Jürgen Habermas, Francis Fukuyama, Leon Kass (George W. Bush's bioethics tsar) and the Harvard political theorist Michael Sandel – a belief in an ontologically robust idea of human nature. But this idea is not borne out by either Darwin's own purely conventionalist account of species identity or the general drift of transhumanist thought towards a 'posthuman' condition. Indeed, Harris looks progressive only because of the primitive state of the most controversial enhancement technologies. This means he can have his cake and eat it: He can gesture towards a transhumanist future but for now his hardest cases

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[85] Jonathan Glover, *What sort of people should there be?* Penguin, 1984. Like many transhumanists, Harris conflates the 'superman' image of the transhuman (i.e. better humans) with the 'cyborg' image, which is a more likely outgrowth of CT-based enhancements: i.e. incorporation of hybrid carbon-silicon entities (including genetic xenotransplantation) that will likely reorient people's sentiments so as not to privilege the human. In the late 1980s, Donna Haraway promoted the cyborg image – then a staple of science fiction – as a model for feminism, given that 'human' meant white male humans. However, it's not clear whether female humans (black or white) benefit from this proposed redistribution of sentiment.

[86] Whether this relativisation of disability actually benefits or simply marginalises even further those traditionally treated as physically disabled remains an open question.

[87] One highly publicised rearguard attempt to halt such free-floating enhancement policies comes from the communitarian political philosopher, Michael Sandel, *The Case against Perfection: Ethics in the Age of Genetic Engineering* (Harvard University Press, 2007). Sandel argues that ableist ideals violate the integrity of well-established social practices -- including games -- that rest on norms of fair play. However, perhaps the most thoughtful discussion of this issue comes from a clinician at the University of Pennsylvania medical school, who attempts to draw lessons from the history of cosmetic surgery, which, after having begun as war-related reconstructive surgery, developed in a largely unregulated fashion in the consumer market: Anjan Chatterjee, 'Cosmetic neurology and cosmetic surgery: Parallels, predictions and challenges', *Cambridge Quarterly of Healthcare Ethics* (2007): 16, 129-37. An interesting feature of Chatterjee's account is the role assigned to Alfred Adler's 'inferiority complex' theory in converting cosmetic surgery into a free-floating biomedical treatment.

concern the prospect of humans in more-or-less their current embodiment living indefinitely.[88] To be sure, such cases raise interesting metaphysical questions, given the long-standing link that Western culture has forged between the meaning of life and the inevitability of death. However, it will not be long before advances in enhancement technologies broaden the metaphysical issues to include what the medieval scholastics called 'the problem of universals', namely, how can the same form be communicated in different configurations of matter. More concretely: How would one determine whether an entity substantially different in material composition from today's humans is still human – or at least sufficiently human to merit the value normally invested in humans?

At first glance, Harris' faux progressivism reflects the familiar philosopher's flight at dusk, to recall Hegel's line about the Owl of Minerva. In other words, *Enhancing Evolution* mainly provides reasons for discarding positions that the onward march of science has already made irrelevant. However, their irrelevance has yet to be fully appreciated because these 'undead' positions are conveyed by the likes of Habermas and Fukuyama who for now remain prominent in public intellectual life. For the most part Harris rightly rejects their views, though sometimes his arguments could be more forceful.

For example, Habermas worries that genetically designed offspring would lack any sense of moral autonomy by virtue of having been – and knowing to have been – produced as means for realizing the ends of parents who, say, wanted a child with certain looks and talents.[89] Harris counters by observing that child-rearing has been always to some extent instrumental, the only difference now being our enhanced capacities for strategic intervention: Matters that in the past were dealt with diffusely by, say, placing the child in a certain environment are increasingly treated in a more focused fashion with drugs or even germ line manipulation.[90] But this utilitarian response is unlikely to sway Habermas, for whom autonomy is non-negotiable at any price. Harris would have done better to stress that autonomy has been always a procedural, not a substantive, value. In other words, we respect people's autonomy by treating them a certain way, *regardless* of what we know about them. Thus lies the wisdom of John Rawls' 'veil of ignorance' as the original position from which to determine the fundamental principles of justice.[91] But more importantly, the material basis for attributing autonomy may be strengthened by enhancement research, much of which aims to reverse the effects of prior causes, ranging from the use of stem cells in regenerative medicine to the removal of memory traces, as depicted in the 2004 Hollywood film, *The Eternal Sunshine of the Spotless Mind*. The result is to expand both the physical and the psychological sphere of action, overturning the commonsense view that age necessarily narrows our existential horizons.

