LIFE IN THE TECHNOCOSMOPOLIS:

GENETIC ENGINEERING AS AN EMBODIMENT OF MODERNITY

by

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ABSTRACT

An argument is made for the claim that genetic engineering is an embodiment of modernity. Genetic engineering is both a research method and a manufacturing process. It requires social processes that intersect academia, government and industry. Embodiment is the process by which a concrete material form is given to an idea or concept. The intent behind genetic engineering is to alter physical characteristics of organisms to meet specific ends. What is culturally determined to be useful, efficient, healthy, and profitable is manifested in the bodies of manipulated organisms. Instrumental rationality and reductionism, dominant characteristics of modern science and capitalist economies, are now colonizing tissue cultures after centuries of colonizing human cultures.

The modernist assumptions embodied by genetic engineering are described as betrayals, fears and tragedies. The first betrayal is not teaching science historically. Without a historical approach, alternative theories are forgotten, and historically contingent assumptions are conflated with objective reality. The second betrayal is not teaching science from a rhetorical perspective. The belief that scientists use a "literal" and value-free language to describe reality obscures the ubiquitous use of metaphors, personifications and anthropomorphic imagery in scientific discourse. The first fear is of uncertainty. Science and technology, it is assumed, will bring greater control and predictive power over our lives but high risk modern technologies such as genetic engineering have intensified uncertainty and unpredictability and are inherently hazardous. The second fear is of "mob rule." This fear is based on an assumption that lay people cannot intelligently and rationally engage in decisions regarding the directions that science and society should take. The first tragedy is hubris, the idea that humanity has the capacity and obligation to exercise dominion over nature. This assumption justifies the manipulation, exploitation and destruction of organisms, ecosystems and non-modern ways of life. The second tragedy is the desire to change the human condition and eliminate suffering through genetic and social engineering experiments. These experiments perpetuate, rather than eliminate, suffering.

Genetic engineering, like modernity, poses paradoxes and exhibits destructive tendencies. They perpetuate the conditions that they are meant to eliminate and erode the theoretical foundations that justify them.

Keywords: genetic engineering; scientific discourse; modernity; embodiment; risk; metaphor

Subject Terms: Technology -- Philosophy; Technology -- Social Aspects; Science – Philosophy; Rationalism

DEDICATION

To my parents,

Gizelle Rhyon Berry, B.Ed, BFA, MA.Ed and Brij M. Berry, BSc, BA, B.Ed. MA, PhD.

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INTRODUCTION

According to Langdon Winner, "the most prevalent way our society explores the possibility of limiting technology is the study of risk."[1] However, he observes that contemporary risk assessment "does not provide a general evaluation on the conditions of modern life" as broad scale social theories such as liberalism or Marxism do.[2]

> As compared to other varieties of moral and political argument, risk assessment seeks a very narrow consensus. It asks us to evaluate circumstances in which there is some chance, perhaps a very remote chance, of harm from activities that are assumed to be socially beneficial in other respects.[3]

The social benefits of new technologies cannot always be assumed, and this is why a broader theoretical approach to risks can be useful. One approach is to analyze modern technologies as being embodiments of the social, economic and political system within which they are created and used, as Winner does.

Sociologist Ulrich Beck describes the modern condition as living in a risk society. For him, the study of the risks of technologies is central to political and social analysis because of their wide-ranging effects, medically, ecologically, socially, economically and politically. Beck focuses on "mega-technologies" that manipulate matter on atomic, chemical and genetic levels because of their long-term global effects and potentially

1 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 138.

2 Ibid., 139.

3 Ibid.

apocalyptic consequences.[4] Winner suggests that studies of risk can include evaluations of modern life, and Beck insists that evaluations of modern life include studies of risk. I have decided to take their advice and argue that genetic engineering is an embodiment of modernity.

Genetic Engineering as an Embodiment of Modernity

Genetic engineering, or recombinant DNA technology, is used both as a research method and an industrial production process (the distinction can be fuzzy in many cases). As a research method, it is a way to construct knowledge within a specific theoretical and ideological framework. It is a part of a social process engaging intersecting communities of scientists and technicians in the academy, government and industry. As an industrial production process, the communities involved in refining and using genetic engineering become more diverse as it is used in the fields of medicine, agriculture, mining, forestry, and environmental cleanup. Consequently, many different sectors of government, from fisheries to finance, are involved in providing support and regulation. The distinction can be fuzzy in many cases. Different sectors of society are also involved, from seed companies to farmers, or from pharmaceutical companies to physicians, for example. As a system of production that creates specialized products for markets, genetic engineering involves citizens directly, as patients and consumers, and indirectly with its environmental, economic and political impacts that affect all of society.

To embody is to give a concrete material form to an idea or concept. The intent behind genetic engineering is to alter physical characteristics of organisms to meet

4 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society,* trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995).

specific ends. What is culturally determined to be useful, efficient, healthy, and profitable is manifested in the bodies of manipulated organisms. Instrumental rationality and reductionism, dominant characteristics of modern science and capitalist economies, is now colonizing tissue cultures after centuries of colonizing human cultures.

My characterization of modernity, as well as the structure of my dissertation, is broken down into three sets of betrayals, fears and tragedies. I see these painful and dramatic aspects of modernity manifested in and perpetuated by various aspects of genetic engineering. Intellectual historian Jacques Barzun characterizes two "betrayals" of early modernity that haunt us today. One is the "failure to teach science historically,"[5] which is discussed in Chapter 1. In a culture where most eyes are looking forward in anticipation of further progress and improvement, the past is devalued and generally ignored.

Contemporary critiques of science as a method of knowledge construction and a social institution draw our attention to historical context. The dominance of a scientific theory is related to the degree of its resonance with its past and present economic and political milieu. Modernity is an era that covers centuries. Some aspects of it have changed and others have not. Modernity is not coherent, unified and without contradictions. Nor is the modern science it conceived and nurtured. Understanding this history is necessary for contextualizing and analysing a range of issues relating to genetic engineering, for example, the conflict between scientists on the safety of genetically modified organisms to human and ecological health, or the confusion around the multiple definitions and meanings of "gene."

5 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 7.

Chapter 2 concerns the second betrayal that Barzun outlines, which is the belief that scientists (or any other scholars) are capable of “precise speech,” an objective and non-rhetorical language. While the Romantics did not see a contradiction in collaborations between poetry and science, the dominant modernist view relegates metaphors, personifications and imagery to the realm of poetry and style, which is opposed to a rigorously objective, scientific, literal and technical language. As a consequence, many orthodox biologists are quick to critique analogies used by those suggesting alternative understandings of biological organization, but remain blind to their own metaphors.

The relationship between language and biology is multifaceted. First of all, all scientific rhetoric employs literary devices such as metaphors. That metaphors can only help in explaining some, but never all, aspects of the things being compared has been largely accepted in the philosophy of science. Scientists and science writers can be blinded by their analogies. Genetic engineering is predicated on the assumptions that reify metaphors that liken cells to factories, DNA to a blueprint and genes to a code. It is the aspects of organic systems that do not behave according to these understandings of life that create “surprises” for molecular biologists. Language itself is one of the main metaphors used to describe genetic phenomena. The metaphors of language and communication that are employed by many biologists use concepts of syntax and grammar. However, the more complex concepts of meaning, interpretation and understanding tend to be paralleled in the organic world in diverse, confused and contradictory ways.

Sociologist of science Bruno Latour characterizes taking the "path of modernity"[6] as leading to two fears. One is the fear of losing any certain access to reality such as the type of absolute certainty that Descartes and Bacon promised was possible. The irony is that, as sociologists Ulrich Beck and Zygmunt Bauman observe, modernity has introduced uncertainty into every aspect of our lives. Chapter 3 focuses on the uncertainties of genetic engineering.

Artificially constructing and inserting transgenic material into cells is possible because on the molecular level organisms are surprisingly similar. However, morphologically and physiologically, they are extremely diverse. Because these more complex aspects of living systems are neglected or poorly understood, the results of experiments, trials and actual manufacturing processes that use genetic engineering are inconsistent, highly variable, unpredictable and often unanticipated. The idea that more research will eventually solve these problems is a fallacy revealed by a detailed review of basic biology and the specific processes used to genetically manipulate organisms. Even basic knowledge of biological systems found in undergraduate textbooks can be used to illustrate that genetic engineering is not only inherently uncertain but also inherently hazardous. Canada's regulatory system grossly exacerbates the ecological problems and risks of genetic engineering by allowing the widespread introduction of genetically manipulated crops without adequate risk assessment. These products are also allowed on the market to be consumed by citizens without assessment of potentially harmful health effects.

[6] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 21.

The second fear, the subject of Chapter 4, is what Latour labels "fear of the mob rule." This fear is based on the assumption that "if reason does not rule, then mere force will take over."[7] It is rooted in a perception of the lay public as ignorant, emotional and irrational and therefore unable to make intelligent decisions about scientific matters that require public policy deliberation. This is a fundamentally undemocratic assumption that is common in debates about the introduction of complex technologies in which private interests have been privileged over public ones. The fear rests on a one-dimensional notion of rationality.

Instead of the singular definition of rationality that served as a foundation for modern science in the seventeenth century, some contemporary social scientists distinguish between two types of rationality when analysing conflicts between citizens and particular specialists. For example, "cultural versus technical," "experiential versus theoretical" or "substantial versus formal" are employed to distinguish forms of reasoning that include morality, experience, emotions and senses as well as instrumental and technical logic from a rationality that narrows itself to instrumental, technical and reductionist logic.[8] Forms of rationality that are more inclusive of various dimensions of human experience produce public opinion which is complicated, pluralistic and often contradictory. However, rejecting its validity on these grounds ignores the different interests, conflicts, debates and disagreements among scientific specialists. Moreover, an analysis of Canadian public opinion polls and the advice of "experts" on issues

7 Ibid., 10.

8 See Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988); Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995); and Michael J. Reiss and Roger Straughn, *Improving Nature: The Science and Ethics of Genetic Engineering* (Cambridge, UK: The Cambridge University Press, 1996).

relating to genetic engineering illustrates that different forms of rationality exist not just *between* but also *within* communities of non-experts and experts. The diversity of views among both scientific experts and the lay public justify the demand for more democratic and precautionary policy-making.

Political sociologist James C. Scott analyzes two “tragedies” of modernism.[9] The first tragedy is hubris, the arrogance of humans when they try to act like gods. Discussed in Chapter 5 are three ways in which hubris has expressed itself in the modern period that relate to genetic engineering. The first, having roots in some Christian traditions, is the idea that humans have a God-given responsibility to exercise dominion over all other organisms. This is rooted in an assumption that we are closer to God by virtue of our consciousness, our supposed intelligence and our alleged capacity for rationality. The whole of nature, and all of its non-human manifestations, do not have a soul or the more secularised concept of a mind. Thus nature is viewed as a resource to be owned, managed, manipulated and consumed, or as Bacon expressed it, nature is our slave.

There are two refinements of this hubris. One is that in the minds of natural philosophers in the seventeenth and eighteenth century, God was an architect or an engineer of life. Natural philosophers who mimicked the mind of God could be co-creators of life. This metaphor has met its full expression in genetic engineering. The second refinement is the desire to control and dominate not just nature but other human beings. Early modern natural philosophers (and now scientists) are closer to God than anyone else. This is by virtue of their rationality, which is seen to be more developed than in lower classes and other cultures.

[9] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 342.

The other aspect of hubris, discussed in Chapter 6, is the notion that modern science is the path to Eden, to Utopia. Modern science becomes the only form of knowledge making that is "rational" and therefore is the best foundation for changing society. All other ways of knowing and forms of social organization are interpreted as inferior, primitive and backward. The philosopher kings, the experts, should dictate the direction of society. And now they should dictate the direction of human and non-human evolution. The path to Eden is through eugenics, and genetic engineering is the perfect tool. The ultimate tragedy is the suffering that is caused by attempts at social and biological engineering.

Chapter 6 focuses on the second tragedy that Scott observes, which derives from the desire to change the human condition. What human nature is, and if it is possible to change it, is far from agreed upon. Are we born of sin or are we born into sin? Will only drugs and surgery improve us, or rather discipline and tolerance? Instead of embracing our humanity, its diversity and the uncertainties that come with it, it is assumed that the flaws, imperfection and corruption that lie in our bodies (and nature as a whole) can be perfected and made more efficient and useful. The desire for precision, prediction, control and certainty is directed towards both nature and society. The inability to accept the limitations of our knowledge of reality creates the antithesis of the desire: greater unpredictability and increasing lack of control.

References to Aldous Huxley's *Brave New World* are ubiquitous in literature on genetic engineering, as he describes a society that strives for human perfection and social stability through the complete technical control of human reproduction and psychological development. A technical elite tightly controls the society of *Brave New World*. It is an efficient and highly, if not entirely, predictable society. I understand the novel as a critique of modernist assumptions and desires. However, as Jeremy Rifkin points out, "The Biotech Century promises to complete the modernists' journey by 'perfecting' both human nature and the rest of nature, all in the name of progress" and create a world not unlike that of Huxley's novel.[10] There is both a tragedy and an irony in wanting to "improve" humanity through biological manipulation. The desire is not to eradicate domination and inequality, but rather to make it morally acceptable and biologically inescapable.

No One Can Be an Expert in Risk

Tracing the betrayals, fears and tragedies of the modern condition and their relationship to genetic engineering requires an interdisciplinary approach. Genetic engineering has social, cultural, political, economic, ecological and medical contexts and consequences. "Expertise" in recombinant DNA technology is commonly associated with a detailed technical knowledge of the methods used to manipulate genetic material. However, I agree with Beck's observation specific to atomic and genetic technologies that "in matters of risk – no one is an expert."[11] For this reason, not only should decision making about controversial new technologies become more democratic, but also the assessment of their risks needs to include disciplines in the humanities, arts and social sciences that currently "take a back seat to the sciences."[12]

In the introduction to *Social Theories of Risk*, physicist turned philosopher Sheldon Krimsky poses the following challenge:

10 Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World.* (New York: Penguin Putnam Inc., 1998), 171.

11 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 109.

12 Ibid., 68; see also 108-109.

> Since the term risk does not define a single discipline, a new challenge is cast upon the social sciences, namely to discover an overarching theoretical framework that best situates risk as a field of study *among* and *beyond* traditional disciplines.[13]

Unfortunately, because of the rapid increase in specialization, use of complicated technologies, and the academic penchant for jargon, crossing disciplinary boundaries is difficult. One option is not to focus on the details of the particular phenomena that different disciplines address but rather look to higher levels of abstraction within which observations are categorized and framed. It is on these levels that bridges between disciplines can be built.

Krimsky lists several questions that a theory of risk needs to address.

> Why do experts disagree about risks?
> To what extent is risk assessment a science and to what extent is it metaphysics?
> Is there an objective basis for a science of risk?
> How is the technical expertise of risk assessment reflected in the socio-economic and political context of science?[14]

All of these questions about risk relate to issues in the philosophy and history of science. The first question begs another question. Why are experts expected to agree about risks or anything else? Western intellectual history illustrates that ancient philosophy and its branches, the humanities and the natural and social sciences, have never been unified. Disciplines within these branches are not unified, and within each field scholars disagree about theoretical assumptions, metaphysical foundations, paradigms and ideologies. It is through conflicts, debates and disagreements between

13 Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 21 (Westport, CT: Praeger Publishers, 1992) (italics his).

14 Ibid., 4. While Krimsky does not define metaphysics here, but his usage resonates with Ian Hacking's definition of metaphysics as referring to "classifications that are not determined by how the world is but convenient ways to represent it." See Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 32.

scholars that concepts and theories develop, become refined, rejected, accepted and/or resurrected. It was assumed by early modern natural philosophers that an objective reality and truth could be accessed with certainty, and as such, consensus among scholars could be achieved.

The attempts to predict risks and estimate the severity of technological hazards often takes place in the absence of "facts" or data. They are based on a way of understanding reality that takes form in theories, paradigms and ideologies. The questions that Krimsky asks regarding the objectivity, metaphysics and political context of the science of risk assessment apply to science as a whole.

In the early debates amongst specialists about the relative safety of genetic engineering with pathogenic viruses, most virologists believed that the recombinant forms would pose less of a hazard than the natural form. However, a minority of specialists were not so sure. "In creating recombinants," a dean of a Medical School asked, "can scientists produce a product that is more dangerous than any of its component parts?"[15] The difference between the two perspectives on biohazards hinged upon how scientists interpret the relationships between parts and wholes, or whether they understood organisms in a reductionist or non-reductionist framework. If the whole (such as a virus or a recombinant organism in this case) is thought to be a sum of its parts, then knowing the parts means knowing the whole. On the other hand, if the whole can have qualities beyond the sum of its parts, the consequences of recombination are inherently unpredictable. One cannot know the effect of recombining parts of organisms in novel ways until one actually carries out specific experiments, and even then, the

[15] Fredrick Robbins quoted in Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy*. (Cambridge: MIT Press, 1985), 120-121.

results may not apply to the use of different genes and different organisms living in variable and fluctuating environments.

Forms of reductionism and non-reductionism are metaphysical viewpoints and characterize ancient philosophical debates about the nature of reality. Ian Hacking observes that these debates still exist in both the natural and social sciences. He points out that because so few scholars "dare to use the word metaphysics…they talk past each other, since each is standing on metaphysical ground in opposition to each other."[16] Within different disciplines there are approaches to reality (inorganic, organic or social) that give ontological primacy to individuals or components and those that give ontological primacy to groups, contexts or systems. These approaches have different forms and within a variety of contexts are called determinist, positivist, essentialist or mechanical, and contextualist, relativist, organic or holistic.

Metaphysical and theoretical assumptions have political consequences such as policy-making, which is why Krimsky, as well as other scholars such as Hacking and Beck, emphasize the political and social contexts of science. For example, the discussions on the danger of recombinant DNA research in the 1970's took place within the context of concerns about how this research should be regulated and who should do it. Even though most specialists thought that using the parts of some viruses and bacteria could be more hazardous than others, many felt that there was

> …no justification for banning recombinant research of any type and placed on those who would limit such research the burden of justifying these limitations.[17]

[16] Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 61.

[17] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 122.

On the other hand, some specialists that thought that given the chance of a catastrophic event, however slim or minute, strict containment of some or all genetic engineering research was necessary and that the burden of proof for ecological and health safety should be placed on the investigators.[18]

Creating categories of potential biohazards, different requirements for containment and restricting some types of research would necessitate the involvement of various government agencies to not only help create containment facilities but also to ensure that proper procedures were followed. Those specialists who did not see inherent hazards in rDNA research and who felt that they were capable of regulating their own research did not deem this type of government involvement necessary. Alternatively, some scientists, such as Ruth Hubbard and George Wald, who were concerned with the potentially catastrophic consequences of this technology, felt that the communities surrounding universities and research centres conducting rDNA research should not only be notified but also consulted and included in policy-making processes.[19] This was a minority position.

The scientists involved in these discussions not only differed in their assumptions and perspectives about biological systems but also regarding the relationships between scientific research, political institutions and society at large. Those who felt that bans and restrictions on research were not necessary felt that the risks were remote and the (potential) medical and scientific benefits of rDNA research were enormous and "that it was morally wrong and politically dangerous to place restrictions on intellectual

[18] Ibid, 122-123.

[19] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 294-311.

activities."[20] But there were also scientists who essentially held the opposite point of view, that the social benefits of the technology were as speculative as its risks and that it was morally wrong and politically dangerous not to place restrictions on "intellectual activities" such as rDNA research, at least until a better understanding of its consequences could be assessed.

In reductionist biology information flow is unidirectional from DNA to cells. Similarly a reductionist view of science and society also sees information flow and influence as being unidirectional. According to this view, science can and should inform what happens in society, but not the other way around. In reality, the dialectical relationship between science and society necessitates an interdisciplinary approach to the risk and hazard assessment of genetic engineering.

Technocosmopolis

Langdon Winner uses the term "technopolis" to describe North American culture and society. It refers to the degree that technologies are integrated with our political and social organization. The technopolis is a "distinctly modern form of power" and "a new order in human history that shapes our sense of what it is to be human."[21] Because of the roles technologies play in our work and economic activity they shape our behaviour, not just our ideas and opinions. Technologies affect us, as Marshall McLuhan observed,

20 Ibid, 139.

21 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), ix.

on the level of senses and perception and have consequently become integrated in our experience of our environments and ourselves.[22]

A technological society such as ours is not defined by its dependence on or use of tools and machines but is rather as a society that is modelled after them.[23] We observe the workings of human and non-human worlds *through* technologies, but we also observe them *as* technologies. The dominant view is that the underlying reality of nature, whether inorganic or organic is mechanical and instrumental. Physicist turned philosopher Stephen Toulmin uses the concept of "Cosmopolis" to trace the relationship between theories of nature and society throughout the modern period.[24] Social organization, from feudalism to neo-liberalism, has always been justified by historically contingent understandings of natural organization. The body is a machine, the mind is a computer, instincts are hardwired, responses are triggered as signals are sent and received. It is this technologically mediated mechanistic understanding of nature that puts the "cosmo" in "technocosmopolis." These issues are discussed in Chapters 1 and 2.

To draw attention to the risks and hazards of a technology like genetic engineering (techno) is to draw attention to the limitations of theories of human and non-human nature (cosmo) and the society and culture that allow technologies and reductionist theories of life and society to dominate (polis). I agree with Robert B. Pippin who characterizes the seeming necessity and urgency for expanding control of nature as

22 Marshall McLuhan, "The Medium is the Message," in *Media and Cultural Studies: KeyWorks*, eds. M.G. Durham and D.M. Kellner, 129-138 (Oxford: Blackwell Publishers, 2001), 136.

23 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 98.

24 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990).

"uniquely modern."[25] I tend to define "modern" technologies as those that embody this particular modernist notion.

Technology is a concept that cannot be taken for granted. Andrew Feenberg suggests that the definition of technology should not be confined to the specific developments that have occurred in Western civilization in the past century.[26] Creating techniques to make artefacts is quintessentially human and not just modern. At the same time human creativity expresses itself in historically and culturally contingent ways.

There is a tendency for proponents of genetic engineering to claim that what they are doing is either "natural," meaning nature itself is a genetic engineer,[27] or merely an inevitable expression of human technological creativity. Beck complains that comparing genetic engineering to fermentation is like comparing a nuclear reactor to a set of pliers.[28] Such comparisons are irresponsible because of the differences between their political and ecological consequences. I specifically use the terms genetic engineering and recombinant DNA technology to avoid the more general term of "biotechnology," which can be understood to mean any technology that uses life forms including ancient ones such as fermentation or cheese-making.[29] Asking for limits, restrictions or

25 Robert B. Pippin, "On the Notion of Technology as Ideology," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 52 (Bloomington and Indianapolis: Indiana University Press, 1995).

26 Andrew Feenberg, "Substantive Rationalization: Technology, Power, and Democracy," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 5 (Bloomington and Indianapolis: Indiana University Press, 1995).

27 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 275.

28 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 95.

29 See C. Kameswar Rao's "Fermentation Biotechnology" on the Foundation for Biotechnology Awareness and Education website (www.fbae.org).

moratoriums on specific modern technologies does not mean that human intellectual or technological creativity will grind to a halt.

Hegemonies, such as the technocosmopolis, are never complete or total. Resistance and alternatives to them always exist within them. So, if genetic engineering is an embodiment of the technocosmopolis, can the technology itself be transformed to become more sustainable and less hazardous? As discussed in Chapters 3 and 4, I take the fairly strong position that the answer is no.

Resistance to genetic engineering lies not in using the technology differently or with radical and critical intent, as some scholars claim communication technologies can be, but in instituting limits, restrictions, moratoriums and bans. The creation of local "GE free zones" where no genetically modified crops can be grown in Canada and worldwide is an example.[30] The burning of genetically modified crops in India by peasants is another example of people expressing their desire for a ban.[31] For many non-industrialized and organic farmers around the world, "progress" in the form of genetic engineering threatens to destroy their way of life, entirely, and potentially forever. The very existence of genetically modified organisms is the problem.

Even though genetically engineered crops and therapies have caused instability, disruptions and damage to the bodies, ecosystems and economic systems that have been exposed to them, an assumption is still made by some scholars that genetically modifying human beings will result in a more stable social system. The assumption

30 See the Council of Canadians "GE Free Canada Campaign" website (www.canadians.org).

31 See Vandana Shiva's "Seed Satyagraha: A Movement for Farmer's Rights and Freedoms in a World of Intellectual Property Rights, Globalized Agriculture and Biotechnology" in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* edited by Brian Tokar, 351-360. London and New York: Zed Books, 2001.

ignores the many different examples of how genetic engineering leads to greater instability, uncertainty and negative consequences.

The desire to apply genetic engineering to human beings is not only expressed as a desire to make individuals healthy and ease human suffering. For some, modifying human beings is necessary to shape a better and more efficient society, a technocosmopolitan brave new world. The relationships between genetic engineering, human nature and utopia are discussed in Chapters 5 and 6.

Scholars such as Jean Baudrillard in *The Vital Illusion* and Jurgen Habermas in *The Future of Human Nature* discuss the cultural meaning and impact of genetic engineering. Baudrillard illustrates how genetic engineering and cloning are an expression of modernist attitudes towards sex and death. Habermas discusses the difficulty of addressing the moral issues and concerns that human genetic engineering raises in our secularised Western society. Both are critiques that illustrate relationships between genetic engineering and aspects of modernity. However, my approach differs in that I point out the problems inherent with the technology, not just its cultural meaning, political problems and potential consequences for humanity.

