Lecture 2: "Science and Society in the Modern Period"
SFU Harbour Centre, 14 March 2007

This is the second in a series of three lectures. To begin tonight I'd like to give a very brief overview of the first one, for those who missed it; at the end, I'll indicate how I will extend the discussion into the third session. **[Slides 1/2]**

A Brief Review [Slide 3]

In the first lecture, I suggested that recent developments in modern science have changed the meaning that science has for our lives. The trajectory of modern science and technology moves from the enhanced capacity to manipulate matter and energy in our external environment – the world "out there" – to the world of our personal space, that is, the sphere of our own bodies and minds. Phrased otherwise, we who seek to turn everything else in the world into "stuff" to manipulate, in order to better satisfy our needs and whims, become such stuff ourselves. Indeed, there is something eminently "logical" in the latest phase of development: The lens of science, focused for so long on the world outside, turns 180 degrees and now peers inside us. Every last aspect of the natural environment has been successfully analyzed, manipulated and steered toward the satisfaction of human purposes – and now it is our turn. **[Slide 4]**

Science has begun to focus on the genetic structures that make us what we are, as a mammalian species, and especially – the great prize – on how our brains and minds work. Neuroscientists want to know, for example, how the mass of tissue in our heads

carries out its amazing, complex operations, the brain functions that we otherwise refer to as mental activity. In neurological terms these operations show up as the firing of neurons in response to chemical neurotransmitter cascades and the generation of patterns of electrical discharges in all directions across the regions of the brain. And once we know how it works, we are on the way to being able to play around with it – to repair it, say, when it's damaged, or perhaps even to upgrade its performance.

At the close of the first lecture I asked: Will we come to think of our brains in the same way as we do a Japanese auto racing engine? **[Slide 5]** Can we imagine just stripping it down, examining its components – memory, mood, learning, reasoning, feeling, and so forth – and then tinkering with the various parts? Is it only fair that we treat our own minds as we do the rest of nature, changing and controlling things to suit our every whim? Are you quite comfortable going down this road, knowing that whatever awaits us at the destination may be impossible to predict?

In becoming "up close and personal," science now touches directly on many of the most sensitive and meaningful domains of life, such as sexuality, inner feelings, and personal behaviour. Looming over all of these domains is a question posed to us that we have never had to answer before during all of human history to date: Would you like to change any of this? And if so, would you like to make such changes not just for yourselves, but for your children, and all of your descendants, while you are at it? Finally, with respect to these questions, do you believe that such decisions are rightfully yours alone to make, without oversight or interference by others or by governments?

Part II: The Long View [Slide 6]

The first lecture ended with those kinds of questions. Tonight, in the second of the series, I suggest that we step back for a moment, and look more closely at the longer course of modern science and its social context. Let's go back to where it all started, in the late eighteenth century, to the period known as the French Enlightenment. **[Slide 7]** This is when Antoine Lavoisier, known as the "father of modern chemistry," lived, during the time when the engine of modern science began to be constructed in earnest. But tonight I want to focus on the contributions made by another remarkable individual from that period, a man with a wonderful name: Marie Jean Antoine Nicolas Caritat, Marquis de Condorcet. **[Slide 8]** By a strange coincidence, Condorcet has exactly the same dates of birth and death as does Lavoisier (1743–1794). Condorcet, a brilliant mathematician, was elected a fellow of the Academy of Sciences at the age of twenty-six. After the overthrow of the monarchy he was an elected deputy in the Assembly, where he was a passionate champion of the rights of women and blacks; but like Lavoisier, he was condemned unjustly and murdered during the Reign of Terror.

The remarkable coincidence of their lives and fates forms a kind of central motif for tonight's lecture: Lavoisier, one of the first great figures in turning modern science toward applications for improving the conditions of human life – the nexus of theory, discovery, invention, and, ultimately, industrial innovations and new products. And Condorcet, who worked out what changes were needed in society as a whole in order to complete the "scientific revolution."

