

# The Dual Role of Science in Modern Society

by

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**Prepared for**  
**The Canada – United Kingdom Colloquium**  
**“Science and Public Policy”**  
November 20-23, 2003  
Tortworth, South Gloucestershire, England

**Also delivered at the**  
**Pacific Centre for Technology and Culture**  
**University of Victoria**  
**Lecture Series Winter 2004**

Revised September 2005

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## *1. Technology and Culture: Overview.*

The contention in this paper is that there is a hidden problem in the relationship between modern science, modern technology, and modern culture. What generates this problem is the unresolved tension between two dominant and competing aspects of the scientific revolution in the modern world. The two aspects I call "inventive science," or science as progenitor of products, and "transformative science," or science as progenitor of cultural change. (The relationship between science and technology in the modern world is so necessary, and so close, that in naming either of them separately I am always referring to both together.) The first goes from triumph to triumph and is essentially uncontested; the second, however, is strongly contested by competing social forces and its ultimate fate is highly uncertain. I shall try to show that this discrepancy holds great perils for humanity. I argue that, unless we address this discrepancy directly and resolutely, the very foundations of the modern world may be undermined.

## *2. Prologue.*

While many of my contemporaries were learning useful skills in graduate school, I was being trained in the intricacies of the Hegelian dialectic. The analysis I'm presenting here is derived from it, and there are three themes I'd like you to watch for:

- (1) Historical development is driven, within discrete epochs, by a process of internal tension within a system of ideas which becomes dominant over time. The epoch in which we find ourselves is often referred to as "modernity."
- (2) Progress – in Hegel's terms, a progressive deepening of the idea of freedom – is a circle: When an epoch of historical development starts drawing to a close, and

nears "fulfillment," the human actors arrive back where they started – not at the same place, to be sure. Rather, this "back to the beginning" means that we are forced to confront that tension, referred to above, squarely and explicitly, and to resolve it. Until this is done we cannot move further forward, and unless it is done, we face certain practical difficulties (to be explored later) that can threaten to undermine the achievements of that epoch.

(3) Hegel used a famous metaphor – "the Owl of Minerva takes flight at dusk" – to convey the idea that our insight into the essence of any historical epoch only occurs when it is drawing to a close, when the internal tension that lies at its core presents itself to historical actors explicitly – clearly and unequivocally – as an inescapable task to be addressed. I believe we have arrived at this point in the epoch called "modernity."

### *3. Where and when it all began.*

The dialogue about science, technology and culture began in England about 400 years ago. Francis Bacon (1561-1626) spent his entire life on this subject, trying to win government support for a grand project to promote technological innovation.\* As a young man he even tried to seduce the Virgin Queen by writing a stage-play about the need to have the state support and fund organized research – but undoubtedly Elizabeth I was distracted by more pressing problems at that time, represented both by the Spanish Armada and by the would-be assassins among her own citizens who were working on behalf of the Vatican.

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\* For a fuller discussion see William Leiss, *The Domination of Nature* [1972], chapter 3 (Montréal: McGill-Queen's University Press, 1994).

Bacon never gave up, but he ended his life a bitter and disappointed man, and not only because his political enemies had succeeded in disgracing him, having him removed from his position as Lord Chancellor on trumped-up charges of bribery. He had also, in his own estimation, failed to convince his influential contemporaries to support his great project – the betterment of humanity’s conditions of life through a new conception of science and sustained technological progress. He was up against a powerful, ancient institutional alliance between philosophy and religious dogma, which looked with disdain at what was referred to then as the “mechanical arts” (what we call applied sciences and technologies).

Only towards the end of the eighteenth century, after the Enlightenment and the French Revolution had swept away this ancient dogma, could it be said that Bacon’s view had triumphed. (Bacon was a great hero in the eyes of many of the Enlightenment thinkers.) And it was only in the works of these eighteenth-century thinkers that the full richness of Bacon’s original message became clear – for, remarkably, Bacon, standing at its point of origin, had in fact defined the essential, internal tension in the epoch of modernity. This tension may be described as the two-sided significance of science and technology for society, to which I shall assign the labels *inventive science* and *transformative science*:

- (a) By the term *inventive science* I mean the promise of “the conquest of nature,” the vision of an endless stream of new products and technologies to enhance the material conditions of life and human well-being.
  