But Harris' blindspot goes beyond his philosophical obsession with telling history's losers exactly why they have lost. He is almost completely blind to the truth contained in their concerns, perhaps because he is so lacking of a religious sensibility. The missing link between Hegel and Marx, Ludwig Feuerbach became notorious for arguing that the Judaeo-Christian God was simply the alienated projection of all that

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[88] Harris, *Enhancing Evolution*, pp. 67-8.
[89] J. Habermas, *The Future of Human Nature* (Cambridge UK: Polity, 2002).
[90] Harris, *Enhancing Evolution*, pp. 137-42.
[91] John Rawls, *A Theory of Justice*. (Cambridge MA: Harvard University Press, 1972).

humans valued in themselves, only now used to judge and dominate them. To be sure, there are both empowering and disempowering features of this cognitive tendency. Feuerbach, himself a theologian by training, was debarred from the academy because he promoted Humanism as an empowering religious successor to Christianity. Other post-religious practices have included state-worship and the identification with corporate entities more generally. While Hobbes' *Leviathan* and Hegel's *Philosophy of Right* may be read as relatively even-handed treatments of the pros and cons of such alienation, Marx, Freud and many 19th and 20th century thinkers have stressed the pathological dimensions. A radical transhumanist movement like ableism aims to redress the balance by justifying human self-sacrifice for the sake of some other being that more fully realizes what we most value in ourselves. Not surprisingly, in the hands of gurus like Ray Kurzweil, research into artificial intelligence and artificial life looks like high-tech political theology, what the popular writer Erik Davis has called 'TechGnosis'.[92]

I said that Harris is 'almost completely blind' to the radical nature of the transhumanist challenge. The one aspect he sees is the need for people to participate more actively in scientific research relating to enhancement, what he euphemistically urges as their 'mandatory contribution to public goods'.[93] Harris justifies such participation, despite its risky aspects, on both scientific and moral grounds: Not only is it likely to improve the range and quality of the scientific findings but also it addresses our obligations to promote our own and future generations. Harris' book ends on this note, which is not bad. Needless to say, were public participation in enhancement research to attain the status of jury duty, it might also establish good will for a form of inquiry that is bound to challenge our sense of who we are in the years to come.

6. Conclusions: Very General Policy Recommendations

I do not consider what follows my final word on this very interesting but continually unfolding topic. However, it will do for purposes of meeting a deadline.

One should not think of the disciplines involved in the CT agenda as somehow driven by their separate paradigms towards convergence, which once fully realized can then be applied for the benefit of society. On the contrary, the relevant sciences are pursuing many different agendas at once, progress in which is currently driven by the client base – not least its patience in waiting for the relevant breakthroughs that would serve its interests. This state-of-affairs has rendered biology a financially successful but intellectually incoherent discipline, which philosophers sometimes dignify by saying that the science operates with a 'disunified ontology'.[94] Thus, people who call themselves 'biologists' are driven, on the one hand, to search for 'deep' explanations for social traits already present in species that evolutionarily preceded it and, on the other, to reverse that implied history through micro-level manipulations of the sort associated with CT. Under the circumstances, overlap in the client bases probably better explain any existing tendencies towards convergence than some philosophically

[92] Erik Davis, *TechGnosis: Myth, Magic and Mysticism in the Age of Information*, Harmony Books, San Francisco, 1998.
[93] Harris, *Enhancing Evolution*, p. 196.
[94] The *locus classicus* is John Dupré, *The Disorder of Things* (Harvard 1993).

inspired notion that independent lines of free inquiry tend to converge on a common truth.[95] In this respect, states and inter-state bodies – as long as they remain major players in the funding and regulation of scientific research – are in an unusually good position to provide direction at both the level of theory and application.

A realistic starting point for policy is not a generalised scepticism towards the promised enhancement technologies associated with CT but an expectation that many will come to pass, albeit perhaps in diminished form. In any case, a minimal state or inter-state response would be to ensure that current socio-economic inequalities are not exacerbated by the introduction of enhancement technologies in a market environment. Of course, a more proactive policy would be preferred, especially one prepared to quickly incorporate enhancement technologies into established social welfare systems, while monitoring the consequences of mass adoption and restricting access outside those recognised systems. However, here two obstacles need to be overcome:

(1) In principle objections from a broadly natural law standpoint about the violation of 'human being'. Rather than giving the religious origins of this concern a free pass, as a gesture to political tolerance, it will become increasingly important to contest the empirical basis for its concerns – Is everything about the human body sacrosanct? If so, why? These matters have seriously contested within the theological traditions of Judaism, Christianity and Islam, and so there is no reason to think that the most vocal and perhaps stereotypical religiously inspired objectors to enhancement are representative of all considered opinion.

(2) However, a more substantial long-term problem is the element of risk that individuals will need to assume as new enhancement technologies are made generally available. The increasing concern with protecting human subjects during clinical trials and other experimental settings merely offloads the difficult question of the conditions under which a proposed enhancement is considered sufficiently safe to be made available *en masse*. It is unlikely that there will ever be clear answer. Indeed, there are likely to be major failures along the way, though hopefully not on the scale associated with faulty eugenics policies in the past. Nevertheless, states and inter-state bodies will need to provide some sort of welfare safety net or insurance against the risks that individuals will obviously undertake – and be encouraged to undertake -- by subjecting themselves to enhancement regimes.

[95] A good example would be a public relations or advertising firm that invests in both evolutionary psychology and CT research, the former producing knowledge about what cannot be changed about human response patterns (which means indirect market strategies that play on those hard-wired biases) and the latter knowledge of what can be changed (which may mean further investment in such changes so as to avoid the need for indirect marketing).