I will be referring in particular to his remarkable book, *Sketch for a Historical Picture of the Progress of the Human Mind*, which he wrote while he was on the run and in hiding from the agents of the Terror. **[Slide 9]** In his *Sketch* he developed the idea that the analytical approach developed for the sciences of nature should be applied to the study of society, where it would combat the historical accumulation of ignorance and superstition. The bright future he envisaged for humanity in this work contrasts tragically with the dark fate that, he knew, awaited him.

In effect, he described there an alliance between the growth of the sciences of nature, on the one hand, and the emergence of the sciences of society, on the other. Both should, in his view, advance in parallel. He thought that a methodical application of the scientific attitude would lead to progress in social issues, such as justice, equity, tolerance, and education. I will try to illustrate what Condorcet had in mind, in terms of social institutions, and then ask where we now stand, in terms of his vision. But first we need to step back further still, to where it all started.

The dialogue about science, technology and society began in England about 400 years ago. **[Slide 10]** Francis Bacon (1561-1626) spent his entire life on this subject, trying to win government support for a grand project to promote technological innovation.[1] 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 by the Spanish Armada and the would-be assassins among her own citizens who were working on behalf of the Vatican.

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 today we call applied sciences and technologies).

Only towards the end of the eighteenth century, after the French Enlightenment and the French Revolution had further weakened this ancient dogma, could it be said that Bacon's view had triumphed. (Bacon was a great hero in the eyes 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 glimpsed, although from a distance, the essential, internal tension in the epoch of modernity. **[Slide 11]** 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 basic research and new 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.

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 harnessing 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. **[Slide 12]** After all, the lives of Bacon and Hobbes spanned two centuries of continuous religious warfare, ferocious and sadistic in nature, on the European continent. **[Slide 13]**

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, rallied against its opponents within European culture.

Part III: Progress of the Human Mind [Slides 14/15]

The enlightenment project is wonderfully summed up in Condorcet's *Sketch for a Historical Picture of the Progress of the Human Mind*, which was first published posthumously in 1795. 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 also 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.

He envisioned a future in which "the dissemination of enlightenment" would "one day include in its scope the whole of the human race."[2] The process called "enlightenment" is founded on a way of thinking that instructs us "to admit only proven truths, to separate these truths from whatever as yet remained doubtful and uncertain, and to ignore whatever is and always will be impossible to know." The gradual extension of this method into the realm of "moral science," politics, and economics has enabled thinkers "to make almost as sure progress in these sciences as they had in the natural sciences." **[Slide 16]** He continues:

> This metaphysical method became virtually a universal instrument. Men learnt to use it in order to perfect the methods of the physical sciences, ... and it was extended to the examination of facts and to the rules of taste. Thus it was applied to all the various undertakings of the human understanding.... It is this new step in philosophy that has for ever imposed a barrier between mankind and the errors of its infancy, a barrier that should save it from relapsing into its former errors under the influence of new prejudices,...

The battle-cry of the partisans of enlightenment had three demands: reason, tolerance, and humanity. This was its program:[3]

> Thus, an understanding of the natural rights of man, the belief that these rights are inalienable and indefeasible, a strongly expressed desire for liberty of thought and letters, of trade and industry, and for the alleviation of the people's suffering, for the proscription of all penal laws against religious dissenters and the abolition of torture and barbarous punishments, the desire for a milder system of criminal legislation and jurisprudence which should give complete security to the innocent, and for a simpler civil code, more in conformance with reason and nature, indifference in all matters or religion which were relegated to the status of superstitions and political impostures, a hatred of hypocrisy and fanaticism, a contempt for prejudice, zeal for the propagation of enlightenment: all these principles, gradually filtering down from philosophical works to every class of society ....

These rhetorical injunctions were accompanied by concrete proposals for universal education, social insurance, increases in labour productivity, reform of the penal system, and gender equality. And Condorcet believed that one of the first fruits of the dissemination of enlightenment would be the cessation of warfare among nations.