- (b) By the term *transformative science* I mean the penetration of the “ethos” of the modern scientific method *throughout all of society and its institutions*. Specifically, the experimental method, with its emphasis on the objective

demonstration of results, confirmed in a peer-review process; a thoroughly skeptical attitude to all received wisdom and traditional belief; the search for the "laws of nature" existing independently of human thought and interests; and what we would now call an "evidence-based" approach to the analysis of the causes of human misery, ignorance, and backwardness.

I shall argue later that the second is even more important than the first.

Bacon was well-aware that to most of his contemporaries the wisdom and value of this project was not at all self-evident. We can imagine an objection: 'Are you insane? You want to put a greatly-enlarged human power – obtained by a harnessing of nature's vast powers through a new understanding of nature's laws – into the hands of a savage and fanatical humanity, whose wickedness threatens to burst the frail bonds of society at every moment?' He could have heard such an objection from his slightly younger contemporary Thomas Hobbes (1588-1679), the greatest of modern political theorists, for one. After all, the lives of Bacon and Hobbes spanned two centuries of continuous religious warfare, ferocious and sadistic in nature, on the European continent.

But Bacon was too enthralled by his own project to consider the objection seriously. He acknowledged the dilemma – namely, that an enlarged "power over nature" placed into humanity's hands would need to be superintended, somehow – but he dismissed it with a formulaic response. In his book *The New Organon* he wrote: "Only let the human race recover that right over nature which belongs to it by divine bequest, and let power be given it; the exercise thereof will be guided by sound reason and true religion." He would not live to see the triumph of his program, however.

Towards the end of his life he consoled himself by writing a utopian fantasy, *The New Atlantis* (first published posthumously in 1627), depicting a form of society where an élite scientific research establishment sets its own rules and runs the investigations of nature independently of political authority.

During the ensuing two centuries – through the end of the eighteen-hundreds – there were not all that many new “products” emanating from scientific laboratories, although the foundations of invention were being laid down in the new sciences of chemistry and physics. During that period, however, the second part of the bargain, transformative science, triumphed over its opponents within European culture. This triumph is wonderfully summed up in the great posthumous work by the Marquis de Condorcet (1743-1794), *Sketch for a Historical Picture of the Progress of the Human Mind*.<sup>†</sup> This text is the clearest statement of the idea that the new scientific methods are not only important for the truer understanding of nature. Rather, their highest importance lies in the fact that they can and should be diffused throughout society, by means of universal education, and that social policy and social institutions will be rendered more humane and just as a result.

#### 4. *Where we are now.*

If we were to “fast-forward” another two centuries, and glance at the “products” of the new sciences and technology in terms of their impacts on human life (at least, where they are widely available to the population, that is, in Western advanced industrial

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<sup>†</sup> Condorcet, a member of the aristocracy, supported the French Revolution, but he was arrested during the Terror and committed suicide while awaiting execution. See *The Domination of Nature*, pp. 77-79.

economies), we find that the following risks, among many others, have been substantially reduced:

- ❖ Mortality risk of childbirth for women;
- ❖ Infant and early-childhood mortality;
- ❖ Traditional infectious diseases (cholera, smallpox, etc.);
- ❖ Malnutrition and inadequate housing;
- ❖ Ignorance (lack of basic education);
- ❖ Personal security (crime);
- ❖ Political oppression, injustice, and torture;
- ❖ Debilitating and dangerous labour;
- ❖ Gross suffering from accidents, disease, and dental decay;
- ❖ Overpopulation pressure (birth control) – arising in large part from controlling the above-mentioned risks!; and
- ❖ Lack of treatment for important mental disorders.

All of these victories are summed up in the increase of average life-spans. If Francis Bacon could come back to observe all this, I am sure he would say: ‘Congratulations. You did it! The job is done.’

Well, not quite done. There are many respects in which the job is not yet done, but here I want to concentrate on only one – and not the one represented in the idea of “science the endless frontier,” associated with the figure of Vannevar Bush (1890-1974).<sup>‡</sup> Or the one represented by the brave new world of the genetic prophets, who envision extending human life-spans to multiple hundreds of years, engineering “human perfection,” and developing an ability to create entirely new life-forms based on the

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<sup>‡</sup> [http://www.livinginternet.com/i/i\\_bush.htm](http://www.livinginternet.com/i/i_bush.htm)

platform of the "minimally necessary genome."<sup>§</sup> Rather, I refer to the one that will take us back to the point where I started these remarks: The internal tension in the project of science for modernity, the tension between *inventive science* and *transformative science*.