For example, Habermas discusses the need for a comprehensive perspective on developments of reproductive technologies rather than momentary regulatory needs, which I completely agree with. However, he suggests that this is the case because of "the advances of biotechnology, and with gene therapy meeting with success..."[32] Which successes? As illustrated in Chapter 3, gene therapy has led to death and severe

[32] Jurgen Habermas, *The Future of Human Nature* (Malden, Massachusetts: Polity Press, 2003), 18.

iatrogenic illness. I agree with Habermas, but not because of the "successes" but rather because of the consistent and dramatic failures of genetic engineering.

Both books focus on the genetic engineering and cloning of human beings. However, while I do discuss human nature and cultural assumptions in my latter chapters, I believe that integrating examples of agricultural developments and experiments is necessary. It helps to bring attention to problems inherent to the technology itself, regardless of which organisms it is applied to. If genetic engineering does not always work in petunias and pigs, why would we assume that it could work on humans?

CHAPTER 1:

THE BETRAYAL OF NOT TEACHING SCIENCE HISTORICALLY

> The depreciation of historical fact is deeply and functionally ingrained in the ideology of the scientific profession.
>
> Thomas Kuhn[33]

One of the betrayals that Jacques Barzun says characterizes the modern Western philosophical tradition is the failure to teach science historically. Barzun illustrates this failure in the assumptions of nineteenth century intellectuals Darwin and Marx. Because of the "appearance of unity and revolutionary newness" with which these thinkers saw themselves and were seen (and still are), re-examinations and re-evaluations of alternative conceptions of the world both contemporary and previous to these scholars was (and still is) not deemed necessary.[34] These thinkers are commonly understood to stand in isolation not only from their mentors, peers and rivals, but also from their social and cultural matrix. The achievements of nineteenth century "heroes," such as Darwin, who represent realism and scientific truth, appear to come directly after those of Copernicus, Newton and Galileo. The context of "the nineteenth century is made to appear foolish, romantic, ignorant, complacent, Victorian and superstitious."[35] The focus on individuals as opposed to epochs or milieus gives intellectual history the

[33] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 138.

[34] Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 326.

[35] Ibid., 14-5.

appearance of being a linear chain of independent thinkers. These historical figures have come to embody "rationality" in irrational social environments.

The singular, modern notion of rationality as reductionist, mechanical and materialist has become so ingrained that any critique of scientific materialism has come to be viewed as an attack on reason itself. Because technologies are taken to be the "proof" of scientific rationality and progress, questioning them "appears as folly."[36] Barzun's observation is a recurring theme in literature dealing with both technology and modernity. Langdon Winner also comments on the reluctance to examine notions of progress and our cultural attachment to technology, as doing so would bring our whole cultural foundation into question.[37] For Zygmunt Bauman, "the problem with us is that we stopped questioning ourselves" and "no longer recognize any alternatives" to modern society.[38]

One of the challenges to critiquing progress, technological advancement and other foundations of modernity is that it is difficult to suggest what could take its place. As Pippin argues, any attack on the assumptions of modern science presumes that alternatives exist, but "it is not at all clear what new science or technology would look like."[39] This problem exists because either, as Winner points out, it is accepted that a new science requires cultural, political and economic changes,[40] which are exceedingly

36 Ibid., 15.

37 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 5.

38 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 22.

39 Robert B. Pippin, "On the Notion of Technology as Ideology," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 50 (Bloomington and Indianapolis: Indiana University Press, 1995).

40 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 67-70.

complex and difficult to envision, or as Hacking explains, because science itself is seen to develop by its own internal logic, and we simply "cannot predict what will come next."[41]

These sentiments reflect the modernist predisposition for always looking ahead instead of analysing the present or the past. Critical theorists Max Horkheimer and Raymond Williams observe that the conditions necessary for change already exist.[42] The degree to which alternative and oppositional "senses of the world" exist within a dominant system "is a matter of constant historical variation."[43] This historical interpretation necessitates focusing on the social conditions in which scientific theories develop as opposed to individual genius.[44] For Barzun, a large part of the "betrayal" in not treating science historically is that alternatives, such as Romanticism, which developed critiques of mechanical materialism, have been forgotten or ignored. It is because of the rhetoric of modern natural philosophers that we have come to view these alternatives as worthless or at best as a "step" in the linear progression towards rationality and truth. Scientists have a tendency, my history of biology professor used to say (repeatedly), to throw out the baby with the bathwater.

41 Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 72. He is specifically referring to alternative forms of science.

42 Max Horkheimer, "Traditional and Critical Theory," in *Classical Sociological Theory,* eds. C. Calhoun, J. Gerteis, J. Moody, S. Pfaff, K. Schmidt, and I. Virk, 316 (Malden, MA: Blackwell Publishers Inc., 2002); and Raymond Williams, "Base and Superstructure in Marxist Cultural Theory," in *Media and Cultural Studies: KeyWorks*, eds. M.G. Durham and D.M. Kellner, 157-159 (Oxford: Blackwell Publishers, 2001).

43 Williams, ibid., 159.

44 Max Horkheimer, "Traditional and Critical Theory," in *Classical Sociological Theory,* eds. C. Calhoun, J. Gerteis, J. Moody, S. Pfaff, K. Schmidt, and I. Virk, 306 (Malden, MA: Blackwell Publishers Inc., 2002).

Throwing the Baby Out with the Bathwater

A characteristic of adherents to modernism is a shared belief in the superiority of modernity over antiquity. Robert Pippin states that to understand the role of science and technology in modern life we need to understand the "intellectual and social crises" that led to the "modern rejection of pre-modern politics."[45] He describes the assumption that a technically efficient mastery of nature is automatically for the greatest public good as "uniquely modern."[46] In order to historically contextualize this assumption, Pippin suggests that the following questions be explored:

Why did this view arise when it did?

Was it a rational thing then to believe?

For whom and under what conditions?[47]

The idea that modernity was a decisive break with the past goes back to the seventeenth century. In *Cosmopolis: The Hidden Agenda of Modernity*, Steven Toulmin suggests that the linking factor in the analogy of political revolutions and the scientific revolution is the belief that the system that was in place before must be entirely rejected and destroyed.[48] His interpretation of the historical context of early modernity addresses Pippin's questions.

Toulmin argues that modern science developed in response to the social, political, intellectual and spiritual crisis that was brought on by the Thirty Years War. The

45 Robert B. Pippin, "On the Notion of Technology as Ideology," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 54 (Bloomington and Indianapolis: Indiana University Press, 1995).

46 Ibid., 52.

47 Ibid., 57.

48 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 176.

"dreams of the rationalists" for a rational method, an objective, unified science and an exact language were inspired by a desire for a meeting place where consensus and unity could be achieved in the face of religious fundamentalism, political instability and violence.[49] This led to the rhetoric of "starting from scratch" and rejecting the pre-modern. Toulmin illustrates that plurality, ambiguity and the lack of certainty in philosophy was more acceptable prior to the scientific revolution than after.

The idea that alternative and even contradictory theories and worldviews can have explanatory power and that all ideas are inevitably partial and limited implies that certainty, truth and objectivity, the cornerstones of modern science, simply cannot exist. The legacy of the desire for consensus and unity is the difficulty scientific communities and other organisations dependent on "expert advice" experience when confronted with disagreements and conflicts among scholars. But intellectual history illustrates that consensus and unity have never existed in science or any academic discipline and furthermore that disagreements are necessary for theoretical development. Disagreements among scholars of various disciplines regarding the risks, hazards and benefits of genetic engineering are not unique to this technology.

That intellectuals and scholars reassess cultural and political assumptions after periods of turmoil is not unique to the seventeenth century. An assessment of the role of scientific and technological progress as well as the role of scientists in Western society takes place after every war.[50] In his review of scientific publications and conferences in the 1970's, Sheldon Krimsky explains how the concern that many biologists had about genetic engineering research in its infancy as well as the public's right to know about

49 Ibid., 99.

50 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 4.

new technological developments was shaped by the controversial use of biological warfare in the Vietnam War.[51] The irony that the modern period is fraught with both constant war and increasing religious fundamentalism despite the dreams of early modern philosophers is not lost on Toulmin. Taking war and fundamentalism into consideration, he observes that without "critically and discriminatingly refining inherited ideas," we are likely to recreate the conditions that led to the revolution in the first place.[52]

Another interpretation of the historical context of modern science that helps to answer Pippin's questions is David Noble's *The Religion of Technology*. Unlike Toulmin, who does not go into the details of the religious beliefs of early modern natural philosophers, Noble focuses on the relationship between changes in natural philosophy and Christian theology. One of the branches of Protestant theology was Millenarism. This branch is characterized by the belief that Eden can be recreated on earth and that Man, like Adam, is superior and has dominion over all other creatures on Earth.[53] In order to recreate Eden and realize mankind's role of exercising dominion over nature, a new theory of knowledge and a new metaphysics was required.[54] Here we have another impetus for the rhetoric of revolutionary newness that came with the modern era. Although Millenarism was marginalized in the Counter-Reformation and war torn continental Europe, it had respectability particularly in Britain and among Puritans. Noble

51 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy*. (Cambridge: MIT Press, 1985), 14-15 and 340.

52 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 176.

53 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 45.

54 Ibid., 48.

traces the reflections of this branch of theology in the works of Bacon, Newton, Boyle and other fathers of modern science.

Noble's interpretation helps to explain why the ideals of our scientific heroes took root and have persisted in North America, especially the US, whose political and cultural foundations are based on Puritan values.[55] He explores the interconnectedness of empiricism, technological development, capitalism and Puritan spiritual ideas. Notions of perfection, the desire to control nature and to change the human condition have historical roots and are all key motivations behind both agricultural and medical applications of genetic engineering. The break with the past that modern science represented cannot be characterized as a break from Christianity, but rather the impact of the values of a particular sect of Christianity.

William Leiss as well, in the *Domination of Nature*, argues that the "rhetoric of the rationalist tradition" defines modernity as an opposition to preceding forms of science and social organization rather than as a transformation of them.[56] Leiss looks at the synergy between the mechanical view of nature, the rise of manufacturing and the development of bourgeois society in making instrumental rationality a dominant worldview. While he does not go into the details of the social, intellectual and spiritual "crisis" that led to the scientific revolution, he acknowledges it and his understanding of the relationship between modernity and pre-modernity dovetails with the works of Toulmin and Noble. Leiss shows that contemporary relationships between science, technology and society are not new. These relationships may be hitting a critical point in

[55] See also Winner's discussion of the technological constitution of American culture in Chapter 3 of *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986).

[56] William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 178.

our time, but their roots go back much further. Genetic engineering is a current example of the relationships that Leiss explores. The distinctions between manufacturing and research, industry and academia are not clear in the commercialisation of life science technologies.[57]

What Was Being Rejected?

While there are different interpretations of the complex series of events and historical tendencies that led to the rise of modern science, there is agreement that early modern scholars felt the need to reject their predecessors. The opposition that was created between the two periods resulted in a series of more specific oppositions that have come to characterize modern science.

The Aristotelian views of matter that dominated scholarly circles in the middle Ages were in constant contestation by those of his teacher, Plato. Aristotle did not accept Plato's understanding of the senses as corrupting our perception of reality. While he agreed that they could be misleading, he accepted the fact that they could not be ignored or repressed. He did not think that form could be abstracted from material things or that knowledge came purely from logic or the mind. My interpretation of the differences between Plato and Aristotle is that Plato did not care at all for biology and believed that mathematics, as the study of abstract form, was the only way to understand reality. Aristotle, on the other hand, was more rounded in his interest in natural philosophy and studied biology and medicine as well as physics. Perhaps this predisposed him to include different methods to approach phenomena instead of

[57] The problems with the lack of these distinctions is developed in Chapter 4 in this thesis.

embracing one universal way of knowing. Leiss describes Aristotle as having an "organological outlook" on things that inclined him to see the laws of nature as relating to qualities and forms as opposed to Plato's view that all of nature had "quantitatively determined and lawfully ordered relations,"[58] a view which has dominated modern science.

According to Toulmin, the attraction to the Platonic view of reality in the seventeenth century came from the desire for certainty and consensus that characterized the works of Descartes, Newton and Bacon. Through examination of the writings of scholars and intellectuals prior to the Thirty Years War, he suggests that plurality, ambiguity and the lack of certainty were not seen as evidence of "error" but rather as the "price of being human."[59] From this perspective, expecting unity and consensus could only be a result of "human presumption, self deception and folly."[60] Leiss describes one of the assumptions of modern science as understanding disharmonies and inconsistencies as "flaws" in not only experiments and theories, but in communities of scientists as well.[61]

Toulmin points out that abstract, timeless, and universal theoretical propositions became the only legitimate form of knowledge, as opposed to oral, local and particular forms of knowledge.[62] All those aspects of human experience that could lead to conflict and disagreement such as emotions, senses, morality, metaphysics and rhetoric were viewed as irrational or as obstacles to rational thinking. I do not include religion in this list

58 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 108.

59 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 29.

60 Ibid.

61 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 139.

62 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 49.

because all early modern philosophers were deeply religious, and the idea of science and religion as being opposed is more of a characteristic of the nineteenth and twentieth centuries.

Consensus Never Existed

Raymond Williams points out that it is easier to distinguish the main characteristics of an epoch rather than "distinguishing different phases within an epoch, and different moments within the phases."[63] This is most certainly the case in describing the changes within the rather large historical periods of "pre-modern" and "modern" in Western history, which makes any discussion of the transitions between and within them far from easy.

While one of Barzun's critiques of the ideas of Darwin and his contemporaries is that they "wove together so many incongruous strands of thought" that the works of their disciples are fraught with "confusion and chaos,"[64] it is important to point out that nineteenth century materialists themselves inherited a confused and contradictory intellectual framework. Barzun acknowledges that the methods and theories of Galileo, Bacon and Descartes prepared the methodological and theoretical foundation for nineteenth century thinkers, and there are many strands of thought that can be traced back to the scientific revolution. But monumental to the nineteenth century, and central to Barzun's analysis, was the change in the view of matter that came with evolutionary thinking. The idea of biological evolution implied that matter could transform itself, which

63 Raymond Williams, "Base and Superstructure in Marxist Cultural Theory," in *Media and Cultural Studies: KeyWorks*, eds. M.G. Durham and D.M. Kellner, 157 (Oxford: Blackwell Publishers, 2001).

64 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 326.

contradicted the dominant view in the seventeenth and eighteenth centuries that matter was static and uniform. Despite this change in perspective, many other assumptions of Bacon, Descartes and other early modern thinkers were not questioned.

One of the major tensions that arose out of the scientific revolution was between mathematical and empirical methods. Evelyn Fox Keller has written at length (*Making Sense of Life*) about the conflicted relationship between the mathematical and empirical traditions in the field of biology. Also, in the race to crack the DNA code, Lily Kay in *Who Wrote the Book of Life?* identifies two main methods used by competing groups, the mathematical logic of the geneticists and the empirical methods of the biochemists.

Toulmin represents the mathematical tradition with the works of Newton and Descartes.[65] Like Plato, they characterize truth as ideal forms and fixed laws abstracted not just from the complexity but also from the corruption of physical reality. The deeply religious Newton and Descartes wrote of natural philosophy as theological and spiritual and above the vulgarities of practical concerns. Bacon, on the other hand, who represents the empirical tradition, was all for practicality and technology. The whole point of natural philosophy, in Bacon's view, was both the understanding and control of nature. However, all three shared two fundamental assumptions. One is the idea that human reason had to be purified from the body and its passions and senses and the other is the moral imperative of expanding knowledge.

While Toulmin uses the mathematical and empirical traditions to illustrate the "Janus Face" of the scientific revolution, he does not go into detail as to how ambiguous individual thinkers were. For example, Leiss describes "Bacon's prescriptions" for his

65 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 104.

new scientific method as "a muddle" despite his desire for certainty, coherence and unity.[66] The relationships between alchemy, Christianity and modern science also illustrate the fact that the relationships between different worldviews, historical periods or institutions are never simply oppositional because they themselves are not internally consistent.

Barzun characterizes the intellectual climate of the nineteenth century as a "banishment of anthropomorphic ideas" such as vitalism and notions of divine will and purpose, which were seen as metaphysical and superstitious.[67] Again this can be traced back to the seventeenth century when natural philosophy was defined in opposition to magic, astrology, alchemy and other animistic traditions.[68] Yet several fathers of modern science, for example Newton, Boyle and Bacon, practiced alchemy.

Although it originated in antiquity, alchemy's golden age was in the Renaissance. In the eighteenth and nineteenth centuries, when it was not yet known that our heroes of science had practiced it, it was deemed pseudo-scientific and mystical. Not only was the canon of knowledge developed by alchemists throughout history a foundation for modern chemistry, but the moral imperative for understanding and dominating nature as well as its strong empirical and experimental framework were also absorbed into early modern natural philosophy.[69]

It was discovered in the early 20th century that Newton had been a practicing alchemist for most of his life, as was Robert Boyle the "father of chemistry." Because

66 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 47.

67 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 322.

68 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 74.

69 Ibid., 40-43; and David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 35-38.

alchemy was a secret practice, neither of these natural philosophers published the results of their experiments but only shared them in very exclusive and private circles. Newton did not make any reference to his practice of alchemy in any of his famous published philosophical writings, and Boyle had even written the famous *Sceptical Chymist* openly denouncing alchemy. Boyle, unlike Newton, practiced alchemy until his death. No one knows why Newton stopped practicing, but his commitment to alchemy did not contradict his desire to find universal truths that he thought alchemy could help to achieve. Nor did the mystical and spiritual dimensions of alchemy contradict his idea of natural philosophy as a way of accessing divine wisdom.

The proof that Newton practiced alchemy became public when descendents auctioned off his papers in the 1930's. That many 17^{th} century natural philosophers dabbled in alchemy was not openly acknowledged by succeeding generations of disciples. (True to Plato, the ideal form of modern science needed to be protected from the corrupting forces of reality.) Since the release of the papers, historians and philosophers of science have been interpreting the effect of his alchemical practice on his theories.

Based on Toulmin's interpretation, one conflict can be seen in the abstract mathematical nature of Newton's legacy and the empiricism of alchemy. However, also rather interesting is the conflict between the animism of alchemy and the mechanism that is conventionally associated with Newtonian physics. Just as there are universal laws in Newtonian physics, there are universal processes in alchemy that connect the inorganic and organic worlds, and the celestial to the earthly. However, the universe of the former is a machine, and the universe of the latter is alive.

Historian Richard Westfall comments on the drastic difference between alchemical and mechanistic concepts:

> ...the program of the mechanistic philosophy dedicated itself to the proposition that the underlying reality of nature is utterly different from its surface appearance...In reality it is a complex machine; the very concept of life is an illusion.[70]

Alchemy is a way of understanding nature that gives matter and nature the capacity to transform and alter itself, which was why alchemists thought that they too could alter and transform matter. Christian theology on the other hand tended to see nature as passive, as a "background" that did not change unless manipulated by God or humans who were understood as separate from nature. "Christianity's triumph over animism," Leiss explains, was to render natural objects and environments inert and without their own "spirit" and agency.[71] Alchemy was a pre-Christian practice and its vitalistic concepts of matter survived through centuries.

Noble suggests that

> Increasingly distancing themselves from both popular animistic lore and alchemical and hermetic philosophy, which assumed a divine presence in nature itself, the mechanistic scientists distinguished and divorced God from creation.[72]

Yet somehow early modern natural philosophers reconciled the animistic alchemical view with their mechanical view of nature as well as their well-documented religious beliefs regardless of any contradictions.

70 Richard S. Westfall, "The Influence of Alchemy on Newton," in *Science, Pseudo Science and Society,* eds. Marsha P. Hanen, Margaret J. Osler, and Robert G. Weyant, 147 (Waterloo, Ontario: Wilfred Laurier Press, 1980).

71 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 30.

72 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 63.

Mechanistic materialism and Christianity are *not* inherently contradictory. God, very simply, is the designer of the machine.[73] The laws that governed nature had been set up at the time of creation. Nature (matter and the body) was static, stable, inert, mechanical and repetitive. Motion, change and design were within the realm of the mind, rationality, consciousness and God. Matter could not set itself in motion. It required some *higher* agency.[74] Mind and matter were not only separated, they were given a relationship of domination and submission. Whether the relationship was between God and Nature, or between the human mind and body, or between the rulers and the ruled, those elements capable of rationality were understood to have authority and control. The static and power-laden hierarchical conception of natural and physical organization was orthodox Christian doctrine and was not in any way opposed to the natural philosophy of early modern thinkers.

Heretics

The concept of matter as living and thinking was heretical in both theological and philosophical spheres. A 16th century miller, at the age of 70, was tried and executed by the Inquisition for heresy for having animistic and vitalistic (and evolutionary!) concepts of nature. Inquisitors recorded the miller's view of nature and God during a trial:

> In the beginning the world was nothing, and…it was thrashed by the water of the sea like foam, and it curdled like cheese from which later

73 This is precisely what the newest form of creationism, the theory of "intelligent design" does. Creationist biologists, who cannot be simply accused of not understanding the science of life, use their knowledge of the intricate and complex mechanisms in the tiniest forms of life to prove their point. [See biochemist Micheal J. Behe's book, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: The Free Press, 1996), as an example of this form of argumentation.]

74 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 118-121.

> great multitudes of worms were born, and these worms became men of whom the most powerful and wisest was God.[75]

Nothingness, cheese and worms have a power to transform and organize themselves without God. God is created by nature and from matter and not the other way around. There are alchemical concepts in the miller's ideas, and the author who has written his story speculates that he may have come across books in the travelling underground library of alchemical texts. In Newton's own alchemical writings, one finds reference to organic processes through which matter transformed itself such as "fermentation" and "putrefaction."[76]

While not burned at the stake, natural philosophers who found the characterizations and separation of mind and body arbitrary (and in some cases ridiculous) were ostracised in the eighteenth century. Toulmin argues that the idea of matter as living or thinking was "heterodox" and gives examples of "marginalized thinkers" who emigrated to other countries to avoid the scorn of their communities. In England and France nonconforming scientists were not forced to emigrate, but it certainly helped to do so.[77] For example, the French natural philosopher Julien de La Mettrie suggested, "We could accept the vital and mental activities of organisms as natural outcomes of the material structures," provided his peers gave up their "dogmatic distinctions" that separated mind and matter.[78] No reconciliation occurred and he immigrated to Germany. The nonconformists were not attacked intellectually, nor were

75 Carlo Ginzburg, *The Cheese and the Worms* (Baltimore: Johns Hopkins University Press, 1980), 58.

76 Richard S. Westfall, "The Influence of Alchemy on Newton," in *Science, Pseudo Science and Society,* eds. Marsha P. Hanen, Margaret J. Osler, and Robert G. Weyant, 161 (Waterloo, Ontario: Wilfred Laurier Press, 1980).

77 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 123.

78 Ibid., 122.

their scientific explanations proven inadequate. They were attacked personally or on the grounds that they were politically subversive.[79]

Understanding this aspect of the history of science puts into perspective the treatment of non-conforming peers today. Ulrich Beck actually uses the term "heretical" to describe the "alternative" scientific theories that challenge the status quo.[80] Biologist Barry Commoner also comments on how scientific communities will not only reject experimental results that contradict the dominant paradigm but also ostracise the researchers responsible for it.[81]

The most recent examples of this behaviour tend to involve conflicts with the agendas of the corporations. At the Rowett Institute in Aberdeen, Scotland, nutritionist Dr. Arpad Pusztai's research on the safety of eating genetically engineered potatoes revealed that not only was the engineering process unreliable, but that rats fed on the potatoes developed serious health problems. He was dismissed from his position as head researcher, his results were confiscated, and his reputation smeared.[82]

Another more recent example is the case of Dr. Ignacio Chapela at the University of California, Berkeley. Dr. Chapela published an article in *Nature* along with David Quist, which revealed that native corn in Mexico had been contaminated with transgenic material from GM corn varieties. *Nature* withdrew its support of the article amid criticisms directed at Chapela's methodology. (Later studies have since validated his findings.) The

79 Ibid., 128.

80 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 51.

81 Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's Magazine* 304, no. 1821 (2002): 45.

82 See Chapter 1 of Jeffrey Smith, "A Lesson from Overseas," *Seeds of Deception: Exposing Industry and Government Lies About the Safety of Genetically Engineered Foods You're Eating,* 5-46 (Fairfield, IA: Yes! Books, 2003) for a comprehensive account of Pusztai's treatment.

combination of this event and his open critique of his university's twenty-five million dollar research collaboration with biotech company Novartis disrupted his career. Prior to the publication of the article, Chapela's department voted thirty-two to one in favour of his tenure. Amidst the controversy over the corn article, and despite support from his peers and students, the university denied him tenure in 2004.[83] (He has since been vindicated, reinstated and awarded tenure in 2005.)

These and other cases of scientists being punished for apparently antagonizing corporate interests are bringing the relationship of industry and academia under scrutiny, and it should. However, these relationships have a historical dimension as well. As Noble illustrates, many of the founding members of the Royal Society of London in the seventeenth century came from families with entrepreneurial and trade interests. Whether intentional or not, the work of the Royal Society reflected these interests.[84] Leiss also points out that the mechanistic worldview and the use of machines in manufacturing goods developed alongside each other in a dialectical relationship.[85] Both authors illustrate that there is a historical tendency in science, when debates arise around technologies and research agendas, to be biased in the direction of industrial interests.