Condorcet has an interesting reason for suggesting that advances in the natural sciences are the original foundation for a broader social enlightenment. He remarks that "all errors in politics and morals are based on philosophical errors and these in turn are connected with scientific errors." What he is saying is that there is a connection between our conceptions of natural processes, on the one hand, and our understanding of society and individual behaviour, on the other; I find this to be insightful. Once the "progress of the physical sciences" is launched, he claims, this "inexorable progress cannot be contemplated by men of enlightenment without their wishing to make the other sciences follow the same path. It offers them at every step a model to emulate ...." This theme is nicely summed up in the following sentence: "Just as the mathematical and physical sciences tend to improve the arts that we use to satisfy our simplest needs, is it not also part of the necessary order of nature that the moral and political sciences should exercise a similar influence upon the motives that direct our feelings and our actions?"[4]

If there is one core idea in Condorcet's conception, it is surely this: The "progress of the sciences" that defines the enlightenment project is a double-sided phenomenon. It encompasses both the physical and the moral sciences or, using my terminology, the combination of inventive and transformative science, or technology and ethos. It is a

process with a built-in mechanism ensuring its indefinite continuation: "The progress of the sciences ensures the progress of the art of education which in turn advances that of the sciences."[5] The inner unity between these two dimensions is something which Condorcet seems to have taken for granted. He saw the two sides as arising in quick succession over the course of the seventeenth century and flourishing together throughout the eighteenth. In short, a more sophisticated chemistry and physics, on the one hand, and enlightened social behaviour, on the other, were two sides of the same coin. That this is an inner unity, and not just a coincidence, is shown by Condorcet's emphasis on the great advances made possible by the invention of the calculus: It is not only a methodological pillar of the new natural sciences, but also of such innovations in social welfare as insurance and pension programs, which require the use of probabilistic analysis in order to function well.

Like many of you, I suspect, I believe wholeheartedly in the enlightenment project. I believe that the values guiding this project are intrinsic goods. I also believe that the success of this project is a pragmatic good, because we need it to succeed if we are to be able to adequately contain the downside risks associated with the deployment in society of the vast new powers bestowed on humanity by the modern sciences of nature. And here is where the trouble lies.

Part III: Rupture [Slide 17]

The unity envisioned by Condorcet failed to take root. Instead, what happened was, as the epoch of modernity unfolded in the period after 1800, the intrinsic differences contained within the two-sided structure of the sciences (physical and moral) came to

the fore. In a nutshell, the two sides in the internal tension, inventive science and transformative science, did not in fact continue to support each other; rather, and increasingly, they have become dissociated. This resulted in the *hyper-development* of one side (the inventive) and the *under-development* of the other (the transformative): Beginning with nineteenth-century industrialism, radical changes in the technologies of industrial production simply swamped the far weaker trends in social transformation.

What happened on the European continent during the first half of the twentieth century provides the grim proof of the failure of Condorcet's vision. The two world wars acted as a kind of one-two punch against the illusions summed up in the notion of the "progress of civilization." In the ideology of nineteenth-century imperialism, the mission of civilizing the savage peoples of Africa and Asia had been assigned – by themselves, of course – to the European nations. The First World War shattered this first illusion definitively: For how else could one describe what happened on the battlefields of Belgium and France in the years 1914-1918 except by the terms barbarism and savagery? And it was the introduction of gas warfare in 1915 that provided the first intimation that there was worse to come. By 1945, it had become abundantly clear that what had happened in Europe over the preceding thirty years was no "reversion" to a state of "primitive" murderousness: No, this was a march forward to a new state of affairs, where the most advanced products of human reason would be called to the service of the most depraved and basest impulses.

My main theme in these lectures is science and society, so I want to concentrate on only this aspect of these twentieth-century horrors. One of the illusions shattered by

the First World War was that of an international brotherhood of scientists (at that time they were all men, with the sole exception of Marie Curie). Very quickly upon the outbreak of hostilities these ties began to shatter as leading intellectuals lined up behind their governments in patriotic denunciations of the enemy. **[Slide 18]** In 1914 ninety-three distinguished Germans, including fifteen leading scientists such as Max Planck, signed a manifesto addressed "to the civilized world," strongly defending their country's right to go to war; immediately, senior scientists affiliated with the national academies in Britain and France expelled those of their foreign fellows who were from Germany and Austria. Einstein – who was then in Berlin and who had refused to sign the manifesto – attempted to stimulate interest in a counter-petition, entitled "Appeal to the Europeans," which called upon the intellectuals to maintain their solidarity across national borders; he could get no support. His bitterness and frustration is evident in this comment from 1917, made in a letter to a Swiss colleague: "All of our exalted technological progress, civilization for that matter, is comparable to an axe in the hand of a pathological criminal."[6] **[Slide 19]**