What happened was, as the epoch of modernity unfolded in the period after 1600, the intrinsic difficulties hidden within its two-sided structure come to the fore. In a nutshell, the two sides in the internal tension, inventive science and transformative science, no longer support each other but, increasingly, have become dissociated. This results from the *hyper-development* of one side (the inventive) and the *under-development* of the other (the transformative): Beginning with nineteenth-century industrialism, the *products* begin to overawe the *ethos*.

I don't have time to argue the point here, so I will just state it as a proposition: What I am talking about is the *cultural mission* of the scientific-technological ethos. Some of its features are: a decline in the secular influence of religion, especially in the field of public education; the spread of the philosophy of *rationalization* (in the Weberian sense) throughout all social institutions – what Weber referred to as the "disenchantment" of the world; and the application of what we can call an "evidence-based" approach to the management of public health and safety, in medicine, law, the justice system, social welfare policy, and so on. There are many other features, of course – I have just offered some examples. We might take something like Québec's "silent

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<sup>§</sup> See my essay (2003), "Elementary, my dear Watson": <http://www.leiss.ca/chronicles/88>



revolution" as a late-stage example of this process as it appears in the form of a comprehensive "program" of social and cultural transformation.

Thus it is fair to say that this cultural mission remains alive and well today, at least in some respects. In other respects, however, it is challenged by countervailing forces which, it seems to me, are increasingly powerful. In other words, the first important point to be made is that, whatever successes have been chalked up in the service of this mission, those successes are not permanent victories. Rather, they remain contested and challenged, even in the heartland of their triumph, namely, the modern economies of the industrialized West. One way of imagining this is to say the two sides (inventive and transformative) no longer exist in a mutually supportive relation, but instead have begun to follow independent paths of historical development.

There are two aspects of this dramatic and fateful change. First, the disintegration of the two sides in this relation first appeared where this historical dynamic originated, within Western society itself – in the two world wars of the twentieth century, and especially in the descent into the madness of totalitarian ideologies, fascism and Soviet communism. The thinkers of the Frankfurt School captured this process with the phrase "dialectic of enlightenment": The project of "rationalization" of society and technology splits apart, where the increasingly powerful "means" (the methods and tools supplied by a rational science of nature) are used as weapons in the service of irrational "ends," the ideologies of social domination.\*\* As of

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\*\* See Rolf Wiggershaus, *The Frankfurt School: Its History, Theories, and Political Significance*, tr. Michael Robertson (Cambridge, Mass.: MIT Press, 1994).

about 1940, it might be said, the ultimate outcome of this process for Western democracies literally hung in the balance. It was a matter of pure chance that the Nazi regime's own administrative chaos, and its single-minded pursuit of the extermination campaigns against those called *Untermenschen* while military battles raged, may have contributed to its weakness and collapse before its scientists had succeeded in developing atomic weapons.

In this context we saw the first sign that Western society might have begun to lose control over the terms of the Faustian bargain it had made long ago. That sign was the decision by the Allies to weaponize the newly-discovered power of nuclear energy during the Second World War, a decision driven by the fear that Germany might do so first. J. Robert Oppenheimer and other scientists of the day agonized over it, knowing that a fateful threshold had been crossed with our entry into the nuclear age. Again, it can be said that, at various times during the Cold War, under the threat that the vast arsenals of hydrogen bombs held by the U. S. and the Soviet Union might be unleashed, the fate of modern civilization once again hung in the balance. That threat has not yet disappeared, and these days fears of nuclear proliferation are a major preoccupation of the international community.

Second, for Bacon and his followers, this was supposed to be a project undertaken on behalf of humanity as such. But the same division that first appeared within Western society itself – where the products began to overawe the ethos – now has been reproduced in the divided state of the human population as a whole. Now

inventive science is fully global and international, but transformative science is far from being so.

My belief that we have reached a decisive phase in this historical project of modernity is grounded in an evaluation of the significance of the newest revolutionary technology, namely, molecular biology and the prospects for human genetic engineering. I am thinking especially of the capacities we will soon have to deliver the following kinds of products: gene therapy and gene enhancement; germline gene therapy; extending life-spans by a factor of 2 or more; and manipulating genes that code for brain functions and behavioural outcomes. For the first time in human history, we are being presented with a technological capacity that can reach deeply into extraordinarily sensitive dimensions of life: the integrity of the person and the family, the concept of the person 'made in the image of God,' and – especially – the unity of the human community itself (as a result of the possibility of creating genetically isolated subpopulations).