The claim that corporate influence on scientific research is a corrupting force is not without validity, but it does not critically examine other problems inherent to the structure of science and its role in society now or in the past. Money and corporate

83 See Organic Consumers Association, "Firing of Biotech Critic Ignacio Chapela Mobilizes Students & Professors at Berkeley," OCA, December 12, 2004, http://organicconsumers.org/ge/ignacio121304.cfm.

84 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 58-59.

85 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 91-92.

influence alone do not determine theoretical and methodological orthodoxy in science, and a corporation cannot silence any scientist or scholar on its own. Whistleblowers are ostracised by their peers, their department and sometimes by the administration of the entire institution to which they belong. Ostracising unconventional and unorthodox scientists is a part of the Western scientific tradition. Because unity and consensus or, in Kuhnian terms, adherence to the dominant paradigm is an expectation, direct corporate influence is not the only factor in the marginalization of dissenting scientists.

The histories of Lynn Margulis and Barbara McClintock are well known because they are vindicated heretics. Margulis' symbiotic theory is now accepted even though she and her work were rejected for a long time. In the 1970's Margulis provided evidence from molecular biology and electron microscopy that supported the idea that plant and animal cells evolved through symbiotic relationships between different bacterial cells.[86] Margulis challenged the dominant paradigm. In the words of science writer Jeanne McDermott, "while most American biologists emphasize the role of competition in evolution, Margulis stresses symbiosis."[87] Despite her success, her support of the Gaia hypothesis, which also stresses symbiotic and complex interdependent relationships between life forms, still tends to leave her somewhat marginalized in the scientific community, but she has the freedom and support to continue her research.

Barbara McClintock's discovery of transposons was not understood and was largely ignored until molecular biologists discovered the same thing two and half

86 See Lynn Margulis, *Origin of Eukaryotic Cells; Evidence and Research Implications for a Theory of the Origin and Evolution of Microbial, Plant, and Animal Cells on the Precambrian Earth* (New Haven: Yale University Press, 1970).

87 Jeanne McDermott, "Lynn Margulis: Vindicated Heretic", in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 47 (Cambridge: MIT Press, 1994).

decades later. Even though she received a Noble Peace Prize in her eighties, her methods of discovery and general understanding of organisms has not been absorbed into conventional biology. Transposons are also known as jumping genes or mobile genetic elements because they can be excised and reinserted into other parts of the genome. McClintock observed that transposons played a role in activating or repressing the expression of other genes. Many of McClintock's peers had difficulties understanding her work. Not only did her findings challenge the notion of the genome as "a fixed linear sequence,"[88] the idea that the cell may influence certain mutations which are not random also challenged orthodox biological theory.[89]

McClintock's findings ascribe agency to organisms *as a whole* rather than viewing them as being controlled by the nucleus and genetic material, which are frequently treated as analogous to a brain or control tower. Margulis' theory of evolution highlights the mutalistic and cooperative processes that occur between organisms, not just the competitive struggle for existence and better genes.

Their understanding of biological systems challenge orthodox biological theory by describing organisms as active agents in their own regulation, development and evolution as opposed to passively carrying out genetic instructions or merely responding and not interacting with their biotic and abiotic environments. Similarly, the heretics Toulmin refers to were challenging the view of matter and nature as passive, static, stable and inert and the reduction of motion, transformation and change to abstractions of the mind rather than qualities of matter itself.

88 Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: W.H. Freeman and Company, 1983), x.

89 Ibid. (Preface and Chapter 1).

What was heretical in the seventeenth and eighteenth century should have been reframed critically in the nineteenth when the shift to evolutionary thinking took place. Evolution implies that transformation and purpose, qualities originally ascribed to rationality and mind, are qualities of nature and bodies in the biological sciences. Embracing evolution meant acknowledging that nature could transform itself without divine will or human manipulation. Nature could design and organize itself into complex forms. Even "unconscious" creatures as lowly as bacteria could "solve problems."

However, the mind/matter split was not reconciled by evolutionary thinking. Even though I was taught that Darwin had "swept such finalistic teleology out the front door"[90] by eliminating any last remaining notions of divine will and purpose in biology, I think it merely blew back in the back door. Nineteenth century scientists "substituted a scientific teleology for a theological one."[91] This substitution, according to biologist Francisco Ayala, meant that the agency and sense of purpose once ascribed to God became ascribed to mutations (genes) and natural selection (environment). "The chaotic universe of change was made rational," Barzun observes, by "blind forces and struggle."[92] The cell and the organism (representative of nature and bodies) were still not given any autonomy, causal primacy or regulatory control. According to Richard Lewontin,

> Darwin's alienation of the environment from the organism was a necessary step in the mechanization of biology, replacing the mystical interpenetration of interior and exterior that was without any material

[90] Ernst Mayr, "Cause and Effect in Biology," *Science*, 134 (1961): 1504.

[91] Fransisco Ayala, "The Autonomy of Biology as a Natural Science," in *Biology, History and Natural Philosophy,* eds. Allen D. Breck and Wolfgang Yourgrau, 1-16 (New York: Plenum Press, 1972), 9.

[92] Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 323.

> basis. But what becomes a necessary step in the construction of knowledge at one moment becomes an impediment at another.[93]

This "impediment," the alienation of the organism from its environment, is the orthodox view in biology. In the late nineteenth and early twentieth century gene theory was seen as an attempt to "liberate the study of genetics from the taint of preformationism" and "the ancient lore of animism."[94] But it has not been liberated. DNA and genes are described as though they are rational, conscious entities that organize inert materials into living machines, factories or republics, just as humans do.

> The marvel of DNA is its ability not only to govern and regulate the processes inside the cell, but also to build all the machinery and raw materials, too![95]

The impact of evolutionary thinking on the split between mind and matter has left a rather confused and contradictory way of understanding how bodies can transform themselves or how matter has agency. It is acceptable to describe genes as controlling, governing and regulating, but it is "mystical" to ascribe these activities to the cell, organism or to Earth itself. Because it is through imagery, personification and metaphors that we can identify what biologists think of as active and passive, the persistence of the ancient lore of animism will be developed further in the next chapter on rhetoric and logic.

93 R. C. Lewontin, "Genes, Environment and Organisms," in *Hidden Histories of Science*, ed. R.B. Silvers, 131 (New York: The New York Review of Books, 1995).

94 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 126. Preformationism is a deterministic theory that the entire organism was already preformed before fertilization, and therefore development was merely a process of unfolding what already existed.

95 Steve Jones and Borin Van Loon, *Genetics for Beginners* (Cambridge, England: Icon Books Ltd., 1993), 77. Steve Jones is a geneticist.

Romanticism

There are several reasons why Romanticism has become "embarrassing to invoke"[96] in both the natural and social sciences, but without a doubt its animistic tendencies is a major one. As Theodore Rozak expresses it, the process of understanding is a "holistic, ecstatic synthesis of fact and value, and nature, spirit and self."[97] This approach to epistemology and nature is "comparable to the divinity imputed to [nature] in primitive and animistic modes of thought."[98] This is a fairly unpopular approach to reality, but it is only one aspect of the Romantic worldview.

Romanticism developed also as critique of materialism, nationalism, the idea that prosperity came with greater production, and the notion that progress was tied to both industrialism and science.[99] There is a great deal of resonance between eighteenth century Romantic concerns and contemporary critiques of modernity.

> Their world, like our own, was one in which the shadow of doubt had fallen over rationality, the status of the true and real had become matters of public concern, and fearsome new technologies had trespassed on fundamental assumptions about human nature.[100]

Romantics were concerned with both social and intellectual consequences of modern science. From a social and political perspective, the alienation of humans from their environment through industrialism was a critical issue, and from an epistemological perspective, the alienation of scientists from their objects of study was another.

[96] David J. Black, *The Politics of Enchantment: Romanticism, Media and Cultural Studies.* (Waterloo, Ontario: Wilfred Laurier Press, 2002), 17.

[97] Leo Marx, "Reflections on the Neo-Romantic Critique of Science," in *Limits of Scientific Inquiry*, eds. Gerald Holton and Robert S. Morrison, 68 (New York and London: W.W. Norton and Company, 1979).

[98] Ibid., 70.

[99] Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 331-2.

[100] David J. Black, *The Politics of Enchantment: Romanticism, Media and Cultural Studies.* (Waterloo, Ontario: Wilfred Laurier Press, 2002), 5.

Barzun describes the intellectual and cultural milieu of the nineteenth century as the "triumph of scientific materialism" over the "flexible and humane pragmatism of the Romantics."[101] Barzun's distinction between scientific materialism and human pragmatism is similar to Toulmin's distinction between the abstract, universal and absolute theoretical propositions that defined early modern science and the pre-modern acceptance of local, oral and particular forms of knowledge.[102] The latter "enlarges our comprehension by showing how separate truths are relative to the act of knowledge and the reality of experience."[103] Romantic epistemology included those aspects of humanity that mechanist modern thinkers wanted to exclude from rationality: emotion, senses and the body, imagination, morality and the complexity of experience. Because the totality of experience has qualities that cannot be captured through language, Romantics acknowledged the limits of theory and explanation for understanding reality.

J. David Black distinguishes this approach from post-modernism. Both post-modern and Romantic perspectives reject the idea that any "metanarrative" such as Christianity, Marxism or liberalism, can provide an objective and unified approach to reality. However, post modernism tends to focus on the personal and local, which in its relativistic extremes parallels the individualizing tendencies of modernity. The Romantic approach to plurality (which I tend towards) is that regardless of whether or not metanarratives, ideologies, metaphysical positions, cosmologies or worldviews can be universally true and provide a perfectly accurate account of existence, human beings need them to interpret themselves and their environments. The issue is not about truth

101 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 16.

102 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 49.

103 Ibid., 352.

or falsity but rather being aware of the limitations inherent to all high levels of abstraction.

Romanticism and Morality

One of the reasons that Romanticism has met with "fierce resistence from scholars across the ideological spectrum"[104] is that it is often characterized as committing the naturalist fallacy. In critiquing Marcuse's notion that moral order can be sought in the inherent and objective qualities of nature, Habermas claims that

> It is a dream of a nature with whom we could speak, of a nature that is itself a moral agent and with whom a reciprocal moral relation is a possibility. Like all romanticism it correctly rejects the claims of science to intellectual hegemony, but incorrectly thinks it can do this only by rejecting Science's validity.[105]

I agree that there is a problem in seeking morality in a nature that is interpreted through historical and cultural contexts because essentially we can find justification of any behaviour in the many and diverse aspects of physical reality.[106] However, that scientific concepts reflect and shape values and morality and cannot be separated from them is also a Romantic notion that we could do well to keep. The domination of nature, which, as many (especially Marxist) scholars have pointed out, is correlated to the domination of one class by another, or one culture by another, was a moral imperative of the early modern philosophers who built the framework for science. Both Noble and Leiss make arguments that the domination of nature and the moral imperative of

[104] David J. Black, *The Politics of Enchantment: Romanticism, Media and Cultural Studies*. (Waterloo, Ontario: Wilfred Laurier Press, 2002), 29.

[105] Jurgen Habermas quoted in Steven Vogel, "New Science, New Nature: The Habermas-Marcuse Debate Revisited," in *Technology and the Politics of Knowledge*, eds. Andrew Feenberg and Alistair Hannay, 29 (Bloomington and Indianapolis: Indiana University Press, 1995).

[106] This issue will be further developed in chapters five and six.

advancing knowledge only makes sense in a particular religious context. That the assumptions of modern science have been secularised has not changed anything other than making science's morality invisible to itself. Science, as Ulrich Beck sees it, is a "secular power without God" and therefore without limits, and this is what makes it so dangerous.[107] In a complete inversion, many specialists and experts hold the idea that limiting and regulating science is dangerous. The moral imperative to advance knowledge serves to justify the failure to take responsibility for the consequences of science and technology.

I disagree with Habermas' latter statement, which characterizes Romanticism as rejecting science's validity. I agree with Leo Marx who characterizes the Romantic critique of science as questioning the *adequacy*, rather than the validity or reliability, of the scientific method as an approach to nature. Instrumentalism and empiricism are valid forms of analysis, but they must be complemented (not replaced) by synthesis and integration or what Emerson calls "analogising and intuitive modes of perception."[108] Marx describes differences among Romantics as to the degree to which science is seen as the cause of modern problems,[109] but they generally agree that scientific knowledge is reliable in its "own proper sphere."[110]

Habermas' characterization ignores how the phenomenological approach to nature that Romantic natural philosophers such as Goethe used and endorsed has greatly contributed to the canon of scientific knowledge that we have today. In fact,

107 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 90.

108 Leo Marx, "Reflections on the Neo-Romantic Critique of Science," in *Limits of Scientific Inquiry*, eds. Gerald Holton and Robert S. Morrison, 63 (New York and London: W.W. Norton and Company, 1979).

109 Ibid., 68.

110 Ibid., 71.

Goethe is credited with founding the field of morphology. His insights into anatomical relationships provided a foundation for my training in modern botany. However, while his conclusions are accepted, his methods are typically denigrated as "idealistic and metaphysical."[111] The methods of Barbara McClintock, who eventually won a Nobel Prize for her discovery of transposons, were similarly evaluated. In the middle of her career, when very few of her peers understood what she was doing, the term "McClintockism" was coined among her peers and essentially meant unscientific.[112]

While she never declared herself a Romantic, she did call herself a "mystic."[113] McClintock understood that a "commitment to the unity of experience and the oneness of nature" plays a role in scientific discovery.[114] Goethe expressed this as an "intuitive perception of the whole" in the process of observing.[115] The path to discovering and understanding "elementary laws" of nature is not only logical, according to Einstein, but also intuitive and "supported by being sympathetically in touch with experience."[116] My interpretation of why this aspect of scientific discovery and creativity is usually understood as a quirk of famous scientists (and a flaw of not so famous ones) is that what these scientists describe is experiential and unspecifiable. What exactly is synthesis and integration? How does one teach awareness of the "oneness of things"? Yet for Goethe, McClintock and Einstein, it is essential. The limitations of the scientific

[111] E.M. Gifford and A.S. Foster, *Morphology and Evolution of Vascular Plants,* 3rd ed (New York: W.H. Freeman and Company, 1989), 2.

[112] Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: W.H. Freeman and Company, 1983), 193.

[113] Ibid., 204.

[114] Ibid., 201.

[115] W. Heitler, *Goethe's Way of Science: A Phenomenology of Nature* (New York: State University of New York Press, 1998), 65.

[116] Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: W.H. Freeman and Company, 1983), 145.

method are twofold. First, by itself it can only give a picture of "nature in pieces."[117] Secondly, it serves as a framework for knowledge making after the moment of discovery is over, it does not reflect *how* we know.[118]

According to physicist turned philosopher Michael Polanyi, understanding the "whole" within which the parts we are observing are submerged involves processes of both analysis and integration.[119] But the process of integration is so personal and idiosyncratic, for example Goethe's communication with nature or McClintock's intimacy with corn plants and their chromosomes, that it cannot be taught as a recipe or a set of rules. "Imitation may serve as guidance," Polyani advises, "we alone can catch the knack of it; no teacher can do this for us."[120] But just because we cannot describe the totality of the experience of discovery, or for that matter the totality of nature and reality, does not mean that it does not exist.

Ignoring the limitations of *how* we come to know nature and, consequently, *what* we know about it has troubling consequences. McClintock observes the relationship between the theories, methods and techniques of conventional science and the environmental damage brought on by technologies:

> We're not thinking it through, just spewing it out...technology is fine, but the scientists and engineers only partially think through their problems. They solve certain aspects, but not the total, and as a consequence it is slapping us back in the face very hard.[121]

117 Ibid., 205.

118 Ibid., 203; McClintock had a great deal of respect for Eastern philosophy as did physicists Erwin Schrodinger, Neils Bohr and Robert Oppenheimer. McClintock was drawn to Tibetan Buddhism and thought that they truly understood how we know.

119 Michael Polanyi, *Knowing and Being: Essays by Michael Polanyi* (London: Routledge and Kegan Paul, 1969), 126.

120 Ibid.

121 McClintock quoted in Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: W.H. Freeman and Company, 1983), 206.

How hard genetic engineering is slapping us in the face from an environmental perspective is discussed in Chapter 3.

Mètis

Science has long been understood through two types of knowledge, *episteme*, which is the abstract and universal, and *techne*, which is practical. However there is a third concept of knowledge that also comes from antiquity. It is called *mètis*. James C. Scott resurrects this concept to help "explain scientific invention and insight" because even episteme and techne together cannot account for it.[122] *Episteme* represents the "formal procedures of rational decision making" that early modern natural philosophers came to see as superior over all other types of knowledge.[123] *Techne* may be more practical but also is reduced to procedures and is "best suited to activities that have a singular end or goal."[124] *Mètis,* on the other hand, is a form of practical knowledge that is based in local and particular experience, cannot be reduced to a set of rules and is difficult to teach.[125]

The concept of mètis has similarities with the form of knowing that Romantics describe. It resonates with the pragmatic and phenomenological approach to human experience that "accepted the local, timely and particular aspects of practical knowledge" that was more acceptable to scholars prior to the scientific revolution.[126] Mètis also

[122] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 320.

[123] Ibid., 322.

[124] Ibid., 322.

[125] Ibid., 336.

[126] Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 29.

resonates with Donna Haraway's concept of "situated knowledges." Knowledge is always made in a place, at a particular time and within and between bodies (which includes the mind.) She too sees some tendrils of her ideas connecting to the ideas of the Romantics in the eighteenth century.[127] While we do not have to jump on a neo-Romantic bandwagon, we should at least acknowledge that in our own Western culture and philosophy, there have been scientists who never took the mind out of the body when observing nature or their own ways of knowing. And some of these scholars we think of as geniuses. Not teaching science historically is a betrayal indeed.

[127] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 190.

CHAPTER 2:

THE BETRAYAL OF BELIEVING SCIENTISTS ARE CAPABLE OF PRECISE SPEECH

By "precise speech" Barzun is referring to the "objective", "value-free" language with which scientists are expected to describe and explain their ideas and observations. Among the several oppositions that have come to characterize modernity, the separation of logic and rhetoric is a key one. Prior to the 17th century both logic (a chain of reasoning) and rhetoric (the language used to convince the audience of the validity of the reasoning) were equally legitimate fields of philosophy.[128]

The separation of logic and rhetoric had two impacts according to Toulmin. One was that questions such as who is speaking to whom in what forum and with what examples were no longer perceived as important.[129] Secondly, the term rhetoric itself became a "slur"[130] and was used to imply an attempt to manipulate, rather than convince, an audience. Rhetorical tools such as metaphors, metonymy, personifications and imagery suffered the same fate.

"During the rise of empiricist epistemologies in the sixteenth and seventeenth centuries," metaphor enthusiast Mark Johnson writes, "metaphor suffered a beating at

[128] Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 30.

[129] Ibid.

[130] Ibid.

the hands of 'scientific minded' philosophers."[131] However, since the mid-twentieth century, Johnson observes, in Western philosophy, the meaning of metaphor has changed from denoting a stylistic and literary form to a form of logic.[132] This meaning of metaphor has been acknowledged more readily in the history and philosophy of science that science itself.

Metaphor has also been traditionally seen as belonging to the realm of Romantics and poets and as opposed to "sterile" scientific language.[133] Some contemporary scholars, such as Donna Haraway, have the opposite view that metaphors are an integral part of scientific discourse.[134] Donna Haraway points out that seeing the organism as a poem, a medium of expression, as eighteenth century romantics did, may be a welcome intellectual change from seeing nature as a set of codes needing to be decoded and opened to exploitation.[135]

There are two aspects to the relationship between language and biology I want to discuss. One aspect is the denigration of the metaphorical and the linking of "objectivity" with the "sterile" or literal nature of scientific discourse. The other aspect is that language itself is a powerful metaphor used to describe and explain genetic phenomena. What Haraway's observation brings attention to is that there are different metaphors related to

131 Mark Johnson, "Metaphor in the Philosophical Tradition," in *Philosophical Perspectives on Metaphor*, ed. Mark Johnson (Minneapolis: University of Minnesota Press, 1981), 11.

132 Ibid., 3.

133 Ibid., 15.

134 For example, philosophers of science make this acknowledgment in their work: Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995); Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996); Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999); and Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk*, ed, Sheldon Krimsky and Dominic Golding, 4-22 (Westport, CT: Praeger Publishers, 1992).

135 Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 188-190.

language that can be applied to understanding nature and biological phenomena, and they reflect different theoretical and methodological approaches.

Theory and Metaphor

In the introduction, attention is drawn to the fact that scientists, specialists and experts do not agree about the risks of genetic engineering and many other new technologies. But the disagreements do not stop there. Krimsky observes that the attempt to predict risks and estimate hazards in the absence of data is always based upon some theoretical foundation.[136] In "The Role of Theory in Risk Studies," Krimsky calls for an interdisciplinary "overarching theoretical framework" for a better understanding of risks and risk assessment. His discussion revolves around the specific needs for such a theory rather than what a theory is. "I have been particularly careful to avoid defining *theory*," he writes.[137] Why is this?

Krimsky, who originally studied physics, compares the use of the term "theory" in the natural and social sciences:

> too often the term theory is too loosely applied outside of the highly formalized natural sciences...several examples of the shallow application of the term theory in the social sciences [are]: vague conceptualisations of descriptions of events; prescriptions of desirable social behaviour; any untested hypothesis or idea.[138]

However, philosopher of science Sergio Sismondo uses the adjective "loosely" to describe how natural scientists apply the term "theory" and describes the natural sciences as having "no firm criteria that distinguish theories from hypotheses, models or

[136] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 89.

[137] Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 7 (Westport, CT: Praeger Publishers, 1992) (italics his).

[138] Ibid., 6.

single pieces of knowledge."[139] The first step in trying to establish an interdisciplinary overarching theoretical framework is illustrating that the various disciplines in the natural and social sciences share the characteristic of defining theory loosely, or more strongly put, not being precise in talking about theories. Similar to mètis, or practical knowledge, scientists learn concepts, laws and theories through their application and as an activity rather than in the abstract.[140]

What to do? Philosopher of science Dudley Shapere suggests that identifying paradigm cases of theories is easier than defining what a theory is.[141] It is indeed easier to describe what a theory must address in particular, but what is a paradigm? As it turns out, the term paradigm suffers from the same lack of precision as theory.

In their discussions of theory, Krimsky and Kuhn, refer to the same illustration of the plurality of meaning from Ludwig Wittgenstein.[142] Wittgenstein pointed out the idea that a singular and precise definition is not necessary for an object, concept or activity to have meaning and for communication to take place. He gave an example of a leaf: some people may visualize a maple leaf, others an oak leaf, others an aspen leaf, and so on.[143]

139 Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996), 23.

140 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 46-7.

141 As cited in Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 7 (Westport, CT: Praeger Publishers, 1992).

142 *Philosophical Investigations* cited in Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 7 (Westport, CT: Praeger Publishers, 1992); and Thomas S. Kuhn, *The Structure of Scientific Revolutions,* 2nd ed (Chicago: University of Chicago Press, 1970), 44.

143 This is a particularly interesting example for someone who has a degree in botany. Upon reading it, I realised that because of my studies, I understand "leaf" to be a concept and part of a particular theory of plant development and botanical evolution. I did not think of a particular shape or object but rather that a leaf is defined by its structural and developmental relationships to other parts of the plant. And then I remembered Gregory Bateson using a metaphor comparing anatomy and language, that one part has meaning or is defined by its relationships to other parts. I meditated on this for quite a while and a fair amount of this dissertation unfolded in my mind. So, some people may think of a maple leaf, others an oak leaf, and yet others the core of an idea for a dissertation.

However, in particular communities, particular concepts may be more unstable than others. For example, in the scholarly world, the term "toilet" could be considered more stable that the term "theory."

Ian Hacking uses the label "elevator words" to describe loosely defined terms within academic communities. He gives the example of the terms "fact," "truth," "reality" and "knowledge."[144] Essentially these are all things that modern science is responsible for discovering and agreeing upon. Hacking issues a warning that these words have become circularly defined and have undergone "mutations of definition and value" such that readers should be "wary" of arguments that use these terms.[145] The definitions of these terms have become so localized that they can be only understood in specific contexts. Keller concurs and using biology as an example, shows that the concept of theory is not used in a unified manner. She employs the term "epistemological cultures" to describe the localization that Hacking refers to.[146]

An epistemological culture is constituted by the norms and mores of a particular community of scholars who share definitions of terms such as "theory," "knowledge," "explanation," "understanding" and "practice"[147] – which are essentially "elevator words." Because I can only hold a certain number of definitions at any given time, I choose not to make a distinction between Keller's epistemological cultures and Kuhn's "paradigms". A paradigm is the "entire constellation of beliefs, values and techniques of a given community." It is also a disciplinary matrix, a metaphysical position, a set of values

144 Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 22.

145 Ibid.

146 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 4.

147 Ibid., 4.

determining theory choice and a group's shared commitments.[148] It can also be thought of as a way of seeing.