As we know, there was worse to come. Between the wars the foundations of atomic physics were being laid down, and this just happened to be an overwhelmingly German scientific accomplishment. During the six years between Hitler's accession to power in 1933 and the outbreak of war in 1939, a large number of these scientists had fled for their lives – because, of course, they were Jews. The line of research that led to the proof of the possibility of nuclear fission had been undertaken by Otto Hahn and Lise Meitner in Berlin in the 193os. The decisive results were achieved in late 1938 and published a few months later. At once the community of exiled European physicists, by

then scattered across Britain and the U. S., realized that it might be possible to make an atomic bomb, and they were terrified that this possibility might be realized first in Nazi Germany. Three of them, all Hungarians by birth – Leó Szilárd, Eugene Wigner, and Edward Teller – drafted the famous letter that Einstein sent to President Roosevelt in August of 1939, out of which the Manhattan Project and the bomb eventually emerged.[7]

[Slide 20]

As the effort to build the bomb advanced toward successful completion in late 1944 and early 1945, some of these scientists tried to influence the U. S. government's decision on using this new weapon against Japan. These attempts were made during the months of June and July, 1945, during the run-up to the first test, which took place at Alamogordo, New Mexico, on July 16. **[Slide 21]** The first document is called the "Franck Report," after its lead author, James Franck, a physicist from Germany and winner of the Nobel Prize in 1925; the group which signed it included his fellow emigré, Szilárd, and five American scientists.[8] The drama in the events they had lived through is evident in their statement – referring to their fears about work on an atom bomb in Nazi Germany – that "to the last day of the European war we were living in constant apprehension as to their possible achievements." This is preceded by a most interesting passage, invoking an idea to which I will return later in this lecture:

> [I]n the past, scientists could disclaim direct responsibility for the use to which mankind had put their disinterested discoveries. We feel compelled to take a more active stand now because the success which we have achieved in the development of nuclear power is fraught with infinitely greater dangers than were all the inventions of the past.

They then went on to offer the government advice on the deployment of their weapon.

They had begun to think ahead to the postwar period and to the changes in the whole scope of international relations that would follow upon the dropping of an atomic bomb. And, even though the war in Asia was still raging, they argued that "international agreement on total prevention of nuclear warfare" was the "paramount objective" at that decisive time in history. The conclusion they drew from this principle was that there should be no "unannounced attack against Japan" using a nuclear weapon; rather, the terrible power of this new weapon should first be demonstrated "before the eyes of representatives of all the United Nations, on the desert or a barren island." They further argued that, if Japan did not react to this demonstration by surrendering, then the weapon could be used against it – but only after both the sanction of the United Nations, and of American public opinion, had been obtained.

Leó Szilárd fretted about the fact that the signatories were getting no response from Washington, and so he tried once more. **[Slide 22]** Perhaps he did so in part because he felt a special responsibility. Not only had he been the key player in drafting the Einstein letter in 1939; he had also, earlier that same year, carried out the decisive experiment at Columbia University which showed that a nuclear chain reaction, involving the production of fast neutrons, was possible – an event he describes in his memoirs:

> On March 3, 1939 everything was ready and all we had to do was to turn a switch, lean back, and watch the screen of a television tube. If flashes of light appeared on the screen, that would mean that neutrons were emitted in the fission process of uranium and this in turn would mean that the large-scale liberation of atomic energy was just around the corner. We turned the switch and saw the flashes. We watched them for a little while and then we switched everything off and went home. That night there was very little doubt in my mind that the world was headed for grief.[9]

Szilárd also drafted the new petition because he wanted to advance a different set of reasons for not dropping the bomb except as a last resort. In his eyes the Franck Report relied too much on the grounds of expediency; in other words, its case was based on the view that the unannounced first use of the bomb against Japan would make postwar negotiations about the proscription of nuclear weapons difficult if not impossible.