This is itself the end-point of a logical progression. The growth of the new science first extended "outward" from human agents to external nature, mastering – through the disciplines of physics and chemistry – the immense forces inherent in matter and energy and harnessing them to human purposes. Having succeeded on this plane it returns, in biology and then molecular biology, to the sphere represented by the nature of the human agents themselves, to the human person as a phenomenon of nature and as an "object" of scientific understanding – and potential transformation.

Here you can see clearly the dialectical progression at work. In its initial phase, the project for the domination of nature takes the nature that is external to the human agent (the "environment") as its object, "objectifying" it as purely a sphere of matter and energy fields. The human agent remains secure in this orientation to the environment, as pure materiality, because it also claims to know itself to be, in its own essence, qualitatively different – as the possessor of "spirit" – in the religious, not the philosophical, sense. The agent thus stands over against its own self-generated process of inquiry and transformation of nature as something *essentially* different. And yet, inevitably, this is a false differentiation; the project has an internal contradiction, in that its own method (science) cannot validate the truth of its claim to be essentially different. Inevitably, the difference collapses, and the human agent confronts itself as fully integrated into objectified nature, i.e., as – paradoxically – a self-objectified entity.

For one illustration, I refer you to an account in the *New York Times* (12 February 2004), about a paper published in the journal *Science*, where South Korean scientists announce they had cloned human embryos and extracted embryonic stem cells:

"Of course," he [Dr. Woo Suk Hwang] said, "we acknowledge that there will be controversy. But as scientists, we think it is our *obligation* to do this [emphasis added]."

The paper describes the successful process in detail, with precise information on how to start the embryos growing and what solutions are best to nourish them. That recipe appears to advance the likelihood of reproductive cloning. When fertility laboratories fertilize eggs, grow embryos to the same developmental stage as the embryo clones and implant them in a human uterus, 40 to 60 percent end up as babies.

The scientists stress that all the research was in the laboratory, in petri dishes. No embryo was implanted in a woman. The women who provided unfertilized eggs that were needed to start the cloning process were not paid. The research was financed by the government of South Korea, where cloning to create a baby is illegal.

Dr. Hwang is an expert in animal cloning, and Dr. Moon is a medical doctor who trained in the late 1980's at a leading American fertility center, the Jones Institute for Reproductive Medicine at the Eastern Virginia Medical School in Norfolk. That is one of the very few places where researchers have extracted human stem cells from embryos that were made the usual way, by using sperm to fertilize eggs.

Until now, no one had even come close to using cloning to create a human embryo or even a monkey embryo, to say nothing of extracting stem cells from one. Stem cells are the research prize. They appear after an embryo has grown for five or six days, its cells subdividing within the hard casing of the egg. Although the embryo at this stage contains about 100 cells, it is still no bigger than the original egg, nearly invisible to the naked eye....

"Now you have the demonstration that everyone was waiting for," he [Dr. Jose B. Cibelli, Michigan State University] said. "Whether this approach will be applicable to making babies, I don't know. And I hope I never find out."

In the act of cloning itself the human agent announces that it believes itself to be exactly like the rest of nature, i.e., pure materiality. But note especially the first sentence in the quoted passage, with its reference to the "obligation" to take this step: The idea is that the human agents are not "free" to decide whether or not to do so; rather, it is the "project" itself which dictates what we must do. Presumably, it will continue to dictate to us where we must go along this path, wherever it takes us.

Where does this path lead? The science of genomics intends to characterize fully the complete DNA code for all living things, plants and animals (including ourselves) alike – or, at least, all of them which hold any interest for us. It also intends to understand completely the mechanisms whereby genes do their work – how they create the proteins that then produce first cells, then tissue, and then complete organs, including the brain, how they are switched on and off, how and why "mistakes" may occur (giving rise to inherited diseases, including serious psychological disorders), and how their "outputs" might be modified or enhanced. (For example, there has been much talk already about creating "super-athletes" through gene manipulation.) Genomics will

wish to complete its knowledge of how a gene might be entirely deleted from a DNA sequence, or added to it where it has never before existed, and what the consequences are of doing so (we already know that there are many unintended secondary effects from adding or deleting particular genes).

There is a great prize lurking in the background – namely, to know how to manipulate the genes that code for the development of the most complex structure in all of nature, namely, the human brain. In the Fall of 2003 the Paul Allen Foundation, based in Seattle, announced a plan to fund neurogenetics research designed to identify – within a period of five years – all of the genes that are responsible for creating the brain's structure and properties. And when that is done, as it surely will be, the scientists will turn to us and ask: What would you like us to do with this knowledge?