Seeing Is Believing: Theory as Worldview

The Greek word *theoria* originally meant looking at or viewing.[149] Thomas Kuhn frequently uses the metaphor of vision to explain consensus within a paradigm and incommensurability between paradigms. He gives the example of two people with the same retinal impressions who see different things and two people with different retinal impressions who see the same thing.[150] When a paradigm shift takes place, scientists see something that they had not seen before.[151] Similarly, according to Haraway, "struggles over what will count as rational accounts of the world are struggles over how to see."[152] When experts disagree, they are disagreeing about different ways of seeing. "All theories carry with them a particular viewpoint," writes biologist Brian Goodwin, "a way of seeing phenomena that produces sharp focus on certain aspects of reality and blurred vision elsewhere."[153] Theories are sometimes described in terms of metaphors, analogies, models, maps and patterns. All of these help us visualize concepts and ideas in our "mind's eye." Either theories "use" metaphors, are based on metaphors, or

[148] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 181.

[149] Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 207.

[150] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 126-127.

[151] Ibid., 85.

[152] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 184.

[153] Brian Goodwin, *How the Leopard Changed Its Spots: The Evolution of Complexity* (New York: Simon and Schuster, 1994), vii.

actually are metaphors. Paradigms have also been described as having similar relationships to metaphors and analogies.[154]

1. Theories and metaphors are not reducible to rules or components.

Kuhn describes theories and paradigms as not being governed by rules. Similarly, Mark Johnson notes "the imaginative leap occurring in a metaphor is not rule governed and therefore not reducible to a set of rules or a systematic procedure of understanding."[155]

Paradigms are a fundamental unit of scientific research that cannot be reduced to its atomic components.[156] Kuhn compares a paradigm shift to a change in a "visual gestalt," meaning that a change in worldview does not occur item by item or piecemeal, but rather, all at once.[157] Gestalts "are complex characteristics that are constituted by the relationships of simpler characteristics, but still cannot be completely analysable into elementary characteristics."[158] Metaphors as well cannot be reduced to their components "and in any attempt to do so one loses sight of all the aspects necessary to make it meaningful."[159] One of the reasons that a rule based definition of theories and paradigms is desired is the expectation that they could then be broken down into a

[154] See Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996); and Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970).

[155] Mark Johnson, "Metaphor in the Philosophical Tradition," in *Philosophical Perspectives on Metaphor*, ed. Mark Johnson (Minneapolis: University of Minnesota Press, 1981), 39.

[156] Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 10.

[157] Ibid., 85.

[158] Steven C. Pepper, *World Hypotheses: A Study in Evidence* (Berkeley: University of California Press, 1961), 168.

[159] Mark Johnson, "Metaphor in the Philosophical Tradition," in *Philosophical Perspectives on Metaphor*, ed. Mark Johnson (Minneapolis: University of Minnesota Press, 1981), 30.

recipe for knowledge construction that could be easily followed. However, epistemological processes cannot be explained by reductionist analysis alone.

2. *Can theories and metaphors be true or false?*

One of the differences between "standard" (literal) and "poetic" language pointed out by Jan Mukarovsky in 1932 is that truthfulness is not an issue for poetic language.[160] Herein lies also a common distinction between science and art: that science is used to make truthful statements about the world, whereas art is an expression of the artist's interpretation of the world. Just as scientific language is supposed to be literal, scientific theories are supposed to be an attempt at being true and falsifiable against the background of an objective reality. The "dreams of the rationalists" for a rational method, a unified science and an exact language are intricately intertwined with each other.[161]

Theories not only include or "use" metaphors; there are structural similarities between the two. But if metaphor, once the "handmaid of poetry,"[162] is the mistress of scientific discourse, where does this leave the issue of truthfulness and falsifiability, the cornerstones of the scientific method? For philosopher of science Sergio Sismondo

> ...understanding how a model can be a conceptual approximation to the truth is not difficult once we see the way in which models function as metaphors: models represent the world through a lens that identifies some structures as the relevant objects of study.[163]

160 Jan Mukarovsky, "Standard Language and Poetic Language." In *The Routledge Language and Cultural Theory Reader*, eds. L. Burke, T. Crowley, and A. Girvin (London and New York: Routledge, 2000), 229.

161 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 77.

162 Agnes Arber, *The Mind and The Eye* (Cambridge: Cambridge at the University Press, 1954), 40.

163 Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996), 132. Note the metaphor of "lens".

From a purely philosophical point of view I agree, however, to accept that theoretical statements can be metaphorical and "approximately true" we have to accept that theories and metaphors are approximately false as well. But which parts are true and which parts false? What are the consequences of this imprecision?

"Approximate truth" justifies the claim by some scientists and technicians that technological disasters such as Chernobyl are "almost impossible." Ulrich Beck calls this way of thinking irresponsible. "Almost impossible" he explains, "is a statement that remains true without recognizing the falsity of theories or seeking improvement."[164] Technological disasters are not seen as evidence of errors in the theoretical frameworks that spawned them, but rather, Beck complains, as due to human failure or a technical glitch that can be worked out.[165]

Truth is traditionally defined as being universal, but most contemporary scholars have problems with such absolutism. "Every truth has its limits," according to Barzun, and a danger lies in taking truths out of their limits.[166] Botanist Agnes Arber, who defines the genius of biologists as lying in their choice of analogy, also understands that the "failure to recognize its incompleteness" and limitations is a problem.[167] Arber points out that in antiquity, philosophical arguments were presented as dialogues including different points of view, which contrasts with modern science whose scientists are "expected to take a single definite view."[168]

164 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 91.

165 Ibid.

166 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 348.

167 Agnes Arber, *The Mind and The Eye* (Cambridge: Cambridge at the University Press, 1954), 40.

168 Ibid, 112-3.

Many contemporary scientists turned philosophers and philosophers of science call for a more pluralistic approach to theories. This is a point of resonance with pre-modern and Romantic thinkers. Many scholars, for example, Arber, Portmann, Haraway, Hacking, Keller, Barzun, Toulmin and Sismondo, share the idea that "nature is too complex and interconnected to fit into any one theory or model,"[169] and that objectivity lies in "a multitude of viewpoints"[170]. Resistance to this idea is tied to the fear of relativism and uncertainty.

Toulmin defines our task as "fighting intellectual reductionism" rather than building a "new universal or grand narrative."[171] Neither is there one true account of reality, nor are there an infinite number of different accounts of reality. (For example, Steven Pepper characterizes six "world hypotheses" each of which are based on what he calls "root metaphors.") I do not think that there are endless ideas, theories or understandings of reality floating around in people's heads. Leave it to Western intellectuals to grossly overestimate their own creativity and individuality and project it onto everyone else.

3. *The metaphysical aspects of theories and metaphors.*

Krimsky identifies two main paradigms in the social sciences, "individualism" and "contextualism," which he says have similarities to "reductionism" and "non-

[169] Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 300.

[170] Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 96.

[171] Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 193.

reductionism" in the natural sciences.[172] Similarly contrasting views of reality have also been analysed as atomism and holism, mechanism and organicism, dichotomous and dialectical thinking. Hacking also describes the "science wars" as occurring between two approaches to phenomena. On the one side there are "constructionists," who tend towards relativism, and on the other, "essentialists" who tend towards absolutism.[173] For Hacking, constructivists emphasize historical contingency and indeterminism and essentialists emphasize inevitability and determinism.

Since not all experts share the same theoretical foundations, disagreements abound. Krimsky explains,

> One of the most important ways that analogy enters into theories of risk is in how we think about wholes and parts. We either draw our analogy from scientific reductionism...in which the whole is fully explainable by the parts or from non-reductionist models...in which the whole has unique qualities that cannot be explained by the parts.[174]

Either way, both are attempting to account for a whole, for the total of something but in different ways.

There is another modernist assumption to break down in regards to metaphor, and that is the dichotomy of science and metaphysics. Metaphysics is a branch of philosophy that investigates the nature, constitution and structure of reality as a whole and also embraces the concerns of epistemology and the general structure of how we think about the world, nature and reality. The dichotomy between metaphysics and

172 Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 15 (Westport, CT: Praeger Publishers, 1992) (italics his).

173 Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999),14. Of course, the scholarly world is not so simply split into two extremes. Both Krimsky's and Hacking's categories describe tendencies and predispositions of scholars who hold these views in varying degrees [Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 15 (Westport, CT: Praeger Publishers, 1992)].

174 Sheldon Krimsky, "The Role of Theory in Risk Studies," in *Social Theories of Risk,* ed. Sheldon Krimsky and Dominic Golding, 15 (Westport, CT: Praeger Publishers, 1992).

science (specifically positivist science) is based on the assumption that all aspects of reality are knowable through the methods of science, but this in itself is a claim about the constitution and structure of reality and is therefore metaphysical.

Kuhn characterizes the “metaphysical parts of paradigms” by the models, metaphors and analogies deemed acceptable and useful by a given community.[175] Because “the unified whole defies pictorial thinking”[176] and totality cannot be analysed, analogised, explained and described, we fill in the gaps between our observations and experiences with analogies, theories, and paradigms. Reductionism and non-reductionism are metaphysical pictures of the world and can be identified through analogies. These viewpoints do not define disciplines, but rather ways of understanding or seeing.

Hacking observes that in the analysis of social and cultural phenomena, politics, ideology and power matter more to social constructivists than metaphysics when illustrating how certain knowledge and systems of categorization are used in power relationships.[177] The debate is in part based on metaphysical positions which Hacking describes as “certain pictures of reality, truth and discovery.”[178] “Neither scientists nor constructivists dare to use the word metaphysics, ” Hacking continues, “they talk past each other since each is standing on metaphysical ground in opposition to each other.”[179]

Identifying what metaphysical grounds scholars are standing on through analogies and metaphors is important for two reasons. One is determining whether

175 Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed (Chicago: University of Chicago Press, 1970), 184.

176 Agnes Arber, *The Mind and The Eye* (Cambridge: Cambridge at the University Press, 1954), 104.

177 Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 58.

178 Ibid., 60.

179 Ibid., 61.

consensus on an issue can be achieved or not, which is helpful in technology policy-making and regulation (see discussion in Chapter 4). The other is that analogies and metaphors can be shared between disciplines and are useful in building interdisciplinary bridges.

Language and Biology: Reducing Context to Code

The devaluation and separation of rhetoric from logic is related to the desire that arguments become universal and absolute. The audience no longer mattered. The language of philosophy should be exact and literal. The audience can be seen as a context and an environment within which an argument, a debate or a discussion takes place. Similarly the context of the cell, organ, organism and ecological environment in which protein making takes place is also devalued in reductionist attempts to understand the inner logic of the genome.

Biology experienced a "linguistic turn" as many other scholarly fields did in the 1950's. But while the humanities and social sciences began to address issues of audience and context, biology did not. The language metaphors that began to creep into biological discourse with the discovery of the structure of DNA did not come directly from linguistics, but were instead mediated through information and communication research conducted by the military.

The three levels of analysis in studies of language and communication (syntax, pragmatics and semantics) are key to understanding the conceptualisation of heredity as a "communication problem."[180] Lily Kay quotes Claude Shannon, one the co-founders of

[180] Lily E. Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford University Press, 2000), 150.

information theory, who declared, "The semantic aspects of communication are irrelevant to engineering aspects."[181] From the standpoint of information theory, Kay continues, the "problems of pragmatics were irrelevant as well." It did not matter "whether a message originated with or reached a human or a monkey."[182] One can see how this logic has been embraced in genetic engineering. The genetic "messages" encoded in distinct genes are thought of as universal and should be received in the same way regardless of the organism receiving it. This was despite the understanding brought forth in the 1950's by philosophers like Ludwig Wittgenstein and John Austin that the meaning of a message is not universal, and receiving messages is not a passive process. This form of reduction is common to mechanistic approaches to reality.

In the field of communication studies there was a shift in the 1930's and 1940's from mass communication models that took audiences as passive "targets" for information to a more ethnographic approach in which audience members were seen to play a more active role in producing the meaning of messages.[183] Communication scholars Mattelart and Mattelart characterize mass communication theories as describing the process of receiving messages as like receiving a "hypodermic needle."[184] The parallels between the communication and medical model lie in the assumption of universal effects of standardized messages/medicines due to the homogeneity of the audience/patients. Lily Kay extends this medical/communication model of active transmission to passive receivers as also being analogous to the work being done on

181 Ibid., 21.

182 Ibid.

183 Armand Mattelart and Michele Mattlelart, *Theories of Communication* (London: Sage Publications, 1998).

184 Ibid., 26.

guided missiles and targets during the mid century development of mathematical theories of communication. This analogy is also used in reductionist descriptions of the body where the brain sends messages to a passive body or the nucleus sends messages to a passive cell. The reduction of "context to code," as Mattelart and Mattelart describe the process of localising meaning in a message, was a process occurring in many different fields at the same time. In regards to genetic engineering, the understanding of DNA as a code tends to devalue the importance of cellular and environmental contexts.

The cell and the organism of which DNA is a part are not passive. Keller uses well known genetic phenomena to illustrate the importance of shifting away from focussing so much on the structure of genes and looking at the cellular and organismal regulation of the genome in order to understand how proteins are made. She thinks we should be "filling the gap" between "genetic information" and "biological meaning."[185]

As early as 1902 linguist Benedetto Croce suggested that we should be focussing on meaning at the levels of semantics and pragmatics rather than syntax.[186] His concern was the confusion of "physical facts" like consonants and words with expressive facts like sentences.[187] Croce's understanding that language does not have a reality outside of its use by people in particular contexts also applies to the understanding that a gene does not have a reality outside its use by the cell and that the cell itself fits into wider organismal and ecological contexts.

185 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 230.

186 Benedetto Croce, "The Identity of Linguistic and Aesthetic," in *The Routledge Language and Cultural Theory Reader,* eds. L. Burke, T. Crowley, and A. Girvin, 35 (London and New York: Roultledge, 2000).

187 Ibid., 37.

It is interesting that Croce uses the metaphor of an organism to describe his understanding of expression: that it must be understood as a whole and not by its constituent parts.[188] Both the meaning of a sentence and the form of an organism can only be understood as a set of relationships, not a series of absolutes. Reciprocally, C.H. Waddington, a biologist who strongly advocated the integration of genetics and embryology suggested

> Perhaps to use an analogy not much cruder than many that pass muster in information theory, it is only words that can go into solution and become the playthings of biochemists, but sentences remain always within the domain of the morphologist.[189]

Sassure's suggestion that perhaps language and memory were best conceptualised as form and not as a substance resonates with an idea much more popular with embryologists and morphologists than geneticists, that is "it is not matter but form that is perpetuated during cell division."[190] In reductionist approaches, the concept of form as having three dimensions that develop and change through time and space has been reduced to the two dimensional concept of information that causes changes in its context rather than being altered by its context.

Ecology (or Evolution) and Epistemology

Gregory Bateson's concept of "ecology of mind" was an interdisciplinary framework with which to analyse ecology (or evolution) and epistemology.[191] He

[188] Ibid., 35.

[189] Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995), 100.

[190] Lily E. Kay, *Who Wrote the Book of Life? A History of the Genetic Code* (Stanford: Stanford University Press, 2000), 89.

[191] Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 182.

suggested that we should apply what we know about cognitive systems to ecological systems and vice versa. Again we find that the metaphor of language and the study of form is central to connecting these two realms.

While using the language of cybernetics (which works against his ideas because of its tendency to be mechanical), he specifically defined information as a process by which differences and changes are perceived, sensed or known. One can only perceive things in relations to other things and the selected (or filtered) differences between them become information. Bateson gives an example of the phoneme "p" which only has meaning when it is in a word, placed in a sentence that is a part of a conversation or a text that is being understood in a wider cultural and social context.[192] This idea is also mirrored in the work of Jacques Derrida who was writing about the same time as Bateson. He uses the term "differance."

> Whether in the order of spoken or written discourse, no element can function as a sign without referring to another element which itself is not simply present. This interweaving results in each "element"- phoneme or grapheme – being constituted on the basis of the trace within it of the other elements of the chain or system. This interweaving, this textile, is the text produced only in the transformation of another text.[193]

For Derrida, language and semiotic codes are effects of the processes of meaning making through difference and reference and not the cause of meaning. In a similar fashion, Keller thinks that the stability and function of the genome within the cell is an endpoint for developmental biology rather than a starting point, as it is in genetics.[194]

[192] Ibid., 166.

[193] Jacques Derrida, "Semiology and Grammatology: Interview with Julia Kristeva," in *The Routledge Language and Cultural Theory Reader,* eds. L. Burke, T. Crowley, and A. Girvin, 246 (London and New York: Roultledge, 2000).

[194] Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 30.

Embryologists in the early-to-mid twentieth century had a tendency to explain developmental processes as cells "knowing" where they were in a body and what to do. This easily invited criticism that their ideas were "vitalistic."[195] One of the fairly accepted problems with Neo-Darwinism is that it ignores embryology and development. Michael Ruse explains that because of the tendency towards vitalism, reductionist biologists "stayed away" from findings in developmental biology.[196] I think these fields were ignored because, as Ruse himself observes,

> There is so much richness at the molecular level, and at the non-molecular level, that showing the latter as a logical consequence of the former would be an undertaking of horrendous theoretical and practical difficulty.[197]

It is much easier to assume genetic determinism and ignore both specific research and entire fields that contradict its premises. Furthermore, the embryology-genetics debate was not about whether life requires an activating principle, which characterised the disagreements between vitalists and mechanists in earlier centuries, but rather whether the cell contains a program for development or whether the cell is a program for development itself.[198]

Cells and zygotes are not homogenous. Contained in maternal cells are proteins that activate the transcription of genes. These proteins are asymmetrically localized in specific regions of the maternal cell. As nuclear division occurs, the chromosomes are exposed to different concentrations of these proteins and so are subject to differential levels of gene activation and differential rates of protein transcription. Consequently,

195 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 176.

196 Michael Ruse, *Philosophy of Biology Today* (Albany: University of New York Press, 1988), 80.

197 Ibid., 28.

198 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 176.

differences in the concentration of new proteins are created. The combination of different concentrations of different proteins activate and repress other genes and create a cascading of effects (or interweaving of elements) that lead to differentiated cells of the embryo, which then lead to differentiated tissues and ultimately different body parts.[199] Essentially the genome (like all other organs of the cell and the cell itself) is sensitive to differences (chemical, magnetic, electric, light, heat) and the interaction between differences. Before proteins are *expressed*, the cell senses differences and its response depends upon the tissue, organ, organism and external environment that it is within.

Evolutionary Epistemology

Prior to Bateson and Derrida, Wilhelm Dilthey suggested that "elementary logical operations" and initial "perceptual knowledge" is based on comparing, differentiating, noting sameness, separating and relating. These operations are inherent to any sense-experience. They are interpreted and then can be expressed.[200]

The concept of difference can be applied to divergent phenomena such as how we come to know things or how an organism develops in a coherent manner. But it is not the only concept that is exchanged across disciplinary borders. Bateson was deeply critical of game theory, utility theory, and all other "economic and monetary analogies" that reduced the behaviour of humans and all other organisms to problem solving and optimalization.[201]

199 Ibid., 186.

200 Wilhelm Dilthey, *Selected Works Volume III: The Formation of the Historical World in the Human Sciences*, eds. Rudolf A. Makkreel and Frithjof Rodi (Princeton and Oxford: Princeton University Press, 2002), 8.

201 Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 94-96.

For example, according to Sismondo, "realists only need to claim that science aims for fruitful metaphors which capture something of the subject matter."[202] He gives the example of game theory and aggression models as being useful and heuristic devices in order to understand evolutionary biology. These are designed to model competition among strategies that are "genetically coded for." It is the *strategies*, not the individual organisms that compete and play the game. He justifies the use of such games and models as capturing some aspect of biological reality despite the "obvious human correlations" in the assumed responses to competition and conflict. Also the models aim at optimality and stability "even though there are good reasons to believe evolutionary processes lead neither to stabilization or optimalization."[203] He calls them "attractive falsehoods" and "convenient fictions."[204]

In another chapter, he uses the ideas of philosopher David Hull to illustrate how an evolutionary framework can lead to "good representations" of how science itself works. Hull's description of scientific activity is based on Richard Dawkins selfish gene theory. This understanding of theoretical development is called evolutionary epistemology. Essentially theories are seen as genes. They replicate and pass on their structure through scientists, who in interacting with their environment cause the replication of theories to be differential. "Selection *upon* interactors"[205] (scientists) by the social environment is what leads to differential representation. Selection *by* scientists of the replicators (theories) results in the most useful theory, and the most often used

[202] Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996), 132.

[203] Ibid., 129-130.

[204] Ibid., 130.

[205] Ibid., 45 (italics mine).

replicator becomes dominant. "Useful facts" will "survive the pool of scientific resources and falsehoods and useless facts with tend to be forgotten, refuted or left behind."[206] "Truth and fruitfulness are selected for"[207] and success and fruitfulness (which are not defined) are taken as signs of truth.[208]

Evolutionary epistemologists accept that ideologies "diverging from the truth" can change the environment and consequently change what is selected for,[209] but their very use of a Neo-Darwinian framework to explain knowledge construction assumes that Neo-Darwinism is not ideological. By its own logic, the very dominance, familiarity and ubiquity of Neo-Darwinism are proof of its usefulness and truth, even if its truths only represent "some portion of the world."[210] Alternative interpretations of biological organization and development, such as those that ascribe agency to cells and organisms, and not to genes and abstracted "strategies," are viewed as falsehoods and useless facts.

Autopoesis is a theory that conceptualises life and evolution with concepts of knowledge, mind and cognition. It is an alternative to Neo-Darwinian theory in biology. However, its basis in systems theory, which attempted to transcend traditional academic disciplines, taints it somewhat in the minds of social scientists. Systems theory in the nineteen-forties originated with biologists and maintained a rather "organological"

206 Ibid.

207 Ibid., 48.

208 Besides the obvious tautology, it was Bacon who is best known for popularising the idea that truth and usefulness are intertwined; see David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 49. Because technologies are taken as the proof of progress, as has been observed by Barzun and Winner, questioning the theories behind "successful" technologies such as atomic energy and biotechnology is not widespread.

209 Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996), 47.

210 Ibid., 46.

outlook. Unfortunately, it evolved into cybernetics, which became mechanical and reductionist. Anthony Wilden thinks that a living cell should be an analogy of all systems. He complains that the term "system" has been absorbed into a mechanical and Cartesian worldview

> in North America where a new technocracy of mind managers, word processors, information movers and people pacifiers is arising like Dracula out of the coffins of management science.[211]

Described in this way, it is no wonder systems theory fell out of favour, but we don't have to throw out the baby with the bathwater.

In a review of the concept of autopoesis and how the scientists that propound it apply the concept to both biological organization and cognitive function, Mattelart and Mattelart issue the following warning:

> There is a danger that the penchant for totalising conceptions, characteristic of these sectors may lead them very far towards biological interpretations of the world and confirm their complicity in bringing back Social Darwinist theories that thrive in the atmosphere of neo-liberalism. Therein lie the contradictory challenges that the sciences of living organisms present to the social sciences of communication.[212]

What is a "biological interpretation"? Keller introduces her explorations into differing explanations of biological form by stating, "biology is not unified by a grand theory nor is a concept of theory shared,"[213] despite the veneer of consensus. Not all biological interpretations are necessarily deterministic.

The separation of the natural and the social that has a long tradition in Western philosophy can be found in much contemporary work. But as Winner points out, despite

211 Anthony Wilden, *System and Structure: Essays in Communication and Exchange*, 2nd ed (London: Tavistock Publications, 1980), xxxviii.

212 Armand Mattelart and Michele Mattlelart, *Theories of Communication* (London: Sage Publications, 1998), 136.

213 Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 1.

the legitimate critiques of the "naturalistic fallacy," the "coercive quality" of naturalism tends to be overlooked.[214] While we want to be able to keep the natural and the social separate, "again and again," Winner continues, "one finds that metaphors used to describe the one are later translated to illuminate the other."[215]

Systems theorists like Wilden and Bateson observed this as well. One of Bateson's justifications for interdisciplinarity was his observation that "in the process of translating theories from one field to another, one finds patterns common to many disciplines."[216] Wilden goes as far as to suggest that the actual role of science to society is "illuminating and teaching new generations about patterns of relationships in the organic, inorganic and social universes."[217]

An interdisciplinary overarching theoretical framework does not have to insist that there is only one way of interpreting organic and inorganic, human and non- human phenomena. It must address the relationship between different theories and paradigms *within* disciplines, and the relationships these different conceptual frameworks have between disciplines.

214 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 129.

215 Ibid., 135.

216 Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), xii.

217 Anthony Wilden, *System and Structure: Essays in Communication and Exchange,* 2nd ed (London: Tavistock Publications, 1980), xxxvi.

Animism and Anthropomorphization

Pepper's characterization of animism as a world theory is that its root metaphor is humans, most commonly illustrated in its personification of nature.[218] He localizes animistic views to archaic and pre-modern cultures and does not consider this worldview as a valid scholarly approach. However, despite the concerted efforts of reductionist natural philosophers, there are strong animistic tendencies in modern biology.