So a mere few weeks before the Alamogordo test Szilárd began to draft a petition, which he then circulated circulated with a request for signatures to all the nuclear scientists working at Los Alamos, Oak Ridge (Tennessee), and the University of Chicago.[10] Eventually he got 68 signatures – and also incurred the wrath of the U. S. Army, who accused him of a breach of secrecy. His "Petition to the President of the United States" was dated July 17 – one day after the bomb was successfully tested in New Mexico. It stated that attacks against Japan using the bomb "could not be justified, at least not until the terms which will be imposed after the war on Japan were made public in detail and Japan were given an opportunity to surrender." The petition went on to state that, even if Japan refused to surrender, a decision to use the bomb "ought not to be made at any time without seriously considering the moral responsibilities which are involved." The United States, it argued, bore

> ... the obligation of restraint and if we were to violate this obligation our moral position would be weakened in the eyes of the world and in our own eyes. It would then be more difficult for us to live up to our responsibility of bringing the unloosened forces of destruction under control.

This petition was intended to be read by President Truman, who was in Germany at the time, but almost certainly senior officials on the president's staff made sure that it never reached him.

In other memos prepared for government officials Szilárd explored alternative strategies for bringing this technology under strict international controls, such as by trying to restrict access to all deposits of uranium on the planet. All in all, this is a fascinating and fateful episode in the history of modern science. A large group of leading scientists, who had been directly involved in both the original research and the technology leading to the atomic bomb, anticipated the prospect of nuclear weapons proliferation and tried to head it off. They did so out of a sense of their personal responsibility, as scientists, for the emergence of this powerful new threat against humanity. I think one can infer from statements made by some of them that, had there been no reason to fear the prospect of the atomic bomb being developed in Nazi Germany, some of them at least might have tried to enforce an embargo on the line of further research that would lead inexorably to the technology of nuclear weaponry. (Some scientists, such as Lise Meitner and Linus Pauling, refused an invitation to join the group at Los Alamos. And during the decisive year 1939, following the appearance of the Hahn and Meitner articles on fission, Szilárd tried to persuade other leading atomic scientists, such as Joliot in France, not to publish any more scientific articles on the subject.[11])

This is pure speculation, of course. And yet I think we should indulge ourselves in these kinds of speculations, and ask ourselves – as I will in a few moments – whether we should raise again, at the present time, *the issue of scientists' responsibility for the consequences of the results that flow from their research*.

Let me give one more illustration from that earlier time. **[Slide 23]** Another one among the remarkable physicists of that era was Max Born, who was the central figure in an extraordinary collection of talents, in the fields of quantum mechanics and atomic physics, who assembled in the German city of Göttingen during the decade of the nineteen-twenties. The list of his doctoral students and assistants includes our own Gerhard Herzberg, as well as Oppenheimer, Heisenberg, Fermi, Pauli, Teller, Wigner, and many others; six among them went on to win a Nobel Prize, as did Born himself. He was also a deeply cultured, principled, and reflective person, and a pacifist, which is why Einstein admired him greatly; the record of the correspondence between the two of them, spanning the years 1916-1955, is an indispensable source for the theme I am exploring with you now.

Born too was forced to flee for his life from Nazi Germany and found refuge at the University of Edinburgh. He was not solicited to go to the U. S. and join the bomb effort, and it's likely he would have refused in any case. He shared the fears about Germany's getting the bomb first, of course, and he is one of those who always believed that Heisenberg had been entirely commited to the German wartime effort. But he was appalled at the idea of nuclear weapons, and moreover, he did not shy away from the conclusion that science and scientists could not avoid a large share of responsibility for the results of their research. Late in 1954 he wrote to Einstein:[12]

> I read in the paper recently that you are supposed to have said: 'If I were to be born a second time, I would become not a physicist, but an artisan.' These words were a great comfort to me, for similar thoughts are going through my mind as well, in view of the evil which our once so beautiful science has brought upon the world. **[Slide 24]**

A short time later, in early 1955, mere months before Einstein's death, he wrote again for the last time to his old friend and drew this conclusion about responsibility:

> Even when one selects a method of making a living which is independent of the search for knowledge, one must then also decide to keep one's knowledge to oneself, or to interchange ideas only privately amongst friends, as was customary during the 17th and 18th centuries, for otherwise others are still going to misuse the results for evil purposes, and I feel that one would then never be free of responsibility.