In my view it is precisely this trajectory of contemporary science, called the genomics revolution, that causes the internal tension between the two ideas of science, transformative and inventive, now to be stretched to the breaking-point. The possibility arises, for example, that many uses of the genetics knowledge described briefly above will give rise to widespread horror and revulsion – and that this reaction will extend to a rejection of the scientific project of modernity itself. In another context, there are forces in the world today which are prepared to use every lethal product of science – including its radioactive materials and genetically-engineered pathogens – against the edifice of modernity itself, against the real enemy (in their eyes): the promise of the ethos of transformative science to “modernize” social policy and social institutions.

Alas, I think that they are right about where their real enemy lies: In at least one key respect transformative science is the more important side of modernity's project, because its success is the presupposition for the secure and lasting enjoyment of the products of inventive science. And now we have arrived at the key point I want to make in this remarks.

### *5. What remains as unfinished business.*

What happened? Now I return to where I started. Historical actors are "compelled" by the process of development to recognize, confront, and resolve the inner tension which characterizes each epoch – in our case (modernity), the double-sided character of its most powerful and defining element, its new science. So far we have just let this tension run its course, allowing the work of science to be driven, blindly and willy-nilly, by other institutional forces (economic growth and wealth creation, imperialism and warfare, the North-South divide, and so on). And in doing so we have allowed the originally "organic" duality inherent in the scientific project (its co-existing inventive and transformative aspects) to shatter and dissolve: Now science as product advances at an accelerating pace, whereas science as ethos appears to be not only stopped dead in its tracks, but to be retreating in some respects.

The task that lies before us is inescapable, urgent, and enormously challenging. We are required to take steps towards mastering the relation between science, technology and society. ("Public policy" is the third term that stands between, or mediates, this relation.) This means, to devise effective institutional structures whereby

the existing imbalance between inventive and transformative science can be rectified.††

The steps include:

- (1) *Comprehending* the scope and dimensions of the problem, both in conceptual terms and as a practical and concrete matter;
- (2) *Analyzing* the path towards innovations in institutional structure that will be adequate to address it;
- (3) *Implementing* new measures within institutions that will begin to carry out the necessary steps.

The purpose of this program is to overcome the dangerous limitations inherent in our present situation, where the global colossus of inventive science builds its resources and influences daily, while transformative science languishes and in places retreats. (The Hegelian term for this process of overcoming is *Aufhebung*, describing a process in which the historical heritage is preserved while annulling the too-limited form it has come to assume.‡‡) To fail in the process of this overcoming is to surrender to the undirected play of competing historical interests and alignments.

We can already glimpse the end-point towards which we must strive: The creation of a global governance structure, matching the global reach of inventive science itself, which can champion and extend the comparable reach of transformative

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†† In the technical language of Hegelian thought: We must "posit" the relationship between science and society as a task, setting it before ourselves as a problematic concern of the highest order.

‡‡ If this appears to be obscure, think of the famous description of the essence of capitalism by Josef Schumpeter, the process of "creative destruction."



science.<sup>§§</sup> But where to begin? The task is to bring the tension between science and society to the forefront, where we can set a program to begin reflecting on it systematically, but in a concrete way. A necessary precondition for its success will be to engage scientific researchers at the most senior level, because there is no prospect for its success, as a practical matter, where they do not become an integral part of this program.

Therefore I propose that every major research funding body in the Western world, as well as every national academy of science, should move towards the creation of an office of science and public policy within its walls. This office would employ dedicated, professional staff charged with the mission of devising specific programs in which scientific researchers, on the one hand, and both policy professionals and elected politicians, on the other, would come together in structured sessions. As defined earlier, these sessions would be devoted to the chores of first comprehending the task before us (recognizing clearly what the problem is), then analyzing it as a practical challenge requiring new institutional structures, and finally implementing those structures in national policies and international conventions.

This is an immense undertaking, and those called to its service will experience many setbacks along the way, until they come to believe that they are engaged upon the labours of Sisyphus. But they cannot be allowed to fail.

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<sup>§§</sup> A public debate held in 1923 between two twentieth-century British giants, the biologist J. B. S. Haldane and the philosopher Bertrand Russell, which was itself an outcome of the horrors of the First World War, foreshadows the present discussion. See *The Domination of Nature*, pp. 4-7.