Predating Bateson by about a decade, plant morphologist Agnes Arber writes of the ubiquity of the human – nature analogies.[219] While she feels that such analogies are valuable, she also notes that there are "many absurdities as well."[220] Bateson sees the "wisdom of animism" as it is generally "easier to use human analogues in an attempt to understand nature."[221]

I think that this is inescapable. Different theories, ideologies and worldviews exist and they all take a particular view of how we make knowledge and project it onto the natural world. Animal morphologist Adolph Portmann uses the term "inner world" to describe how we (or any organism) experience the external world subjectively both as individuals and as a species.[222] Portmann suggests that we can only speculate and anthropomorphize what other organisms experience because we have different inner worlds. For example, E. O. Wilson explains ant behaviour as follows:

218 Steven C. Pepper, *World Hypotheses: A Study in Evidence* (Berkeley: University of California Press, 1961), 120.

219 Agnes Arber, *The Mind and The Eye* (Cambridge: Cambridge at the University Press, 1954), 36.

220 Ibid., 39.

221 Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 256.

222 Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 28-38.

> It is as if each species had a vocabulary of ten to fifteen messages, and everyone took instructions without questions. One message means "Follow me." Another: "On Guard! A threat to public good is present."[223]

We can only understand the perception and response of ants to the chemicals they produce through our own forms of communication and behaviour. Similarly, it is common to understand the relationship between genes and bodies as if molecules are verbal directions.

> There is a reason why dungflies copulate for 35.5 minutes; why big male reef fish turn into females but little male reef fish don't; why female swallows like males with elongated tails; why more promiscuous primates have bigger testes. The reason is simple. Dungflies, reef fish, swallows, and promiscuous primates who do otherwise leave less DNA. The chemically encoded messages, "copulate for just 28 minutes," "if small become female," "prefer somewhat less plumage," and if promiscuous, grow a small scrotum" all get passed on to fewer bodies, and so, tend to die out.[224]

Even though scientists have been able to penetrate deeper into smaller and smaller realms of biological systems, they have not necessarily increased our understanding of them, but have rather projected a reductionist view of the human inner world onto molecules. Seeing organisms as machines is an anthropocentric, if not a strictly anthropomorphic tendency. We are limited to understanding nature's creative capacities only through our own. Morphologists Arber and Portmann both observe that the tendency of biologists to want to use technologies as "prosthetic eyes"[225] results in seeing biological systems as technologies, not just seeing them through technologies. It

[223] Robert Wright, "Three Scientists and Their Gods," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 153 (Cambridge: MIT Press, 1994).

[224] Laura Betzig, "People are Animals," in *Human Nature,* ed. Laura Betzig (Oxford: Oxford University Press, 1997), 1.

[225] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 180.

is perhaps because Arber and Portmann primarily used direct observation of plants and animals (in Goethe's tradition) that their attention is brought to those who do not.

Arber complained in the mid-twentieth century that science was only becoming concerned with "isolated chains of reasoning" of cause and effect.[226] This reductionism, compounded by the growing acceptance of using "manipulative techniques," predisposed biologists to linear and mechanistic thinking. Arber was not opposed to technologies and experimentation, "provided," she qualifies, "it does not become an end in itself."[227] A "machine is a derivative of a living creature and only in a strictly limited sense can it be compared to a creature."[228] Portmann concurs and gives the example that "even though computers can copy or even surpass our cognitive processes, they cannot fully explain them."[229]

According to Portmann, biological development and evolution are "seen most often in terms of technical activities. That is the reason why comparisons between living beings and machines appeal so directly to our imagination."[230] Machines are built for a purpose, and technologies are seen as solutions to particular problems. It is the instrumental rationality of these analogies that poses the main difficulty Portmann has with these analogies. Both science and organisms are seen as "problem solving."

He outlines the danger of reducing scientific inquiry to instrumentality:

> Control of the greatest possible number of living processes is the aim of a growing discipline- biotechnology – whose discoveries are already being exploited on a vast industrial scale. As its findings accumulate, so the

226 Agnes Arber, *The Mind and The Eye* (Cambridge: Cambridge at the University Press, 1954), 22.

227 Ibid., 13.

228 Ibid., 43.

229 Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 32.

230 Ibid., 9.

> economic importance of the new discipline will grow and so it will increasingly affect the allocation of public funds, the planning of large scientific enterprises, the choice of scientific methods, and the way in which scientific questions are being posed.[231]

He observed in the mid-twentieth century that scientific research, which does not have public attention was under-funded and ignored, (perhaps his own investigations in snake scale pattern development). Portmann's fears were prophetic. The sub-disciplines of morphology and organismal biology have shrunk as molecular biology has grown. Genetics is more seductive than studies of organisms as wholes because "chromosomes are more responsive to artificial manipulations."[232] The "temptation" to characterize "the whole by its known parts"[233] is relevant to both the discipline of biology as well as biological systems themselves.

Problem Solving

The reduction of the construction of knowledge to problem solving, trial and error and experimentation is paralleled in the reduction of organisms to problem solvers and nature to an experimenter or even a genetic engineer. What scientists themselves do is projected onto what they study.

> The concept of adaptation is that the external world sets certain "problems" for organisms and that evolution consists in "solving" these problems, just as an engineer designs a machine to solve a problem. So

[231] Ibid., 10-11.

[232] Ibid., 144. Arber actually thought that the growing requirement to learn "manipulative techniques" had more than just a negative impact on morphology and embryology. "To learn how to think effectively" she observed, "is somewhat alien to the scientific temperament" (see *The Mind and the Eye*, 23).

[233] Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 148.

> the eye is the solution to the problem of seeing; wings of flying; lungs of breathing...[234]

While Lewontin and Levins critique this view as unnecessarily alienating the organism from the environment, Portmann illustrates that the flaw in instrumental thinking likes in the fact that "we are surrounded by unaddresssed phenomena" that cannot be explained by function and utility.[235] Similarly, Bateson sees the concept of purpose to be a dangerous concept because we do not and cannot understand totality; we can only speculate on the nature of the whole from what we know.[236] This formed the basis of his critique of game and utility theories.

Another anthropomorphizing tendency is the understanding of nature as conducting experiments like scientists do. Max Delbruck asserts, as many biologists do, that "living cells carry billions of years of experimentation."[237] The cells in this analogy are passive. Who is doing the experimenting and with what? Nature and evolution are personified as the ones carrying out the experiments. Because reductionist evolutionary theories reduce evolution to a mixing and matching of genes, proponents of genetic engineering see scientists as merely recreating a natural process.

Krimsky observes that describing nature in this way is a powerful rhetorical tool. In getting the nervous public to understand nature as a gene splicer, "there would be

[234] Richard Levins and R.C. Lewontin, *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), 25.

[235] Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 100.

[236] Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 299.

[237] Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 103.

less argument that science had developed a unique power over nature that must be carefully controlled by society."[238] The logic of the argument is as follows:

> During the several billion years of life on earth, all or most possible gene combinations have been tried by evolution through the process of mutation and genetic exchange, and any that are not now extant are counteradaptive. Therefore it is extremely unlikely that man could possibly create anything that is (i) novel, or (ii) adaptive for the novel organism. Therefore, there is no significant biohazard inherent in rDNA research. 239

The last few decades have shown that through genetic engineering, novel traits such as making mice and tobacco glow in the dark, and adaptive traits like herbicide resistance have been created.[240] Failing to grasp the limitations of our inner world and blindness to personifications and anthropomorphizations of nature is not just an issue of logic or rhetoric. The limitations of analogies become a part of the technologies based on them. Given the degree to which so many experts and specialists are blind to their assumptions, it is no surprise that they can't see where modern technologies are taking us.

Even if we accept that all we have are "attractive falsehoods" and "convenient fictions," as philosopher of science Sergio Sismondo does, which ones do we choose? And how do we take responsibility for our choices? Truth and utility or representing at least "some portion of the world"[241] is not enough, not when we have such a strong tendency to conflate that portion of the world with an understanding of the whole of it.

238 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy*. (Cambridge: MIT Press, 1985), 265.

239 Ibid., 275.

240 For example, herbicide resistant canola has become a major weed on the Canadian prairies. The conventional means to get rid of weeds, herbicides, do not work on them.

241 Sergio Sismondo, *Science Without Myth: On Constructions, Reality, and Social Knowledge* (Albany, New York: State University of New York Press, 1996), 46.

Bauman characterizes the desire for consensus (which in its extremes is the basis of fundamentalism), the denial of contingency and not looking to alternative orders as "immoral".[242] Bateson sees the destruction of the ecological system of which we are a part with the deadly cocktail of "short sightedness and powerful technologies" as being "immoral."[243] Consequently, Bateson's answer to risk does not lie in the "long and tedious path of computing all the relations between relevant variables,"[244] which is the reductionist approach to totality. To see, as Romantics do, ecosystems and societies as alive is to understand that like all living things they can be poisoned, they can become pathological and they cannot be fixed or recreated at whim like machines. Bateson's organism is similar to linguist Croce's organism that he used as a metaphor for expression – it is best understood as an indivisible whole.

Portmann suggests that the purpose of life, if there is indeed any purpose, "is self expression, not self preservation."[245] In this way he accounts for the diversity and creativity of nature and those "unaddressed phenomena" that do not immediately fit functionalist explanation. Early linguist Roman Jakobsen, in drawing the distinction between literal language and poetic language, described the latter as being "expression for its own sake" as opposed to having some utilitarian and practical function.[246] It is with the fusion of all these ideas that I understand Haraway's notion of "organism as poem"

242 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 216.

243 Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 255.

244 Ibid., 256.

245 Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 99.

246 Roman Jakobsen, "Linguistics and Poetics," in *The Discourse Reader,* eds. A. Jaworski and Nikolas Coupland (London and New York: Roultledge, 1999), 55.

that she resurrects from Romanticism. [247] Poetry, according to Romantics, is not just a genre of literature but also the very model of life itself.[248] If all bodies are "material semiotic entities" as Haraway suggests, than we need to explore all the dimensions of language, not just in its use, but also as an analogy itself.

Problem solving or trial and error is an integral part of the processes of nature, the development of science and the processes of knowledge making. But it does not explain or describe nature's creativity or human creativity in full.

[247] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 189.

[248] David J. Black, *The Politics of Enchantment: Romanticism, Media and Cultural Studies.* (Waterloo, Ontario: Wilfred Laurier Press, 2002), 10.

CHAPTER 3:

THE FEAR OF UNCERTAINTY

Bruno Latour asks the question, "How could we avoid noticing that we have not moved an inch since Descartes?"[249] He is referring to the desire for absolute certainty that characterized the work of Descartes and many early modern natural philosophers. The basis of the fear of uncertainty lies in the restriction of alternatives to two equally problematic choices: a qualified positivism and constructivism or relativism. The former generally characterizes the natural sciences, while the latter finds more acceptance in the social sciences.

The painful irony of the modern condition is that despite the desire for certainty and predictability that serves as a foundation for modern science, modernity has, as Beck observes, "introduced uncertainty in every aspect of life."[250] Beck characterizes modernity as the "risk society" because with the uncertainty has come an increasing number of possible risks and actual hazards. Both Ulrich Beck and Langdon Winner focus on technologies (mainly atomic energy) to illustrate why and how this is happening, but their observations are also relevant to genetic engineering.

Both Beck and Winner are critical of the common response to uncertainties about risky technologies put forth by policy makers and experts who assume that the problems

[249] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 8.

[250] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 22.

will be solved by "more research."[251] With this "solution," Winner observes, political action is unnecessary. Limits are not placed on technological innovation or research agendas, and, as Beck also points out, technological research and manufacturing are sometimes one and the same.[252] Business as usual can continue.

Greek sceptics observed that with an increase in knowledge comes an increase in ignorance, which is why scientific progress, despite its intent, has led to greater uncertainty and less security.[253] Before the advent of molecular biology and electron microscopy, Portmann observes, biologists viewed the cell, not DNA, as a basic unit of life.[254] The increasing amount and detail of knowledge that has come with the focus on genetic and molecular phenomena must be, from Portmann's perspective, integrated with investigation and knowledge of physiology, development, morphology and ecology.[255] This integration was not happening enough in the mid-twentieth century when Portmann was writing, and the problem remains. While we are gaining knowledge of smaller and smaller parts of the cell, our ignorance of the relationships between them, and of the cell, tissues, organs, the whole organism and its living environment grow. Each detail discovered uncovers an exponential number of pathways and relationships needing to be explored.

The problem of growing ignorance and uncertainty is exacerbated by the tendency in the natural sciences to accumulate details and not integrate them with wider

251 Ibid.,106; Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 143.

252 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 106.

253 Ibid., 103.

254 Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 3.

255 Ibid., 3-7.

bodies of knowledge. Moreover, life is too complex to ever fully understand it in full scientific detail. For these reasons, not only does ignorance increase, but the destructiveness of technologies based on limited knowledge that has not been integrated with wider contexts increases as well. The uncertainty of the processes and consequences of genetic engineering is not a problem that can be solved with more research.

> No matter how far our power of technical control over nature is extended, nature retains a substantial core that does not reveal itself to us.[256]

It is not only what we do not currently know, but what cannot be known about the complexity of life that makes genetic engineering an inherently unpredictable and hazardous process.

Cartesian Biology

Geneticist Ricarda Steinbrecher's critique of genetic engineering begins with a critique of mechanistic philosophy, which analyses the world by breaking it down into its constituent components. In this view, each component has its specific function, and its behaviour follows laws that are constant and predictable.[257] The failure of this philosophy is that the relationships between the components are ignored, and the whole is seen as the sum of its parts.[258] The mechanistic approach in genetics and molecular biology leads to a myopic focus on defining the boundaries of a gene and its function. Steinbrecher calls this "treating genes like Lego blocks" that can be picked up, moved

256 Habermas, *Knowledge and Human Interests*, 33.

257 Ricarda Steinbrecher, "Ecological Consequences of Genetic Engineering," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* ed. Brian Tokar, 76 (London and New York: Zed Books, 2001).

258 Ibid., 77.

around and pieced together without any change in function or stability.[259] Philosopher of biology Michael Ruse describes this view of biological organization thus: "shuffle the units one way and one gets a mouse, shuffle the units another way and one gets an elephant."[260]

In 1943, the concept (and slogan) "one gene – one enzyme" was introduced and, despite the accumulation of contrary evidence, is still an assumption in genetic determinist perspectives and the practice of genetic engineering. Similar to Steinbrecher's analogy to Lego blocks, biologist Ernst Mayr called this approach "bean bag genetics."[261] The implication of this point of view is that one gene produces one trait, and many genes produce the whole organism.[262] A reflection of how strongly this simplistic view has a theoretical hold on biology can be found in the reaction to the findings of the Human Genome Project. Biologists working on the project had overestimated the number of genes by over two thirds, (they estimated 100,000 and found 30,000) because of widespread reductionist assumptions.

As scientists critical of the project point out, the expectations of the project were based on a flawed theoretical foundation.[263] The expectations ignored a large amount of scientific knowledge already in existence. This is not the first time molecular biologists have been shocked by their own research. Keller gives an example of the degree of cellular involvement in repairing DNA and maintaining genetic stability, which also came

259 Ibid., 76.

260 Michael Ruse, *Philosophy of Biology Today* (Albany: University of New York Press, 1988), 25.

261 Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 76.

262 Ibid., 75.

263 Ibid., 4; Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's Magazine* 304, no. 1821 (2002): 40.

as a "major surprise" to researchers. She adds that this knowledge was "slow to register in molecular biology."[264]

At the very core of mechanistic and reductionist biology lies the assumption that a gene "codes" for a protein and that genes "govern" the synthesis of proteins. These assumptions are what help biologists and technicians visualize genes as Lego blocks or tinker toys. If this were the case, genetic engineering would not be fraught with as many problems as it is.

Does Genetic Engineering 'Work'?

In the summer of 2001, researchers from the University of Guelph proudly announced that their transgenic pigs, eventually bound for Canadian dinner tables, were good for the environment.[265] These "enviropigs" were altered with genetic material from mice and bacteria to produce a particular enzyme in their saliva. The enzyme, called phytase, aids in the digestion of phosphorous. The idea was that the pigs would digest more phosphorous than normal and therefore less would end up in their manure. Their manure then would be less of an agricultural pollutant. The experiment was called a "success," and both the researchers, and the Ontario Pork Organization which financed the trial, were confident that parts from these pigs would be on our dinner tables in three years.

Neither the Canadian Food Inspection Agency (CFIA) nor Health Canada had approved enviropigs for human consumption. After the experiment, the piglets that died

[264] Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 27. Portmann also wrote about the lack of integration of findings in developmental biology into genetics in Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964).

[265] Margaret Munro, "Mouse Genes Used to Make Cleaner Pigs," *National Post*, July 31 (2001): A.12.

at birth and the surviving piglets, which were killed, were supposed to be incinerated. They were accidentally stored with the carcasses of other animals used in research, which were bound for a rendering plant. The enviropigs became a part of chicken and turkey feed and consequently did end up on Canadian dinner tables, albeit in a different form than intended.[266] After the mistake was discovered, the CFIA recalled the remaining feed and Health Canada conducted research that revealed that the enzyme was destroyed in the rendering process. More rigorous containment procedures have been instituted at the University of Guelph, but the mishap led both the Ontario Ministry of Environment and Environment Canada to review their regulation of genetic engineering research.[267] The University's vice president of research Alan Wildeman observed that, "Things you don't expect to happen can happen."[268] However, while some uncertainties that come with genetic engineering are caused by "accidents" and non-rigorous regulatory requirements for experimentation, there are other uncertainties and unpredictability that are directly associated with the process of engineering transgenic animals.

Looking at the details of the research trial, one finds that out of 4,147 one-celled pig embryos injected with the transgenes, only one hundred pigs were born. This step in the procedure had a success rate of 2.41% and a failure rate of 97.59%. Out of the one hundred born, thirty-three produced the enzyme in the saliva, but not consistently. If thirty-three little pigs that are not producing the same amounts of the enzyme can be

266 Stephen Strauss, "Accident Raises GMO Research Flag," *The Globe and Mail*, Feb 19 (2002): A.7
267 Ibid.
268 Ibid.

considered a "success," then the success rate of the trial was 0.80%, and the failure rate was 99.20%.

While the assumptions of genetic determinism and reductionism can account for the success rate, they do not account for the high failure rate. The function of genes is highly cell and organism specific, and genes do not strictly and directly specify proteins and enzymes, which helps to explain the failure of many transgenic experiments.

While many mammalian transgenic experiments and agricultural crops have high failure rates, there are cases where genetic engineering has seemed to "work," for example, where plants were modified to express herbicide resistance.[269] Without a doubt, herbicide-resistant canola crops have manifested the desired trait, and farmers have been able to apply herbicides without apparent harm to the crop. The problem is that herbicide resistant canola has now become a weed and has infested organic and conventional non-genetically modified canola fields. From this perspective, genetic engineering did not "work." It is impossible to contain, and the only way to slow its spread is to stop growing canola altogether. Canola, like most members of its diverse mustard family, is a prolific seed producer with potential to cross with its many weedy cousins.

The effects of herbicide-resistant crops and crops engineered to kill insect pests on wildlife, pollinators, soil ecology and human health are beginning to be uncovered because ecological relationships have not been adequately assessed when releases of genetically modified crops have been approved. For this reason Steinbrecher dislikes

[269] Unlike mammalian cells, plant cells are done in batches and success and failure rates are not documented as they are with animal cells. The difference in methods will be described later in the chapter.

the term "engineering," which evokes qualities such as stability and precision. She prefers the term "genetic gambling" or "randomeering."[270]

In the next four sections on genetic stability, specificity, natural gene transfer and artificial gene transfer, the many levels of uncertainty that are inherent to the processes of genetic engineering will be illustrated.

Stability

As Evelyn Fox Keller explains it,

> The genetic machinery of the cell provides the most striking example known of a highly reliable, dynamic system built of vulnerable and unreliable parts.[271]

Many critics of genetic engineering, especially if they are biologists, point out that the concept of DNA as a stable and "self replicating molecule" is flawed. Keller points out that ever since the structure of the DNA molecule was discovered there has been a tendency to assume that "how it made copies of itself was explained by structure"[272] and not its interactions with the cell to which it belongs. Let's take a closer look at the process by which DNA is replicated and repaired.

The molecule of DNA is shaped like a double helix. It takes this shape because of the way its constituents are attracted to each other. DNA is mostly sugars, phosphates and what are called bases or nucleotides. There are four different bases whose names are abbreviated as A, T, C, and G. They have complementary

270 Ricarda Steinbrecher, "Ecological Consequences of Genetic Engineering," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* ed. Brian Tokar, 98 (London and New York: Zed Books, 2001).

271 Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 31.

272 Evelyn Fox Keller, *A Feeling for the Organism: The Life and Work of Barbara McClintock* (New York: W.H. Freeman and Company, 1983), 171.

relationships; A binds to T and C binds to G. The simple description of DNA replication goes as follows: the double helix unwinds into two strands, the bases on each strand attract their complementary base from among free floating bases in the cell so that four strands will spiral into two double helices.

In living cells, DNA rarely floats around naked. It is usually found in chromosomes that are constituted by about 40% DNA and 60% proteins called histones. Histones are bound tightly to DNA and are thought to never disassociate from it under natural conditions. It is known that these proteins play a role in keeping DNA tightly coiled when not in use. The DNA of one human cell would stretch over two meters. These proteins mediate the winding and unwinding of DNA when it needs to be translated or replicated. The other functions that histones may play are not known in detail. Transgenic DNA is "naked" or devoid of these proteins. It is unknown what effect its integration into a chromosome will have on the chromosome's integrity. This is the first level of uncertainty inherent to genetic engineering. As will be discussed in the section on natural gene transfers, most naturally occurring naked genetic material in cells are from viruses and are *pathological.*

DNA is replicated when the cell is preparing to divide. A series of experiments that fused cells in different stages of division revealed that every step of cell division and DNA replication is stimulated by changes in the cytoplasm.[273] (The cytoplasm refers to all cell contents including the cell's membrane, but excluding the nucleus.) What stimulates the cell to divide in the first place depends on its context and environment. Sugars are aphrodisiacs to unicellular organisms such as bacteria and yeast and stimulate them to

[273] Bruce Alberts, Dennis Bray, Gulian Lewis, Martin Raff, Keith Roberts, and James D. Watson, *Molecular Biology of the Cell, Second Edition* (New York and London: Garland Publishing Inc, 1989), 732.

replicate. What developmental stage an organism is in will determine the rate and extent of cellular division. The health of a tissue or organ will influence the rate of cellular reproduction in that tissue. The health of the whole body will influence it as well. DNA replication is inseparable from its cellular context, and the cell is inseparable from its context. DNA does not just spontaneously replicate itself, and removed from its context is remarkably inert.

Particular enzymes (proteins that catalyse biochemical reactions) start the process of DNA replication by binding to histones at the critical times. Other enzymes catalyse the process of rotating the helix into a proper position; other enzymes unwind the helix into two strands, additional enzymes inhibit the strands from twisting and coiling, and still other enzymes twist and coil the strands back! All of the enzymes are working in a specific sequence. While it is extremely common to read descriptions of DNA that ascribe agency to it such as "genes make proteins," visualizing the DNA molecule as having things done to it brings our imagination closer to empirical findings.

As new bases are bound to the unwound strands, mistakes, breakages and damage occur. The fidelity of the new strands to the old is maintained by a repair system. Some estimates suggest that errors occur on average at a rate of one per every hundred bases, but with the repair system, errors are reduced to one in ten billion.[274] Repair systems are networks of enzymes and work in four different ways:

1. by checking that the correct bases bind together
2. correcting them if there is a mistake
3. repairing what was missed by 1) and 2)

[274] Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 29-30; and Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's Magazine* 304, no. 1821 (2002): 44.

4. the "SOS" system responds specifically to environmentally caused damage (radiation, UV light etc.)[275]

While a certain degree of stability is necessary for the proper functioning of the cell, mutability and change is also an inherent aspect of life. This is our understanding of evolution and is revealed in the breathtaking diversity of forms with which life manifests itself. In some cases when bases themselves are damaged and cannot bind properly, DNA synthesis will not proceed past that point. If the damage is severe enough, the cell will not divide and will die. This sort of damage can be bypassed by a repair mechanism that is called the SOS system. Enzymes will cut a patch of DNA from another strand and patch the damaged gaps.[276] This system lowers the fidelity of the other normal repair systems and can lead to increased mutability not only in the area patched but also in other areas that were not damaged.[277] While certain types of environmental damage are known to induce this system such as that caused by UV light and benzene,[278] it has also been associated with the increased mutation rates during conditions of severe stress.[279] Specific cellular metabolic processes monitor and maintain the integrity of the genome. Does a cell or organism respond to the integration of transgenic material as a form of damage? Nobody knows. Herein lies another level of uncertainty. The failure of GM cotton crops in not only not expressing the desired trait but in producing low yields and unhealthy plants has been blamed on extreme weather conditions, which could suggest

275 Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 30.

276 David Suzuki, Anthony Griffiths, Jeffery Miller, and Richard Lewontin, *An Introduction to Genetic Analysis Third Edition* (New York: W.H. Freeman and Company, 1986), 349.

277 Ibid., 342.

278 David Suzuki, Anthony Griffiths, Jeffery Miller, and Richard Lewontin, *An Introduction to Genetic Analysis Third Edition* (New York: W.H. Freeman and Company, 1986), 342.