[Slide 25] This harking-back to the world of science as it was three hundred years earlier resonates strongly, for me at least, in the context of the historical references to Bacon and Condorcet made earlier in this lecture.

Part V: The Fate of the Enlightenment Project [Slide 26]

Now I would like to return to Condorcet's core idea which, you will recall, goes as follows: The enlightenment project for the "progress of the sciences" encompasses two interconnected dimensions, the physical and the moral sciences. **[Slide 27]** My suggestion is that what happened in the twentieth century, and continues today, amounts to a rupturing of those two dimensions. In the alternative terminology I employed earlier, contrasting inventive and transformative science, what has been happening is in the *hyper-development* of one side (the inventive) and the *under-development* of the other (the transformative). I would now like to explain more precisely what I mean by this conundrum, and in so doing to set up the main theme for discussion to be pursued in the third and final session in this series.

Since Condorcet's time the physical sciences, and the stream of technological inventions based on them, have marched steadily from triumph to triumph. They now

receive levels of funding across the globe that make the situation in earlier epochs appear laughable by comparison. (When Szilárd was planning his demonstration of nuclear fission at Columbia University in 1939, an experiment on which the fate of humankind may have turned, he had to *borrow* small quantities of beryllium and radium from private companies! I was born in that year: The sea-change of which I speak has occurred during my lifetime.) The other major change in this period is no less significant: Over the course of the last half-century, science has become near-universal on the globe, spreading out from its original base in Europe first to North America and then to other continents.

Not so with what Condorcet called the domain of the moral sciences, however. Here the enlightenment values are, basically, those of classical liberalism: tolerance, political equality and democracy, opposition to prejudice (racism, ethnicity, etc.), absence of the imposition of religious dogma, freedom of conscience and expression, universal education, gender equality, a humane approach to crime and punishment, a peaceful state of international relations, and so forth. My contention is that this side of the enlightenment project is still a hotly-contested zone, in the first place, even in the most "advanced" nations; whatever the gains that have been made there, they are by no means secure. In the aftermath of the rise of Nazism in Germany many people asked themselves: How could this have happened in the land of Beethoven and Goethe? Many reasons have been adduced, including the severe social and economic collapse in the nineteen-twenties. It would be both foolish and shortsighted to think that it could never happen again. In the second place, more than two centuries after Condorcet formulated his agenda, there is hardly any region on the globe, outside of Western

Europe and North America, for which one could persuasively argue that the set of enlightenment values have taken root; on the contrary, in many if not most of those regions, such values are to this day widely disparaged and explicitly rejected.

And it is precisely in this disparity – as between the two sides of the enlightenment project – that I see a steadily increasing risk of catastrophic results.

On the side of the physical sciences, nations and peoples are being handed an ever more complete array of potent technologies. In the last decade we realized that the threat of weapons made with radioactive materials did not vanish with the passing of the Cold War; on the contrary, it now occupies the mad dreams of an ever-expanding complement of state and non-state actors.[13] A newer science, molecular biology, shows the way to the genetic engineering of biological warfare agents.[14] In terms of the scope of the scientific and technological apparatus needed to weaponize its products, today's molecular biology is far more user-friendly than nuclear physics ever will be; indeed, it is well on its way to becoming a backyard-garage type of operation. High-school students in Canada and elsewhere play with DNA sequences, which can be ordered over the Internet and delivered by mail to your home (including viral sequences).[15] Finally, as mentioned last week, both genomic sequencing in general, and the accelerating study of brain function in particular, brings broad powers of manipulation right up to the threshold of the most personal and intimate aspects of a person's mind.[16]

If we were living in a global community where enlightened social values were everywhere unshakably entrenched, I for one would worry far less about the public

availability of the scientific knowledge on which such new powers are based. (I might still be concerned about the sheer pace of such innovations and of our ability to keep abreast of them through adequate policy and regulatory responses.) But we do not live in such a world, nor are we likely to do so anytime soon. Rather, we live with the reality of the rejection of enlightenment values, in most nations of the world, and the recurring challenge to those values even within the societies of the most scientifically-advanced nations. Moreover, we live with bitter conflicts within and among peoples and with the constant threat of witnessing the deployment of weapons based on advanced sciences against ourselves and others. For me, this represents the central "crisis of modernity." I am not convinced that humankind, as a global collectivity, can manage the downside risks associated with this situation. Are you?

So what should we do? That is the subject of Lecture #3, and I want to conclude tonight with a little preview of what I wish to discuss with you at that time. I will pose a series of questions, all related to the general theme of tonight's talk, namely, the rupture between the two sides of the original enlightenment project, and the possible consequences of that rupture. There are both general and specific questions.

1. Do you find (as I do) Condorcet's idea of the necessary unity of the two sides of the enlightenment project persuasive?

2. Is the rupture between the two sufficiently serious so that we should call into question the entire enlightenment project itself? What would it mean to do so?

3. Do scientists – including leaders such as Nobel Prize-winners – have an ethical and social duty to consider (along with the rest of us) their collective responsibility for the consequences of their research?

4. In what concrete and practical ways can we ensure that an ongoing dialogue about such ethical and social duties of scientists will indeed take place?

Thank you very much for coming tonight. **[Slide 28]**

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

[2] *Sketch for a Historical Picture of the Progress of the Human Mind* [1795], tr. J. Barraclough (New York: Noonday Press, 1955), pp. 127ff.

[3] Ibid., p. 140.

[4] Ibid., pp. 163-4, 192.

[5] Ibid., p. 196.

[6] *The Collected Papers of Albert Einstein*, vol. 8, *The Berlin Years: Correspondence, 1914-1918*, English translation by A. M. Hentschel (Princeton University Press, 1998), p. 412.

[7] See generally Spencer Weart, *Scientists in Power* (Harvard University Press, 1979).

[8] http://www.dannen.com/decision/franck.html

[9] See *Leo Szilard: His Version of the Facts*, ed. Spencer Weart & Gertrud Szilard (Cambridge, Mass.: MIT Press, 1978), p. 55.

[10] Szilárd, chapter VI.

[11] Szilárd, chapter II.

[12] This and the following passage are from *The Born-Einstein Letters*, tr. Irene Born (New York: Walker & Company, 1971), pp. 229-33.

[13] See Michael Crowley, "The stuff Sam Nunn's nightmares are made of," *The New York Times Magazine*, 25 February 2007.

[14] E.g., The Sunshine Project, "Emerging Technologies: Genetic Engineering and Biological Weapons" (2003): http://www.sunshine-project.org/publications/bk/bk12.html; and a website maintained by UCLA's School of Public Health, "Epidemiologic Information on Bioterrorism": http://www.ph.ucla.edu/EPI/bioter/bioterrorism.html .

[15] Oliver Morton, http://www.wired.com/wired/archive/13.01/mit.html ("Life, Reinvented," *Wired*, Issue 13.01, January 2005); Jonathan B. Tucker and Raymond A. Zilinskas, "The Promise and Perils of Synthetic Biology," *The New Atlantis*, Number 12, Spring 2006, pp. 25-45: http://www.thenewatlantis.com/archive/12/tuckerzilinskas.htm; James Randerson, "Revealed: the lax laws that could allow assembly of deadly virus DNA; urgent calls for regulation after Guardian buys part of smallpox genome through mail order," *The Guardian*, 14 June 2006: http://www.guardian.co.uk/terrorism/story/0,,1797057,00.html

[16] For the most recent summary of neuroscience research, specifically in connection with legal processes, see Jeffrey Rosen, "The Brain on the Stand," *The New York Times Magazine*, 11 March 2007.