279 Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 36.

high mutation rates under stress. However, the biological cause of the failures is unknown.[280]

When a cell integrates transgenic material, there is absolutely no guarantee that it will not be subject to normal cellular processes such as the DNA repair systems. Being a transgenic organism may be stressful in and of itself since foreign material has been forcibly introduced into its system to make novel proteins not endemic to its natural type.[281]

Cells do have some defences against the expression of foreign DNA (depending on the organism). In some transgenic plant trials "gene silencing" of the transgene has been observed. Very simply, enzymes will bind a specific molecule to a part of a gene to stop it from being expressed. But gene silencing has been observed in some parts of a crop and not others, and to make matters more complicated, the process of silencing can be reversed when enzymes remove the molecule. This can happen in the first or subsequent generations of the transgenic organisms. Why and when silencing occurs is not understood, making the process of genetic engineering extremely unpredictable and the long-term stability of transgenic varieties an open question.

Specificity

There have been spurious claims made to have discovered specific genes responsible for complex traits and behaviours such as homosexuality, intelligence,

280 Ricarda Steinbrecher, "Ecological Consequences of Genetic Engineering," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* ed. Brian Tokar, 96 (London and New York: Zed Books, 2001). She adds that, in 1997, US cotton farmers sued Monsanto for damages due to lost crops. GM cotton crops have failed in India as well.

281 For a more detailed review of mutations in transgenic crops, see "Genome Scrambling – Myth or Reality" by Alison Wilson, Jonathan Lanham and Ricarda Steinbrecher. Both the summary and entire technical report published in October 2004 is available on the EcoNexus website (www.econexus.info).

violence, or most recently, spirituality (the god gene). However, evidence in molecular biology has revealed that genes do not have as much agency and specificity in the making of individual proteins, much less complicated behaviour, as determinists assume. Let's take the simplest scenario to start.

When a protein needs to be made, the portion of DNA where the gene lies needs to be unwound. A complex of proteins bind to the chromosome in a specific place to stimulate unwinding mediated by a network of enzymes as in replication. Unlike replication, instead of complementary bases being attracted to make another DNA strand, complementary bases are attracted to create what is called an mRNA strand. The "m" stands for "messenger" because the mRNA leaves the nucleus of the cell to go to another organelle where the "message" of the bases is "read." RNA is similar to DNA but only has one strand, whereas DNA has two, and the base thiamine is replaced with another not found in DNA called uracil.

Each set of three bases of the mRNA strand, known as "codons" specify an amino acid. Transfer DNA (tDNA) transfers the amino acids to the mRNA where they are attached together in a sequence. This sequence of amino acids is folded into a specific shape by proteins with the apt name of chaperonins. The folded sequence of amino acids is the protein. Again, the gene is not doing anything. It is the enzymes and protein complexes that are engaging in activity.

This is the simplest version possible; let's try to make it more realistic without making it too confusing. (This is a challenge for the author, not a presumed deficiency on the part of the reader.) Most genes have exons and introns. Exons are the parts of the gene that, when transcribed into mRNA, specify the sequence of amino acids. The description of protein making above treated the gene as one exon. Introns are parts of the gene that, when transcribed into mRNA, are spliced out of the mRNA strand by specific enzymes. The remaining portions of mRNA are then assembled together by protein complexes called spliceosomes. The mRNA then leaves the nucleus and attaches to an organelle called a ribosome. It is at the ribosome where amino acids are matched to the codons of the mRNA strand. The amino acids are then linked and folded into a protein.

The function of introns is not entirely known, but then ninety to ninety five percent of the genome that is not used for making proteins is not understood. This huge part of the genome is still sometimes referred to, rather arrogantly, as "junk DNA." Even though an intron is not a coding part of the gene, mutations in them may lead to mutations in the protein.[282]

The folding of the protein is not the end of the line. After folding, proteins may need to have sugars or other molecules added before they become metabolically active. Also, by linking together mRNA transcripts from different genes large proteins (like hemoglobin) are formed.

There are ways that cells process mRNA and proteins that weaken the idea that genes "make" or even specify proteins. So, for example, the attempts to make bacteria produce plant and animal proteins with transgenes do not always work because their

[282] There is one dramatic example where the sequence of introns is crucial. A mutation in one of the introns of one of the hemoglobin genes results in the mutated intron being cut out incorrectly in the mRNA transcript. Consequently, the mRNA transcript only specifies thirty-five amino acids instead of one hundred and forty one. The hemoglobin molecule cannot fold properly and therefore does not function properly. The unfortunate people that suffer from this mutation have the disease, thalassaemia. See Michael J. Reiss and Roger Straughan, *Improving Nature? The Science and Ethics of Genetic Engineering* (Cambridge: Cambridge University Press, 1996), 32-3.

cells lack the capacity to carry out specific modifications, such as proper folding or adding specific molecules, that make the protein functional.[283]

The portions of mRNA that are transcribed from the exons of the gene can also be rearranged in a process called alternative splicing with the help of the specialized spliceosome proteins. With alternative splicing, one gene can be involved in the generation of many different proteins. In cells that have a nucleus (all plants and animals), it is understood that one third of genes are associated with mRNA suitable for the alternative splicing process.[284] The largest number of protein variations associated with just one gene is 38,016. This is a feat of fruit flies who only have four chromosomes.[285]

There are also "overlapping genes." When two genes are next to each other, it is possible that an mRNA transcript can be made utilizing parts of one gene and parts of another. In overlapping genes, DNA that makes up a part of an intron in one gene can be used as a part of an exon in a different gene and vice versa. A gene, an intron and an exon are only identifiable and definable when they are in use. They are temporal, not permanent entities and have relationships with other parts of the genome, the cell and the organisms to which they belong. After reviewing just some of the complexities of protein making, one realizes that the gene loses a great deal of its agency and specificity. These complexities also suggest why the random insertion of foreign DNA

283 Michael J. Reiss and Roger Straughan, *Improving Nature? The Science and Ethics of Genetic Engineering* (Cambridge: Cambridge University Press, 1996), 33. This could be one reason why insulin from GM bacteria has had inconsistent, disabling and in some cases fatal effects. There have been class action lawsuits launched in Canada, the US and Britain. See Paul Brown, "Diabetics Not Told of Insulin Risk," *Guardian*, March 9 (1999).

284 Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 60; and Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's Magazine* 304, no. 1821 (2002): 42-43.

285 Commoner, ibid.: 42.

can be quite disruptive of the structure of a chromosome, and therefore its function and utility to the cell.

As Commoner points out, the transplanted genes have to properly interact with the host organism's metabolic processes to produce the desired effect, and the degree to which those processes are disrupted by the insertion of foreign genes remains largely unknown.[286] Because of mutations, alternative splicing and overlapping genes, there is concern that transgenic organisms may produce novel proteins that are possibly allergenic. Some researchers discovered that a large portion of the DNA of some transgenic soybean plants had been scrambled. It was large enough, the researchers concluded, to potentially produce a whole new protein.[287] The problem with this particular effect is that if we can't identify new proteins because they are new, how do we know whether they are being produced or not? One of the first genetically altered products to go on the market was the amino acid tryptophan produced by transgenic bacteria. Before it was pulled off the market, thirty-seven people died and over a thousand became seriously ill. The company destroyed all the batches and equipment before any analysis was done. The problem may not have been "contamination" in the traditional sense of unclean equipment, but rather that some or all of the transgenic bacteria were also producing toxic substances. We do not know.[288]

The research of Arpad Pusztai also confirms Commoner's concerns. Despite his expectation and intent, his analysis of a batch of transgenic potatoes showed that they contained differing amounts of the desired insecticidal protein. But they also produced a

286 Ibid., 46.

287 Ibid.

288 Jeffrey Smith, "A Lesson from Overseas," *Seeds of Deception: Exposing Industry and Government Lies About the Safety of Genetically Engineered Foods You're Eating,* 109-125 (Fairfield, IA: Yes! Books, 2003).

greater variation in other types of proteins, starches and sugars compared to unaltered potatoes of the same variety.[289] The transgenic process inadvertently altered other aspects of the modified potatoes' metabolic processes. The rats that ate the modified potatoes suffered disruptions to their own metabolic processes as well, with younger rats experiencing the most damaging impacts on their organs. Organs related to the immune system, the thymus and the spleen suffered some damage and white blood cells (which rid the body of pathogens) were more sluggish in the rats that were fed the genetically modified potatoes. Not all rats fed on the genetically modified potatoes had the same reactions. For some, the brain, liver and testicles were smaller than the rats on the control diet, and yet for others the pancreas and intestine were enlarged. In some of the rats a proliferation of cells in the stomach and intestine occurred which can be a signal for the onset of cancer.[290]

More recently an experiment has shown that mice that were fed peas modified to be resistant to insects had an allergic reaction to the novel protein. A bean that is resistant to weevils normally produces the protein. Regardless as to whether the peas were cooked or raw, the mice developed lung damage and inflammation. The protein produced by the peas had a different molecular structure than when produced by the bean, and this is thought to be the source of the allergic reaction.[291]

Different types of proteins and enzymes are not only specific to organisms, but to specific types of cells within organisms. Furthermore, organisms produce different

289 Ferrara and Dorsey, "Genetically Modified Foods: A Minefield of Safety Hazards," 59.

290 Jeffrey Smith, "A Lesson from Overseas," *Seeds of Deception: Exposing Industry and Government Lies About the Safety of Genetically Engineered Foods You're Eating,* 12 (Fairfield, IA: Yes! Books, 2003).

291 Young, Emma. "GM Pea Causes Allergic Damage in Mice." *NewScientist.com News Service,* (November 21, 2005), http://www.newscientist.com.

types of proteins and different amounts of proteins during different stages in their development and under different environmental conditions. Because of neglect of these aspects of development, the inconsistent and unpredictable results of genetic engineering continue to be a “surprise.”[292]

Natural Gene Transfers

Genetic engineering is possible because of the fluidity of the genome. Excisions, insertions and deletions of segments of DNA do occur naturally. Genetic engineers utilize the capacities that organisms have to exchange and rearrange genetic material. There are three main contexts in which rearrangements and gene transfers take place normally.

1) There are mobile genetic elements called “transposons” or jumping genes. The base sequence of a transposon is used to make enzymes that have the ability to excise and to integrate the transposon itself. The deletion or insertion of transposons can activate or repress another entirely different gene so it will start or stop the process of particular proteins being made. Transposons are one way the cell regulates when and which proteins are to be made. They are mostly thought of as a response to some types of stress and changes in the environment. They play a role in the immune response that produces antibodies to deal with toxins or pathogens. The effects of transgene insertion

[292] The empirical research into genetic stability and specificity (outlined in the last two sections) is a part of the reason why the concept of “substantial equivalence” as applied to the regulation of GM crops has been criticized by biologists. The concept implies that GM crops are not substantially different from their traditional counterparts. This is a claim that cannot be made, for example, for the genetically modified peas. Critiques of the concept also stems from the fact that a) the term “substantial” has not been rigorously or quantitatively defined, and b) the contradiction in the claim that that the crops are novel enough to be patented, but not novel enough to require health risk assessment such as feeding trials. See “Beyond Substantial Equivalence” by Eric Millestone et al, *Nature* 401, (1999): 525-526.

on transposon activity and its regulatory role are largely unknown and not widely discussed.

2) Viruses contain either DNA or RNA that is sheathed in a protein coat. The protein coat specifies which types of organisms (and cells) that it can infect, which is why viruses are usually specific to a type of organism (human, bird, pig, cauliflower, tobacco, bacteria etc…). The protein coat of a virus has some compatibility with a particular organism's cell membranes enabling them to fuse and the viral DNA or RNA to enter the cell. Viruses have been known to mutate and infect different species, and this is thought to be the case with HIV (primate to human), SARS (feline to human), swine flu (pigs to human), the current avian flu (fowl to human) and several others.[293]

Even though viruses have genetic material, they cannot reproduce by themselves, illustrating the fact that DNA is not a self-replicating molecule. The process of viral replication requires a host cell. Viruses infect cells, and if they are not destroyed by the host's immune system, they trigger the host cell's DNA replication process, which replicates the virus' genetic material. This may cause the cell's death but not always. Sometimes genetic material from the virus can be incorporated into the host cell's genome. Some viruses have genes that are like transposons; they have genetic elements that are used to produce enzymes that can integrate the viral element into the host's genome. In the case of HIV and tumour-inducing viruses, there is evidence that

[293] See Mae Wan Ho, *Genetic Engineering: Dream or Nightmare?* (New York: Continuum Publishing Co., 1999), 21-2, for more examples.

the viral material integrates at a site that affects cell replication and that viruses may "target" specific sites on host genomes.[294]

3) Bacteria do not have a nucleus that encloses their chromosomes in a membrane forming a distinct organelle. This seems to give them the capacity to pick up and exchange genetic material more easily than other types of organisms. A common way bacteria exchange genetic material is through plasmids, which are essentially rings of DNA that are able to replicate independently from the bacteria's chromosomal DNA. Bacteria can pick up plasmids from their environment (usually left behind by dead bacteria), and they can exchange them during bacterial conjugation. Even bacteria of different species can form a tube between them and exchange genetic material carried on transferred plasmids. Because of these exchanges, bacteria can acquire the capacity for making new proteins in a short period of time. Genes conferring antibiotic resistance are often transferred on plasmids, which helps to explain the rapidity with which antibiotic resistance can spread.

Transfers of genetic material occur between bacteria and higher plants. In the most intensely studied example of this type of transfer between *Agrobacterium*, a soil bacteria, and plants, the transfer of genetic material from a tumour-inducing (Ti) plasmid into plant cells leads to tumour formation. In a process similar to bacterial conjugation, bacterial DNA is transferred to the plant cell and becomes incorporated into the plant's genome.[295] The insertion results in a disruption of the cell's regulatory system affecting its growth and division, leading to a tumour. In order to integrate exotic genetic material

294 Didier Trono, "Picking the Right Spot," *Science* 5626, no. 300 (2003): 1670-1674; and Xiaolin Wu, Yuan Li, Bruce Crise, and Shawn M. Burgess, "Transcription Start Regions in the Human Genome are Favored Targets for MLV Integration," *Science* 5626, no. 300 (2003): 1749-1758.

295 Mae Wan Ho, *Genetic Engineering: Dream or Nightmare?* (New York: Continuum Publishing Co., 1999), 179.

into transgenic plants, genetic engineers have used the invasive capacities of *Agrobacterium* extensively.

As with other types of cells, bacterial cells can also be infected by viruses and have viral genetic material integrated into their own genomes. Whether or not it works all the time, bacteria do have a defence against the insertion of viral material. Bacteria produce "restriction enzymes" which can cut specific segments of DNA out of the genome. They also produce enzymes to heal and fuse it back together. Different types of restriction enzymes cut out different sequences of bases, and there are currently over a thousand types known. They are used extensively by genetic engineers.

The specific capacities of transposons, viruses and bacteria to delete, insert, rearrange and exchange genetic material form the basis of genetic engineering.

Artificial Gene Transfers or 'Randomeering'

M.J. Reiss and R. Straughan list two basic aspects to the method of genetic engineering. The first is to identify the gene that codes for a particular protein. The second is to transfer the gene from one organism to another.[296] Both aspects of the process are fraught with uncertainties.

In order to find the sequence of bases that constitute the gene associated with a desired protein, one must identify the sequence of amino acids that constitute the protein. Once the amino acid sequence is identified, then the sequence of bases on the mRNA transcript can be determined. Well, sort of. Remember that on the mRNA transcript, every three bases, called a codon, specify a particular amino acid. However,

[296] Michael J. Reiss and Roger Straughan, *Improving Nature? The Science and Ethics of Genetic Engineering* (Cambridge: Cambridge University Press, 1996), 34-35.

almost all amino acids can be specified by more that one codon. There are sixty-four codons for twenty amino acids, so the calculated sequence of bases may or may not be the same as that in unmodified genomes.[297] That only the approximate sequence of the exons can be identified is one level of uncertainty in the process. The second uncertainty lies in the fact that introns are excised out of the mRNA transcript before the amino acids are linked. Genetic engineers therefore do not include this "junk DNA" while designing the genes for the "creation" of transgenic organisms.[298] Without really understanding the functions of introns, the consequences of inserting genes without them cannot be predicted.

Once the sequence of the gene has been approximately identified, there are various methods to identify "approximately" where on a chromosome the desired gene may be.[299] A common method uses what is called a "DNA probe." A constructed mRNA transcript that complements the gene is "labelled" by using a radioactive or florescent marker. The labelled mRNA is mixed with chromosomes known to contain the gene. When the strands of the DNA are shaken apart, the labelled mRNA binds to the gene and the marker reveals where the desired gene is on the chromosome.[300] That the location is approximate introduces yet another area of uncertainty in the method.

Genetic material is not literally transferred from one organism to another. Once the gene is sequenced and located, it is excised using the appropriate restriction enzymes. It then undergoes a process called DNA amplification whereby thousands of

297 Ibid.

298 Bacterial DNA does not have introns, which makes them easier to use in genetic engineering.

299 Michael J. Reiss and Roger Straughan, *Improving Nature? The Science and Ethics of Genetic Engineering* (Cambridge: Cambridge University Press, 1996), 35.

300 William Bains, *Biotechnology From A to Z* (Oxford and New York: Oxford University Press, 1993), 110.

millions of copies are made. The various methods to "amplify" the DNA basically involve creating a mixture of organic substances, chemicals and specific enzymes and putting it in equipment that mimics the conditions under which replication occurs naturally but at an exaggerated rate. The most common method uses a PCR (polymerase chain reaction) machine. Polymerases are enzymes that join similar or identical molecular complexes into chains. A polymerase specific to DNA is used in the method. One marketer described the process as follows: "Put your sample in [the machine], close the lid, punch in the numbers and wait."[301] While it may seem easy, amplification methods "suffer to a greater or lesser degree from the problems of their extreme sensitivity to contamination."[302] Such contamination introduces another level of uncertainty into the process of genetic engineering.

Once scientists have copies of the desired genes (or at least so they think), there are several methods at hand to insert the genes into particular cells. Transmission can be with or without a vector. Neither approach can predict where in the genome the transgene will be inserted if it is integrated at all. And no one can predict what the effects of this level of ignorance are. Ricarda Steinbrecher's characterization of the process as "randomeering" instead of "engineering" is fitting.

Randomeering Transgenics: Without a Vector

There are three vectorless methods used on plant cells. All are based on making holes in the plant cell's membrane so that foreign DNA can enter the cell and possibly be

[301] Eric Grace, *Biotechnology Unzipped: Promises and Realities* (Toronto: Trifolium Books Inc., 1997), 31.

[302] Michael J. Reiss and Roger Straughan, *Improving Nature? The Science and Ethics of Genetic Engineering* (Cambridge: Cambridge University Press, 1996), 35.

integrated into the genome. One method literally shoots genetic material into cells with a particle gun. The other two methods involve placing cells in a solution containing foreign DNA and creating holes in the cell walls by exposing them to chemicals or an electric field. Transgenic plants created in these ways start life with a damaged cell. How the damage of the engineering process itself and the production of novel protein affect organisms has not been carefully investigated. If these stresses increase mutability via repair systems and transposons, this may account for the many reports of failed transgenic crops.[303]

A vectorless method for transforming animal cells involves injecting them individually with the foreign DNA. Reiss and Straughan suggest that this method results in a high proportion of cells that take up the DNA[304] but do not cite any examples. I say that this method is not effective and remind the reader of the enviropigs example where only 2.41% of the pig embryos "microinjected" survived. If one ignores this step, then the ratio of pigs with the transgene to the number born is 33%, which is a substantial proportion. However, to make the claim that microinjection is "successful," one must ignore both the first step of the process and the conclusion of the trial where the expression of the gene was highly variable.

303 For a review of such reports from India, China, US, Canada and Austrailia, see "Scientists Confirm Failures of Bt Crops" ISIS Press Release, September 26 2005 (www.i-sis.org.uk).

304 Ibid., 36.

Randomeering Transgenics: With a Vector

Transposons, bacterial plasmids and viruses have all been used as vectors to get transgenes integrated into host genomes, but plasmids and viruses are used most commonly.

It is not just the foreign DNA that it is hoped will confer some desirable trait that enters the host cell. In genetically modified crops it is usually added to genetic elements that confer antibiotic resistance to a specific type of antibiotic and a genetic element that (if it works as intended) should promote constant transcription of the foreign genes. It can be known which cells have integrated the transgene by exposing them to the chosen antibiotic. Those that have picked up the gene also picked up the resistance to the antibiotic. The promoter element is added to bypass the cell's own regulatory system, which normally governs which proteins are made in what amounts and at what times. The transgene, the antibiotic marker and the promoter element all come from different organisms and have been "amplified" so they can be used in large quantities. The common notion of genetic engineering as transferring genes from one organism to another is inaccurate. Rather, artificially constructed mosaics of genetic material that hopefully approximate known genes are randomly inserted into cells, some of which will become transgenic organisms. These organisms may not express the desired trait or may produce the desired proteins, but in variable quantities and in an inconsistent manner dependent on the variable and unpredictable environmental context of the cell, organ or organism. In short, it is all highly uncertain and contingent on many known and unknown variables.

The mosaic of foreign genetic material can be integrated into bacterial plasmids with restriction enzymes. These plasmids can be introduced to bacteria, which are cultured in large quantities to produce marketable proteins and hormones.[305]

The specific type of plasmids used in engineering plant cells to increase the chances of integration comes from the tumour-inducing plasmids of the highly infective bacteria, *Agrobacterium tumfaciens*. Because it is not desirable to have diseased and tumour ridden transgenic plants, naturally occurring non-pathogenic mutants are used. While these forms may be ideal, their non-pathogenic state may be easily reversed by genetic material from one of their pathogenic sisters through the process of transformation.[306]

The "promoter" element of the mosaic transgene typically comes from a virus. Viruses have the ability to bypass the host cell's regulatory system and activate cellular replication mechanisms. There are two main concerns about the use of viral promoters. One is similar to the concern about bacteria exchanging plasmids, and with them potential pathogenicity. Bacteria and viruses are everywhere. In and on organisms, in water, in soil, in air and even in rocks! The danger is that unlike whole viruses that are specific to certain organisms because of their coat, naked viral parts are prone to spread across species. A commonly used promoter from the cauliflower mosaic virus has been

305 Human insulin and growth hormone were among the first proteins to have their genes sequenced, introduced into bacteria, mass-produced and commercialised.

306 Ironically the discovery of bacterial transformation in 1928 was critical in leading to the idea that DNA is hereditary material. In a series of experiments using a virulent and non-virulent form of *Streptococcus pneumoniae* on mice it was found that when mice were injected with heat killed cells from the virulent form, the mice lived. But when mice were injected with heat killed virulent cells and living non-virulent cells, the mice died. It was then known that something in the cell debris transformed the cells. See David Suzuki, Anthony Griffiths, Jeffery Miller, and Richard Lewontin, *An Introduction to Genetic Analysis Third Edition* (New York: W.H. Freeman and Company, 1986), 185-186.

observed to be functional in other plant and animal viruses as well as in many plants, yeast, insects and *E. Coli.*[307]

Because the purpose of the promoter is to overcome the cell's regulatory control and promote uncontrolled protein production, transference of such a promoter to other viruses could make them more virulent. The role that certain viruses play in triggering some types of cancer also has critics worried.[308] The concerns about using viruses as vectors are the same as those regarding the use of viral promoters. Viral vectors are used mostly on human cells and other mammalian cells in medical research and clinical trials of "gene therapy."

Diseases thought to be caused by genetic mutations that inhibit the production or functions of critical proteins are treated by oral or injected supplements of the deficient protein. The idea behind gene therapy is to use viral vectors to insert copies of transgenes into human cells to get them to produce functional forms of the proteins. Vectors made from retroviruses, which are tumour-causing viruses in mammals are used in many gene therapy trials and experiments. Some of these trials have proved deadly.

In 2003, the FDA placed a hold on all active gene therapy trials using retroviral vectors to insert genes into blood stem cells. The action was taken after it was learned that a second child treated in a French gene therapy trial had developed leukaemia. Both children were being treated for the immunodeficiency disease also known as "bubble baby syndrome." These cases are not surprising to virologists who have found that some retroviruses (similar to the one used in the trial) do not integrate into the genome randomly but rather have a preference for sites at the beginning of genes which

307 Mae Wan Ho, *Genetic Engineering: Dream or Nightmare?* (New York: Continuum Publishing Co., 1999), 162-3.

308 Ibid., 257-260.

can turn genes on or off. Some scientists believe that the viral vector used for the French gene therapy trials inserted the transgene in such a way as to promote cancer.[309] This was not the first case where the safety of gene therapy has been brought into question.

The Office of Clinical Trials at the University of North Carolina estimated that six hundred and fifty adverse events, including several deaths linked to gene therapy were not properly reported to the Food and Drug Administration (FDA) in the US from 1990 to 2000.[310] The fatal trial of 18-year-old Jesse Gelsinger at the Institute of Human Gene Therapy at the University of Pennsylvania not only brought media attention and government investigation to Gelsinger's death, but also to many of the other trials and experiments revealing the ineffectiveness and negative side effects of gene therapy.

Gelsinger was born with ornithine transcarbamylase (OTC) deficiency, which means that his body lacked a critical liver enzyme for metabolising ammonia, which is toxic when it accumulates and can cause coma and death. Prior to the gene therapy trial, the disorder was under control with a low protein diet and medication. While he had this congenital disorder, he was neither ill nor suffering from symptoms.[311] On the first day of the trial, Gelsinger was given an injection of the transgenes with an adenovirus vector. The next day he developed a clotting disorder putting a great deal of stress on his liver, magnifying his original disorder, and several hours later slipped into a coma. The following day other complications arose, especially with his lungs. The next day he

309 Andrew Pollack, "Cancer Risk Exceeds Outlook in Gene Therapy," *New York Times*, June 13 (2003): A29.

310 Office of Clinical Trials, "Office of Clinical Trials Newsletter", 1. Volume 2, no. 1 (2004), http://research.unc.edu/oct/documents/Feb-MarNewsletter_000.pdf.

311 Sheryl G. Stolberg, "The Biotech Death of Jesse Gelsinger," *New York Times Magazine*, November 28 (1999): 1.

suffered from “multiple organ system failure” and became brain dead. His life support was removed later that day.[312]

Only because of pressure from the FDA and the National Institutes of Health has the Schering-Plough Corporation, who developed the gene therapy used on Jesse Gelsinger, released information about severe side effects in other patients that should have been reported to FDA as adverse drug events.[313] Every detail of Gelsinger ‘s treatment has been re-examined and rechecked, and no evidence of human error has been found.[314] I interpret deaths and adverse effects as risks inherent to a therapy that injects parts of disease-causing viruses into bodies already not functioning properly. A low protein diet and medication seems much more rational to me.

Fallacies of Genetic Prediction

Critics of genetic determinism suggest that both reductionism and the promise of prediction are “seductive” because of our cultural predisposition to want certainty.[315] We want to know the causes of illnesses and health problems as precisely as possible in order to prevent or cure them. There are two destructive consequences of this desire. First of all, whether a critique of reductionism takes place on a general philosophical level or is specific to genetic determinism, assuming that a specific cause can be empirically determined as well as conflating correlation with cause is common. The causes of most illnesses are multifaceted, complex, variable and difficult, if not

312 Ibid., 6.

313 Ibid., 2.

314 Ibid., 7.

315 Hubbard and Wald, *Exploding the Gene Myth*, 10; and Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 165.

impossible, to pinpoint. Dorothy Nelkin and M. Susan Lindlee warn that "Statistical risk calculation is not prediction," and to confuse them is a problem when the relationship between a "genetic defect" and an actual behaviour or trait is not completely understood.[316]

In her critique of the assumptions of the Human Genome Project, Hubbard gives an example of how the base sequence of a gene correlated with a particular trait can be highly variable. Out of 216 people with haemophilia B, it was found that mutations in the relevant gene occurred in 115 different positions.[317] There are many other complications. For example, haemoglobin and oxygen-carrying proteins can be found in several different forms that are produced during different developmental stages because oxygen metabolism varies in embryos, foetuses and adults.[318] But repeats of genes or similar genes can produce the same proteins simultaneously, as is the case with histones, which are produced in large quantities.[319] A mutation in one gene (and the protein associated with it) may not affect metabolic processes because there are others that can be used.

A second consequence of the desire for certainty is political inaction in the face of environmental and health risks. The nature of risk assessment tends to narrow debates to technical issues. Beck points out that the legal requirements and framework for establishing causality, guilt and liability cannot be applied to long-term global

316 Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 165-6.

317 Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 55.

318 Mae Wan Ho, *Genetic Engineering: Dream or Nightmare?* (New York: Continuum Publishing Co., 1999), 115.

319 Ibid.,115.

environmental damage where causality is ambiguous. However, this irresponsibility is legitimated by science.[320]More specifically, it is legitimated by reductionist science and policy-making where linear chains of cause and effect *must* be established to validate a claim.[321]

Krimsky points out that one of the main challenges to coming up with a framework with which to regulate genetic engineering was its novelty. In the absence of data, analogies, hunches and intuition are relied upon in the attempt to predict risk and estimate hazards.[322] Winner would add to this list, moral and emotional judgments and matters of sheer self-interest.[323] The result is that "prediction" and "likihood" are used in a qualitative, ambiguous and "quasi-scientific" manner.[324]

The double bind that new technologies put our society in is that it is deemed necessary to carry out experiments and use the technologies in order to assess their risks.[325] However, in the mid-to-late seventies when scientists themselves were concerned about the safety of genetic engineering, all experiments and trials were confined to laboratories. Experiments using pathogenic bacteria and viruses already took place in facilities built for containment, and the issue of safety revolved around whether all recombinant DNA experiments should use the strictest containment

320 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 2.

321 Genetic determinists assume a determining one-way relationship between genetic defects and illnesses and behaviours rather than having detailed and rigorous empirical evidence to illustrate this causation.

322 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 157.

323 Langdon Winner, "Citizen Virtues in a Technological Order," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 75 (Bloomington and Indianapolis: Indiana University Press, 1995).

324 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 89.

325 Ibid., 105; and Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 105.

regulations for biohazardous material. It was eventually decided in the late seventies that genetic engineering on the whole was not an inherently hazardous practice.[326]

The first government approved release of genetically modified organisms into the environment took place in the early 1980's. Frost damage to crops can be intensified by a bacterium found on leaves that produces a protein that initiates ice formation and damages the leaves of the plants. Bacteria were genetically modified by deleting the gene associated with the nucleating protein. It was hoped that spraying the "ice-minus" bacteria on crops would protect the crop from damage. However, ecologists found that the ice making capacity of these bacteria helps to shape precipitation patterns and "is a key determinant in establishing climatic conditions on the planet."[327]After ecologists, local farmers and a lawsuit launched by Jeremy Rifkin challenged the introduction of the bacteria in field trials, the bacteria were never made commercially available or released in a large-scale manner.

As Beck observes, the world has become a laboratory itself. In moving out of the controlled environments of laboratories, we exponentially increase the uncertainty that comes with new technological developments. Even risk assessment itself poses risks. Exacerbating this problem is the current blurring of production, research and use in which production itself is a form of technological research.[328] This is the case with millions of hectares planted with genetically engineered crops. Blaming the failure of genetically modified crops on "unusual" weather is simply a case of not taking

[326] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 354-355.

[327] Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World.* (New York: Penguin Putnam Inc., 1998), 75-6.

[328] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society,* trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 105-6.

uncontrollable conditions outside the laboratory into consideration. The impacts of consuming genetically modified food are completely unknown, and the long-term effects of the genetically modified organisms we have already introduced into the environment are unknown. There are not any "control" populations, and the cornerstones of the scientific method, repeatability and falsifiability, do not apply.

There is no experimenter in charge. There is no one to assume responsibility. How, when and who decides, Beck asks, when the experiment has failed?[329]

[329] Ibid.,106.

CHAPTER 4:

THE FEAR OF MOB RULE

Latour observes that the inhumanity, violence and brutality associated with "the unruly mob" is counteracted by an equally inhumane "disassociated, objective and value free rationality."[330] The logic behind the fear of the mob rule is that "if reason does not rule, than mere force will take over."[331] One of the characteristics of this Western philosophical tradition is that certainty, objectivity and rationality are seen as qualities of the mind that ideally should control the body, senses and emotions. Just as the body is understood as a corrupting force in accessing objective reality and not to be trusted, the political body, citizens or the collective public are not to be trusted either. In this view, lay people are uneducated, undisciplined, irrational and over-emotional. Experts and the governing organs that have come to embody the "mind" and rationality should make decisions as to which directions our society should take. Because rationality as a whole is so commonly conflated with scientific, technical and instrumental rationality, the notion of limiting and regulating science and technology through social processes is seen by most scientists and technocrats as unnecessary at best and threatening and dangerous at worst.

330 Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 13.

331 Ibid., 10.

Langdon Winner, who is concerned about the lack of ways in which citizens can participate in debates on scientific and technological issues, is also concerned about the more general "hollowness of modern citizenship," where citizens are reduced to consumers. [332] The political problems that modern technologies pose can be traced back to the roots of democracy itself. Winner contextualizes the lack of established channels for citizens' democratic participation in technological decisions, by pointing out that labourers and craftspeople were not citizens in the ancient Greek "democratic" polis. Conversely, citizens were an elite educated group who, comparatively speaking, need not be concerned with practical matters. Technology and politics were considered different categories.[333]

Even when Bacon broke with ancient views by propounding the superiority of science and technology (which he did not separate) over affairs of the state[334], his utopia involved a technocratic authoritarianism within which citizen participation was not deemed necessary. According to Bacon, the "innate depravity and malignant disposition of the common people," or in Galileo's words the "shallow minds of the common people," justified the idea that control should always be placed in the hands of the elite.[335] Modern science was founded upon this assumption.

Proponents of genetic engineering interpret fears and concerns about the risks and hazards of the technology as evidence of the irrationality of citizens. Scientists that share these concerns are labelled as attention seeking "fearmongers." Krimsky observes

[332] Langdon Winner, "Citizen Virtues in a Technological Order," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 73 (Bloomington and Indianapolis: Indiana University Press, 1995).

[333] Ibid., 67.

[334] Ibid., 70.

[335] David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 204.

that there are two common assumptions about genetic engineering that are made by pro-biotech scientists and policy makers. One is that the scientific and medical benefits outweigh the risks. The second is that placing restrictions on intellectual activities is morally wrong and politically dangerous.[336] Ulrich Beck describes the effects of these assumptions as "blackmail." He points to common responses to citizen fears about human genetic engineering: politicians are only promoting a healthier society, parents only want what's best for their children, doctors have the best intentions and scientists must have freedom of research.[337] Those people concerned with risks and hazards of transgenic technologies would deny needy individuals and society as a whole of the benefits that *could* be reaped.

Defining Risk

For centuries, progress has been viewed as technological development, which is understood as automatically benefiting society. This is the basis of the "presupposition that we will consent without knowing what we are consenting to" in regards to the introduction of new technologies.[338] Now that this assumption is being questioned, integrating citizens into decision-making processes poses problems and challenges. In several case studies involving risk communication around environmental hazards, Krimsky and Plough concluded, "frequently the exercise of local democracy and

336 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy*. (Cambridge: MIT Press, 1985), 139.

337 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 98.

338 Ibid., 90.

personal choice is at odds with the rationality of technical experts."[339] Central to this tension are different estimations and interpretations of the risks involved with modern technologies not just between lay people and "experts" but also between "experts" themselves. As agronomist E. Ann Clark observes, different scientists can look at the same data and come up with opposite conclusions on the safety of GM crops. She continues:

> In reality, there is more than one question, more than one kind of evidence, more than one interpretation, and more than one scientifically defensible conclusion that can be reached, even in a 'science-based' decision making process."[340]

The possibilities of limiting technology in North America, according to Winner, primarily lie in calculations of risk and safety.[341] This makes the issue of who determines and calculates risk and how it is determined of great importance.

Krimsky and Plough critique common studies of public risk perception as constructing a dichotomy between expert judgments and lay perception that categorizes the latter as "irrationalities," while "the cultural underpinnings of risk perception" are left unexplored. [342] Winner also is critical of risk perception studies that discredit concerns with technological hazards by defining them as "irrational."[343] Winner points out that with

[339] Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 302.

[340] E. Ann Clark, "Regulation of GM Crops in Canada: Science Based or...?," August 2003, http://www.plant.uoguelph.ca/faculty/eclark.htm, ¶ 7.

[341] Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 138.

[342] Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 304.

[343] Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 145.

such an approach, "the question as to why some people are worried about certain kinds of risk and not others becomes genuinely puzzling."[344]

In their analysis of risk communication as a social process, Krimsky and Plough describe two types of rationality, technical and cultural (or "experiential"), which are logical and coherent on their own terms but not sufficient on their own.[345] While technical information does not always play a dominant role in cultural rationality, the role of technical rationality in debates about technological hazards is not excluded. However ethical, social, economic and political issues are also examined. Technical rationality, on the other hand, is exclusive and narrowly confines risk to technical and scientific issues.[346] Similarly, Winner, Pippin and Beck understand this exclusive and reductionist view of rationality as posing political problems. Proponents of controversial new technologies tend to understand public opposition as the problem, an error that can be fixed by more information and education to bring the public in line with their point of view. However, democracy, as Winner sees it, "is not a matter of distributing information," but rather lies in accepting a different rationality that develops through experience.[347] There is more openness in the social sciences to acknowledging different rationalities instead of the more conservative, reductionist, dichotomous view of rationality and irrationality. It is within the realm of the social sciences to address the "anthropological,

344 Ibid., 145.

345 Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 304.

346 John Evans [*Playing God? Human Genetic Engineering and the Rationalization of Public Bioethical Debate* (Chicago: University of Chicago Press, 2002)], makes a distinction between two types of rationality similar to Sheldon Krimsky and Alonzo Plough [*Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988)] but uses the terms "formal" and "substantive" rather than technical and cultural to analyze the "thinning of the debate" regarding the ethics of human genetic engineering.

347 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 104.

phenomenological and behavioural" issues necessary for understanding the logic of cultural rationality.[348] If public opinion is to be considered in technology policy-making processes, it should be approached from an interdisciplinary perspective.

In regards to trust, one of the distinctions between technical and cultural rationality that Krimsky and Plough make is that the former places trust in scientific methods, explanations and evidence and the latter places trust in political culture and democratic processes.[349] Technical rationality requires that decision making be "science-based," but does not adequately address the lack of consensus in science, especially on the safety of new technologies.

A Canadian public poll on biotechnology conducted in 1999-2000 concludes that while there are extremes of outright rejection and outright support among citizens, the majority shows "higher levels of uncertainty and mixed feelings towards biotechnology" than in previous years.[350] This is not necessarily because people are skeptical of science and its methods, but they are wary of assessment conducted by either industries themselves or scientists affiliated with industry. The poll showed that even those who are the most skeptical would feel more reassured if the regulatory process included verification of research in biotechnology by scientists independent of both industry and government and perhaps even from different countries.[351] The uncertainty about biotechnology may not always come from uncertainty about the science alone, but rather

[348] Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 305.

[349] Ibid., 306.

[350] Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 10.

[351] Ibid., 5.

the integrity of science and its relationship to political culture and democratic processes.[352] The Canadian regulatory system is science-based, Clark observes, but she adds, "perhaps the more relevant question is whose science, and for what ends?"[353]

Analyses of the construction of biotechnology policy in Canada and the US legitimate citizen concerns. Sometimes referred to as a "revolving door" between academia, government and industry, the tightly knit relationships between these sectors have existed from the beginning of the commercialisation process of biotechnology as university professors themselves have started many biotech firms.[354] These firms "spun off" of publicly funded research and continue to rely on publicly funded researchers and infrastructure. In the development of the biotech industry as well the regulation of its products, "there was really nothing but names separating the private sector from the public sector."[355] There is a bias in the rationality of technical expertise in the context of biotechnology to privilege private interests over public ones.

[352] This point of view is understandable in light of "whistle blowing" by scientists such as Arpad Puzstai. From a Canadian perspective, Health Canada's decision not to approve recombinant bovine growth hormone (rBGH) despite pressure from Monsanto to allow rBGH to market prior to the completion of the approval process was because of the controversy around the safety of the product *and* the attempts to silence concerned government scientists. Citizen and farmer's groups concerns of health risks (to both humans and cows) were not only legitimated by the whistleblowers, opposition to the drug was magnified by evidence of industry influence in Health Canada. Citizen concerns about both product safety and industry influence are legitimate. See Lucy Sharratt's "No to Bovine Growth Hormone: Ten Years of Resistance in Canada" In *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* edited by Brian Tokar, 385-396. London and New York: Zed Books, 2001.

[353] E. Ann Clark, "Regulation of GM Crops in Canada: Science Based or...?," August 2003, http://www.plant.uoguelph.ca/faculty/eclark.htm, ¶ 7.

[354] See Martin Kenny, *Biotechnology: The University-Industrial Complex.* New Haven: Yale University Press, 1986.

[355] Devlin Kuyek, *The Real Board of Directors: The Construction of Biotechnology Policy in Canada, 1980-2002* (Sorrento, BC: The Rams Horn, 2002), 11. Throughout his discussion of Canadian biotech policy making Kuyek traces the careers of scientists that weave through university administration, high ranking government positions, advisory committees and expert panels on biotech policy and sitting on the board of directors or being the chairman and CEO of biotech firms.

Winner observes that the more complicated technologies become, the more authoritarian decision making about them become.[356] Similarly, Pippin characterizes the narrowing of policy issues to technical issues and the necessity of having increasing technical competence to participate in decision-making processes as being central to why such technologies have become a political problem.[357] People do not have a choice but to place their trust in experts and government agencies because they do not understand the technologies themselves. This is not just a limitation placed on the public by scientists, industries and the government; it is also a limitation that many people place on themselves because trust in expertise is a part of our culture. Research into public opinion on genetic engineering indicates that the idea that "experts are better placed to make decisions" on technical issues is shared by many citizens and most experts.[358]

However, because of the physiological, ecological, social, economic and political consequences of introducing genetic engineering into our medical and agricultural practices, geneticist Ruth Hubbard insists that the issues are "too big to be left to experts."[359]

356 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 31.

357 Robert B. Pippin, "On the Notion of Technology as Ideology," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 44 (Bloomington and Indianapolis: Indiana University Press, 1995).

358 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 28.

359 Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 16.

Conflicts Between Rationalities

Ulrich Beck links our cultural predisposition to ignoring our own senses and experiences and putting trust in authorities to political inaction around ecological devastation and other consequences of modernization. According to Beck, research institutes have become our eyes, health authorities have become our ears and environmental ministries have become our hands. Consequently we have lost sovereignty over our own senses and judgment.[360] The fact that the consequences of technologies, which are environmental, medical, social, cultural, economic and political, are experienced by citizens everyday and should, in a healthy democracy, earn them a place in decision making about the introduction of new technologies. I agree with Beck "in matters of risk, no one is an expert,"[361] nevertheless, the majority of us have become disenfranchised in regards to policy-making and exposure to risk.[362]

Like other critics of modernity, Beck also sees the scientific claim to "objectivity by the repression of experience" as being connected to the lack of public participation in technological issues.[363] Unlike Romanticism and its "emphasis on experience,"[364] modern science was founded upon the idea that observation and understanding should be theoretical and value-free. Both Beck and Toulmin observe that abstract, timeless and universal theoretical propositions do not have to have a basis in experience.

360 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 66.

361 Ibid., 109.

362 Ibid., 66.

363 Ibid., 15.

364 David J. Black, *The Politics of Enchantment: Romanticism, Media and Cultural Studies*. (Waterloo, Ontario: Wilfred Laurier Press, 2002), 17.

"Experience puts limits on theory and doctrine"[365] by introducing exceptions, variations, contradictions, conflicts, ambiguity, plurality and a lack of certainty. "Even an optical illusion," Barzun writes, "is a genuine experience," which is why experience tends to complicate things.[366] Toulmin notes that these complexities came to be seen as an "error" and not just a price of being human in early modern times.[367] Krimsky and Plough too point out that the often "ambiguous" or "paradoxical" aspects of public opinion are not "errors" to be corrected.[368] "Concrete reality for one person," Beck states, can be "sheer nonsense for another."[369] Public opinion will never be unified, consistent and conflict free. These are not reasons to reject it.

Difficult policy questions are raised when the two types of rationality are incommensurable. It is important to note that these difficulties not only happen between the "public" and experts but among experts as well. Beck includes both lay people and what he calls "alternative" experts in his call for more inclusiveness in decision making around technologies.[370]

Two examples that can be used to illustrate where both conflicts and compatibilities exist between technical and cultural rationalities are the varied opinions on the labelling of foods containing genetically engineered organisms and patents on life forms. Integrating the concerns and opinions of both citizens and independent

365 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 130.

366 Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 358.

367 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 30.

368 Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 300.

369 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 56.

370 Ibid.,6.

specialists on these issues create challenge to policy making and the survival and success of the agricultural biotechnology industry in Canada.

Krimsky and Plough list three of the most common options for policy makers when rationalities collide.[371]

1. Avoid disclosure. State agencies represent the public and decide for the people. [The industry-government decision to not label foods containing GM substances is a good example of avoiding disclosure.]

2. Appeal to some exemplary and independent authoritative body for public confidence. [The request for an expert panel report on recommendations for the regulation of food biotechnology in Canada prepared by The Royal Society Canada at the request of Health Canada, the Canadian Food Inspection Agency and Environment Canada is an example. The request itself fits into this category but not the results. The report itself challenged the Canadian government's regulatory framework for GMO risk assessment.]

3. Attempt to educate the public into thinking about the issues as "experts" who promote the application of new technologies do. [My interpretation of the1990-2000 Government of Canada opinion poll and the expert panel report is that the government is more concerned with "improving consumer confidence" than engaging in meaningful discourse with citizens and integrating their concerns in policies.]

Avoiding Disclosure

Canadian public opinion polls show that those polled are overwhelmingly in favour of labelling GM foods and would largely avoid purchasing them if they were. "Avoiding disclosure" is clearly one of the policy options Canadian government agencies have taken in regards to labeling GM foods.

According to now retired Industry Minister Allan Rock, the best way to "improve consumer confidence" in genetically modified products is to "ensure Canada has a

371 Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process*. (Dover, MA: Auburn House, 1988), 303.

regulatory environment that supports biotechnology."[372] One would think that the best way to improve consumer confidence is to ensure a regulatory environment that protects citizens. Instead, Rock promised in 2002 that the federal government would double the amount invested in research and development for biotechnology as well as providing infrastructure and funding for "supportive academic research" to biotech industries.[373]

A Statistics Canada report confirms Rock's promise and details federal support for biotech in a section entitled "The policy environment":

> In Canada the legal, regulatory and policy environment is much conducive to the development of biotechnology. Companies can obtain refundable tax credits for R&D even if they have no revenues. They can obtain subsidies for research through the Industrial Research Assistance Program (IRAP) managed by the National Research Council...University researchers can obtain research grants from the National Science and Engineering Research Council (NSERC) and the Medical Research Council (MRC) as well as from the Federal Centres of Excellence program...[374]

How and in what way this will improve consumer confidence is not explained, but it is known that "consumer confidence" is lacking in the products and promises of agricultural biotechnology. For example according to the public opinion poll,

> ...there is a growing discomfort with GM food. About half of Canadians say that they are uncomfortable buying GM foods and a significant number said they would stop purchasing for a while if they know a food was GM...Most people advocate an "informed choice" approach to GM foods.[375]

372 BioCanada, "An Interview with Allan Rock," in *BioCanada 2002 Canadian Success Series (*Advertising Supplement to the Globe and Mail) 1, no. 2 (2002): 15.

373 Ibid.

374 Niosi, Jorge. *Explaining Rapid Growth in Canadian Biotechnology Firms: A report presented to The Science and Technology Redesign Project,* Statistics Canada, 88F001MIE No. 8 (2002): 13.

375 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 44.

Yet GM foods remain unlabelled in Canada. Jeffery Barach, a vice president of the National Food Processors Association in Washington, explains the inertia in North America: labelling would be "the kiss of death" for any GM product.[376] Those opposed to mandatory labelling claim that segregating conventional and GM crops is expensive and would increase the cost to the consumer. In an atmosphere of "discomfort" around GM foods to begin with, the concern is that people are not likely to pay more for them than their conventional counterparts.

To evaluate the claim that the cost of labelling in North America would be too high, one should include the fact that most countries in Europe have adopted mandatory labelling of foods containing more than 0.5% GM substances. American Suppliers have already begun to segregate genetically modified crops from conventional ones so as to retain a market share in Europe. This has not had an appreciable impact on European prices. The director of public policy for the American Farm Bureau interprets the European Union's decision as being "more of a trade barrier than an honest to goodness concern" for public safety.[377] The director fails to mention that a European public poll taken in 2000 showed that 94% of those polled wanted the right to choose whether to eat GM foods.[378] Regardless of whether the trade barrier was a factor in the regulatory decision, it still reflects a public consensus.

"Informed choice" is a sensible and fair notion that is understandably valued by people in Canada. While speculative, another possible reason that companies either engaging in genetic engineering or using GM products are lobbying against labelling is

[376] James Graff, "Read Any Good Fruit? The EU Approves Tough New Labeling for GM Food." *Time* 158, no. 5 (2001): 18.

[377] Reuters Press Release, *US Farm Group Say's Europe's GMO Plan Unworkable* (Chicago: Reuters), July 3, 2002.

[378] Ibid.

that currently in North America it is estimated that 65-70% of all processed foods contain products from genetically engineered plants. Genetically altered corn, soy and canola are the most widely grown of all GM crops. The oil, starches and proteins of these three crops are used in an enormous variety of processed foods. If Canada were to adopt a labelling policy similar to Europe, people would suddenly find grocery store shelves full of products containing GM substances. Would they wonder how long they have been consuming them without knowing the truth and why they were not informed?

Appealing to Some Exemplary and Independent Authoritative Body for Public Confidence

As noted above, those polled felt that a body of experts independent from government and industry should be a part of the assessment process. I think that the government's soliciting of the Royal Society of Canada's expert panel report was designed to provide a direct answer to public concerns about the regulatory process. The same public opinion poll I refer to above is also referred to in the report. All the members of the panel are professors, and with the exception of one law professor and one philosophy professor, the remaining twelve authors are in fields of biology, medicine and nutrition. They are experts indeed, and they conclude as follows:

> If testing procedures...disclose a new allergen, health risk or nutritional variation, labelling, would, of course be required. This approach would be consistent with the present regulatory approach. It is important to note, however, that while we believe that labelling should be reserved for specific health risks and nutritional variations, identifying which risks justify a label may not be easy...Though such issues will require ongoing consideration by the relevant regulatory agencies, they do not alter the Panel's general recommendation that a general mandatory labelling scheme is not advisable...There may be uncertain and currently unpredictable health and environmental risks associated with the long-term production and consumption of GM products...However, there are

> also uncertainties and unknowns about the long-term health implication of many non-GM food products. To mandate labelling for potential health risks in GM products alone would promote an inconsistency with no firm scientific justification.[379]

I find this logic flawed and undemocratic for the following reasons.

First of all, the fact that food with the residues of chemical pesticides, herbicides and fertilizers may cause disease and ill health to a comparable degree as GM foods is not a reason for not labelling GM foods. It would be a reason for conducting safety assessments of ALL foods produced with petrochemicals and by modern agricultural practices. Also, scientific research since the 1950's has shown that pre-modern agricultural techniques like poly-cropping, companion planting and what we now know as organic farming produce more food and are much better for the environment because they cause less erosion, are not as disruptive to wildlife, and maintain diversity and soil health.[380] Furthermore, there is at least one scientific justification for the mandatory labelling of GM foods. In order to conduct the surveillance and monitoring of long-term health impacts (such as allergenicity which the Panel establishes as a serious potential health risk) of consuming GM food, people must be aware of what they are

379 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), 266.

380 Johnathon Silvertown, *Introduction to Plant Population Ecology* (Essex England: Longman Scientific and Technical, 1987), 164; Martin S. Wolfe, "Crop Strength Through Diversity," *Nature*, 406, no. 6797 (2000): 681-2.

consuming.[381] These foods have not been proven to be hazardous, but they have not been proven to be safe either.

Secondly, a very simple label stating, for example, "contains oil from genetically modified canola" or "may contain genetically modified products," which are the sorts of labels people are asking for are consistent with current labelling practices that allow for notifications such as "low fat," "organic" or "may contain peanuts." These labels are notifications regarding the nature of the ingredients or the process of their production. Nor are these simple labels scientifically unjustified because they are not making any claims whatsoever about potential health effects. They are merely stating what is or may be contained in the product. On this type of labelling, the panel "withholds comment."[382] The risk of GM foods is narrowly defined as known negative health effects and the real crux of the labelling issue remains unaddressed.

The panel is familiar with the poll that illustrates the degree to which Canadians want labelling and are "uncomfortable" with GM foods. However, the demands for labelling involve a "much broader range of religious/philosophical, ethical, social and political issues" that go beyond the mandate of the Panel even though two specialists in law, philosophy and ethics were included.[383] In the introduction of the report, the Panel did accept that "extra scientific judgements" are inherent in any assessment of risk and

381 Andree and Sharrat, *Genetically Modified Organisms and Precaution*, vii. In this report the authors present which of the recommendations outlined in *Elements of Precaution* the Canadian government have and have not been implemented. For examples of allergic reactions and health problems traced to GM foods, see Jeffrey Smith, "A Lesson from Overseas," *Seeds of Deception: Exposing Industry and Government Lies About the Safety of Genetically Engineered Foods You're Eating,* Chapters 4 and 6 (Fairfield, IA: Yes! Books, 2003).

382 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), 224.

383 Ibid., 223.

did not accept the traditional classifications of "scientific," "social and political," or "religious, ethical or philosophical."[384] On the issue of labelling, however, the panel decided to draw the line between these categories.

Krimsky and Plough observe, "lay people bring many more factors into a risk event than do scientists."[385] These factors are seen to "complicate" the labelling debate.[386] The panel is making recommendations based on how they define the labelling issue (as health risks and nutritional information) and not on how the citizens interviewed defined the issue (as informed choice). The narrowing of definitions of risk to technical ones is one of the political problems with regulation of controversial technologies. Everyone but specialists is excluded by this reductionism from the decision-making process.

Thirdly, in order to establish safety and carry out proper assessment of GM foods, the panel have put together an extensive list of the types of risk assessment trials that must be carried out and the degree to which independent university scientists and governmental agencies should participate in the research and peer review. I think many critics would be happy if such detailed and long-term studies as specified in the report were carried out. However, I have concerns regarding the relationship between conducting research and decision-making. First, the cost of carrying out such extensive risk and safety assessment would fall on the shoulders of taxpayers who were never given the option of not introducing GMO's into the environment and food products in the

384 Ibid., 7-9.

385 Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 305.

386 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), 224.

first place. Second, the findings of any research can be contested and open to different interpretations leaving them inconclusive. The demand for "more research" and "more conclusive evidence" can become endless and stall decision-making.

Many of the issues brought up in the report are summarized in a separate article, "Application of Biotechnology to Food Production in Canada," written by one of the panel's experts, Marc Fortin, professor of plant science at McGill. Even though he understands that regulatory "agencies do not have the resources to conduct their own in-house tests,"[387] one finds in various parts of the article that

> [M]ore experimentation is required on a broader range of antibiotics.[388]
>
> Protocols exist for testing some allergenic reactions, but more research is needed to standardize and implement them...In many cases, more experimental analyses are needed.[389]
>
> Gene transfer to wild relatives has been observed, and we must study the environmental risks more thoroughly.[390]
>
> We need more research to provide answers for many of the questions asked.[391]
>
> We must evaluate through experiment the impact of both current and new approaches for each crop and each gene.[392]

With each new set of scientific challenges that studying the risks of these technologies poses, action and decision making is postponed. There is no end to the wait for better research and one question leads to another, and that question leads to other questions and so on. For Winner,

387 Marc Fortin, "Application of Biotechnology to Food Production," *Isuma: The Canadian Journal of Policy Research*, 2, no. 1 (2001): 103.

388 Ibid., 104.

389 Ibid.

390 Ibid., 103.

391 Ibid.,105.

392 Ibid.

> The confidence in what and how much we know and what ought to be done vanish in favour of excruciatingly detailed inquiry with dozens of fascinating dimensions.[393]

How much knowledge is enough and who decides?

Listing what should be done is not the same as deciding whether we should continue to expose bodies and the environment to genetically modified plant crops *while* the research and experimentation necessary for risk assessments is designed, carried out, and evaluated through peer review. The implication is that things can continue as they are indefinitely until or if ever definitive conclusions can be drawn.

In order to ensure that the risk assessment research is independent from corporate interests and stays clear of the conflict of interest within government agencies that both support and regulate biotechnology

> The Panel recommends that the Canadian government support research initiatives...[394]

> The Panel recommends that federal and provincial governments ensure public investment...[395]

> The Panel recommends a federally funded multidisciplinary research initiative...Funds should be made available to scientists from all sectors (industry, government and university)...[396]

How is all this research going to be funded? The list of research necessary for an independent "science-based" risk assessment would be millions and millions of dollars.

393 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 142.

394 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), xiv.

395 Ibid., xv.

396 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), xv.

Is genetic engineering worth such an expensive regulatory regime? Why should the public have to pay so much for protection from industry interests? Why are business and corporate taxes falling at a time when the costs of preventing and repairing damage to ecosystems and human health are escalating?

Also, even if the public did pay for independent assessment, it would require a change to policies regarding transparency and proprietary information. Some of those Canadians polled wanted independent verification of the trials conducted for regulatory approval. The Panel points out that this is impossible without some disclosure of the results of the trials, which are currently protected as proprietary. They suggest, "while one could make the argument that some of the data provided to regulators needs to be protected" such as the specific genetic transformation and gene constructs, "the Panel does not agree that data pertaining to environmental and ecological consequences should be proprietary."[397] The Panel, like many critics of technology policy, thinks that the burden of proof should be placed on the industry to demonstrate that their products do not pose risks, but the problem is that in order to verify their trials, the research must be available.[398]

The Panel points out two dangerous conflicts of interest in the risk assessment of GM crops, and transparency is one of them. While the panel thinks that the government should insist on greater disclosure, they found that senior managers with various regulatory agencies thought that such a policy would discourage industry research and

[397] Ibid., 213.

[398] Ibid., x. While I agree with the panel, I would also argue that the characterization of gene constructs and genetic transformation should be made available in light of the recent European discovery of the inaccuracy and/or instability of these characterizations in crops that have been approved in North America. For a summary of these studies see Mae Wan Ho's "Transgenic Lines Prove Unstable" (www.i-sis.org.uk).

development.[399] The managers argued it was important for regulatory agencies to maintain a "favourable climate" so industries can develop products and put them on the Canadian market.[400]

The Canadian Food Inspection Agency (CFIA) has assumed its mandate to both promote and regulate GM products. The Panel brings attention to the conflict of interest in the mandate to not only protect people from unhealthy products but also ensure that the regulatory framework is conducive to maintaining the industry's "competitive advantage" so as to dissuade them from seeking markets outside the country.[401]

I agree with the Panel that these issues affect the integrity of the regulatory process, not just the public perception of that integrity. The problem is real.

Attempt to Educate the Public into Thinking About the Issues as Experts Do

Another option available to policy makers, according to Krimsky and Plough, besides avoiding disclosure and appealing to expert panels, is educating the public into thinking like "experts." Technical and cultural rationality have more of a dialectical relationship than a strictly dichotomous one. First, the assumption of the inevitability of the introduction of new technologies and having no choice but to accept their risks is widespread amongst scientists, policy-makers and citizens. For example, according to the opinion poll,

> At this time, there is a widely held sense that biotechnology advances are inextricably linked to societal progress, that its development is bound to modernity, and that its expansion in Canada and worldwide is inevitable.

399 Ibid., 213.

400 Ibid.

401 Ibid., 212.

> Even among those who tend to be opposed to these technologies, this sense is clearly evident and presents itself as resigned acceptance...The issue now is managing the risks, not eliminating them.[402]

The inevitability of genetic engineering is also an underlying assumption of the Expert Panel report, and some of the recommendations encourage university research that both increases "the capacity for independent evaluation *and* development of transgenic technologies."[403]

Second, and as has been touched on before, most experts and many citizens feel experts should make decisions on highly technical matters.

> Among the general public, the dominant view is that they themselves do not have the knowledge or ability to make effective decisions, and that experts (scientists, university researchers, government researchers and policy makers) are much better placed to make these kinds of decisions.[404]

I think it would be safe to say that the Expert Panel would agree. Nowhere in the report is there a recommendation for greater public participation. However, the Expert

402 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 64. I use this example with the awareness that the opinions of Canadians in the focus groups are open to interpretation by those who conducted the research and wrote the report. I have been a teaching assistant for a third year course in the risk communication of genetic engineering. Students were asked to analyse articles critical of the technology from a variety of sources. Perhaps my expectations of third-year students are too high but the sheer number of students who will brutally criticize an article on the negative impacts of genetic engineering on agriculture solely because it was not written by a biologist but rather by a farmer and consequently cannot be "objective" is frustrating. However, given a critique of genetic engineering from a geneticist, the attitude of many of the students change, not only to genetic engineering but also to the whole notion of expertise in general. The pollsters' interpretation as well as my teaching experience illustrates what Ulrich Beck refers to as "losing sovereignty over our own judgements " in *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 66.

403 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), xv.

404 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 28.

Panel shares some of the concerns of citizens that came up in the opinion poll. They feel very strongly about commissioning independent research for regulatory and approval processes and that those processes should be more transparent (not only to the public but to university scientists as well!).[405] According to the experts, the "co-opting of biotechnology" for private interest and gain and government support for the commercialisation of university research reduces the resources available for both government regulation and independent risk assessment.[406] This in turn decreases the reliability of the current regulatory and approval process for GM products and actually legitimates the erosion of public trust in government regulation.[407]

The Royal Society Panel points out that a 1999 Expert Panel on Commercialisation of University Research commissioned by the Canadian Federal government

> ...made strong recommendations to the Prime Minister's Advisory Council on Science and Technology that governments and universities adopt policies encouraging the commercialisation of university research with intellectual property potential.[408]

The Expert Panel on food biotechnology explains how academic-industry relationships impair credibility. Intellectual property protection and the secrecy it encourages are not only antagonistic to openness, "one of the traditional strengths of the

405 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), 215.

406 Peter Andree and Lucy Sharratt, *Genetically Modified Organisms and Precaution: Is the Canadian Government Implementing the Royal Society of Canada's Recommendations?* (Ottawa, Ontario: The Polaris Institute, 2004) point out that the $350,000 spent by Environment Canada to study environmental impacts of GMO's, which is a fraction of what is spent on genomic research, is a fraction of what the biotech industry itself receives through tax cuts, tax credits and encouraging technology transfer from public universities to corporations.

407 Ibid., 217.

408 Ibid.,215-6.

scientific enterprise," they also "do not well serve the public interest in reliable scientific research on safety matters."[409]

Not only can citizen interest and opinion be contradictory, so can the interests and opinions of specialists. The plurality, complexity, ambiguity and paradoxical nature that often characterizes "the public's" analysis of issues also apples to scientific analysis.

Citizen Perspectives on Patents and Intellectual Property Protection

The Canadian poll found that

> Very few of those who are troubled by patenting issues have moral or religious reservation – the objections are raised on the grounds of access and affordability...most tend to believe the overriding principle should be equality of access without financial obstacle.[410]

These concerns mainly refer to the patenting of genes and biotechnological processes for pharmaceutical and therapeutic research. Patents can result in monopoly pricing for twenty years before substantially less expensive generic brands can come out. If the approval process is speeded up the period can be lengthened. Even within the narrowest definition of rationality as self-interest, concerns over monopoly pricing are perfectly rational.

It was noted by the pollsters that the "discomfort levels rose" during discussions of the patenting of the Harvard oncomouse used for cancer research for two main

409 Royal Society of Canada, *Elements of Precaution: Recommendations for the Regulation of Food Biotechnology in Canada* (An Expert Panel Report of the Future of Food Biotechnology prepared by The Royal Society of Canada at the Request of Health Canada, The Canadian Food Inspection Agency and Environment Canada), (Ottawa: The Royal Society of Canada, 2001), 216.

410 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 47.

reasons. One reflects the concerns above, that patenting would affect pricing and availability of drugs to treat cancers. The other is that "for some, the concept of patenting a whole animal brings the issue into clearer perspective and offends at an emotional level."[411] The concept of patenting whole animals is not only discomforting to the public who are learning to assess technological developments in the life sciences but also poses challenges to our legal institutions as well.

In 2000, the Federal Court of appeal overturned an earlier decision that the oncomouse could not be patented in Canada. The Government of Canada then took the issue to the Supreme Court, which in 2002 ruled that the process by which the mouse was modified can be patented, but the mouse and its offspring cannot.

Another example that illustrates the difficulty making decisions about intellectual property is Monsanto's lawsuit against farmer Percy Schmeiser. Monsanto's herbicide resistant canola was found on Schmeiser's Saskatchewan farm, but he did not purchase it, nor was he licensed to grow it. He claimed that it invaded his crops. In 2000 the Federal Court of Appeal decided in favour of Monstanto's claim that the farmer had infringed their patent on "Round-up Ready canola" and was responsible for compensating the corporation. However, the 2004 Supreme Court of Canada's decision that Schmeiser is guilty of patent infringement, but not responsible for compensating the company reveals some of the problems inherent to patents on genes. Schmeiser was guilty because he saved and planted seed containing the patented gene and subsequently sold the crops. However, he did not use the GM canola in the way in which it is intended to be used, that is, he did not spray Round-up on his crops to destroy the

[411] Ibid., ¶ 49.

weeds in his crop, therefore he was not considered to have gained any advantage from growing the GM plants. Consequently, the Court decided against Monsanto's claim for financial compensation by Schmeiser for both damages and legal costs.

Even though Schmeiser was found guilty of infringement, some organic farmers interpret the Court's ruling as opening the door for organic and conventional non-GM canola farmers whose crops are contaminated with GM canola to sue Monsanto for damages. If Monsanto owns the genes and any seeds containing them, they are also responsible for their spread into non-GM crops. Because most GM canola is resistant to herbicides, the conventional means that farmers have to rid crops of weeds do not work on them, allowing the GM canola to proliferate and spread. One farmer explains that on his farm the GM canola is

> ...close to being as thick as a crop. Crop insurance considers nine plants per square meter to be a viable canola crop. Without even trying I have four plants per square meter. This for me is a new weed, and it is here in significant numbers."[412]

As a result, Europe refuses to buy any canola products from Canada because of the potential contamination, and organic canola farmers in Saskatchewan are suing Monsanto and other seed companies for damages due to the loss of the European market. The Federal and Supreme Court's decisions reveal that there are problems with Canadian patent laws. However, currently, no patent reforms are taking place, nor is there development of policies regarding the liability and responsibility of companies for ecological or economic damage incurred by the use of their products.

Again, in Europe, there is increasing opposition to patents on life forms and a growing movement to limit patent protections. So why isn't patent reform taking place?

[412] CBC, "The Controversy Over Genetically Modified Canola," *Country Canada*, aired March 21, 2002.

"The mere discussion of this type of legislation, whether it goes anywhere or not, is very unhealthy for the industry," says Lila Feisee, director of government relations and intellectual property of the American Biotechnology Industry Association.[413] She continues

> Anything that makes patent protection shaky and unpredictable is a huge problem. It drives investors to other technologies. If there is enough of this stuff happening, you'll see people moving away from investing in biotech.[414]

Government policies protect private interests from public ones. The limited debates about labelling and patents indicate that citizen-based decisions would likely seriously disrupt the commercialization of genetically modified organisms and the products that contain them.

Trust in Expertise

One of the problems with placing trust in science-based risk assessment is that even though recent public opinion polls illustrate that many people are willing to accept the risks that come with technologies, the degree of uncertainty in the methods themselves remain largely underestimated. This trust is also based on the assumption of disinterestedness and objectivity, which simply cannot be made. For the most part, science itself is not seen as inherently limited and flawed. Instead, external influences such as government agendas and industry influences are thought to compromise and even corrupt "pure" science. The underlying assumption is that if scientists are independent and left to their own devices to investigate an objective reality with

413 Susan Warner, "Lawmakers Plan Curbs to Patent Power: International Disquiet Pushes Policymakers to Propose New Limits," *The Scientist*, 16, no. 10 (2002): 30.

414 Ibid., 30.

disinterest, they should all agree with each other. The assumption is that consensus is normal and disagreements reveal some type of political contamination.

As Krimsky and Plough discovered in their case studies, even though most people consider any scientist as an expert, when it is found that experts disagree, there is a tendency to doubt the optimists.[415] Herein lies an enormous problem with trusting experts: which experts should we trust?

"The quest for political consensus sometimes leads to atrophy of the imagination," says Langdon Winner.[416] He is referring to the narrow range of issues that constrict the debates on technology, society and the environment. Even though the "nebulous" concept of risk is used in an attempt to reach some simple consensus, Winner points out that policy debates about technology are never settled by what he calls "futile rituals of expert advice."[417] He gives two reasons: one is that "experts" are not defined by their knowledge but rather by their interests, and the other, as mentioned before, is that specialists tend to go into such technical detail that even the most obvious links between a technology and its hazards become uncertain or completely lost.[418] Beck finds this a problem as well and points out that what is a hazard and what is a risk is always a question of definition, the issue is who decides on the definition?[419]

415 Sheldon Krimsky and Alonzo Plough, *Environmental Hazards: Communicating Risk as a Social Process.* (Dover, MA: Auburn House, 1988), 107.

416 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), x.

417 Langdon Winner, "Citizen Virtues in a Technological Order," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 75 (Bloomington and Indianapolis: Indiana University Press, 1995).

418 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 142-3.

419 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society,* trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 71.

Winner and Beck's characterization of the problems facing technology policy resonate with Sheldon Krimsky's exploration of the early conferences and meetings held by biologists to determine the fate and regulation of genetic engineering.

In *Genetic Alchemy* Krimsky describes the 1973 Asimolar conference, the first conference organized by and for specialists working with recombinant DNA technology. The conference was initiated to provide a set of coherent recommendations for the National Academy of Sciences on the use and regulation of organisms employed and created by this technology. Very few specialists from the fields of health sciences were included, and no one from ecology was represented.[420] The issues of risk were narrowly confined to levels of physical containment for the organisms created and used in the process of genetic engineering. Even so, in the process of deliberation, strong disagreements occurred between the highly specialized participants. Those that studied microorganisms felt that their research would be more tightly controlled than those who studied viruses.[421] It was suggested by the organizers of the conference that if the specialists could not "reach a consensus, the issue would be taken out of their hands."[422] If the scientists could not come to some consensus, the issue of regulation would fall under Occupational Safety and the Secretary of Labour.[423] Agreement was not science based but instead rested on the scientists' desire to maintain control over the regulation of their work.

[420] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 151.

[421] Ibid., 147.

[422] Ibid., 147.

[423] Ibid., 141.

That "deep seated uncertainties" cannot be resolved by consulting experts poses a challenge to a policymaking structure dependent on an outdated and flawed positivistic view of scientific and technical knowledge. For example, in a manual on technology assessment for managers, author Ernst Braun warns his readers "hard facts rarely form an adequate basis for a policy decision."[424] Despite the fact that policy makers and corporate managers "desperately" want factual, objective and unbiased information about the future, an "assessment of how great a risk is, is always a matter of opinion."[425] Risk is about probabilities and not certainties. This is not a comfortable notion when it comes to the regulation of technologies that have potentially apocalyptic consequences (such as nuclear, chemical and recombinant DNA technologies). Krimsky observes that the first attempts to predict risk and estimate hazards of genetic engineering when it was still in its infancy were based on a "theoretical foundation"[426] as well as intuition, hunches and analogies.[427] In 1971 cell biologist Robert Pollack observed that scientists who were equally knowledgable about specific viruses and bacteria being used in the early experiments differed in the degree to which they "worried" about the consequences of the experiments.[428] Those who were worried asked more and sometimes different questions about the safety of methods being used in rDNA research. "I see in my own work," Pollack says,

> ...and I see in other people's work that a shade comes over your eyes when the problems affect your own work...I think if I were using it [genetic

[424] Ernst Braun, *Technology in Context: Technology Assessment for Managers* (London and New York: Routledge, 1998), 29.

[425] Ibid., 30.

[426] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 89.

[427] Ibid., 157.

[428] Ibid., 29.

> engineering], I probably would have found my own rationalization for not worrying about it.[429]

Winner suggests that the disagreements between experts are sometimes irreconcilable because they can be based on moral and emotional judgments and matters of sheer interest. Moreover, data and research results can be interpreted within different paradigms or theoretical frameworks.[430] For these reasons "the liklihood that two or more sides can locate common ground," Winner argues, "is virtually nil."[431]

Because morality, emotions, and personal interest are not seen as an integral part of knowledge making, scientists and experts who take different positions talk past one another, tending to focus on the technical details of the subject they are discussing. The importance of debates and acceptance of different points of view is crucial according to a text on technology assessment. The authors state:

> We would like to add that debate in *itself* is worthwhile if only to prevent us from exclusively adhering to a scientific rationale that is poor for its emotional underdevelopment.[432]

One way to deal with disagreements amongst experts is presented in *Vision Assessment: Shaping Technology in the 21st Century.* While it sounds rather democratic to suggest that "...we need to go beyond the way in which knowledge is constructed within disciplines and other forms of social organization" and that "...we need to explore

429 Ibid., 30; Robert Pollack was familiar with adenoviruses, the type of virus used for the gene therapy that killed Jesse Gelsinger.

430 Langdon Winner, "Citizen Virtues in a Technological Order," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 75-7 (Bloomington and Indianapolis: Indiana University Press, 1995).

431 Ibid., 76.

432 Reutzel, Robert, and Gert van der Wilt, "Technology Assessment in the Health Care Area," in *Vision Assessment: Shaping Technology in the Twenty-first Century*, eds. John Grin and Armin Grunwald, 66 (Heidelberg and New York: Springer Berlin, 2000). The italics are theirs. The main aspects of the "scientific rationale" they refer to in this context are the expectation of consensus within their communities and the assumption that science is value and emotion free.

the possibility that wisdom may be contextually discovered between a variety of knowledge systems...,"[433] applying this philosophy to policy making can be difficult.

The example that the authors use to illustrate their claim is why the decision to grow organic or genetically engineered crops should be "contextual" and "regional."[434] The authors are perhaps unaware or ignore several key issues. First these two types of agriculture are based on different ways of relating to and understanding nature that are fundamentally incompatible. Second and from a more practical perspective, organic farming and agribusiness do not only differ in their use of technology, they constitute different social relations and labour practices.[435]

The example is built around a hypothetical region that has certain ecological attributes that provide suitable conditions for growing organic potatoes, but carrots are only grown with difficulty. According to these technology assessment experts, provided there are markets for both types of crops, the compromise is to grow organic potatoes and genetically modified carrots (for what type of characteristic is not specified). The problem here is that the analysis is reductionist and short sighted. The health and composition of the soil, pollinators and other beneficial insects, wildlife and other aspects of the ecology of the region are affected by agricultural practices. The majority of crops are modified to be either resistant to herbicides (the use of which is incompatible with organic farming) or to have built-in pesticides such as Bt (which eventually results in insects resistant to the natural form of Bt that organic farmers use). GM crops destroy

433 John Grin, "Vision Assessment to Support Shaping of Twenty-first Century Society?" In *Vision Assessment: Shaping Technology in the Twenty-first Century,* ed. John Grin and Armin Grunwald, 18 (Heidelberg and New York: Springer Berlin, 2000).

434 Ibid., 18.

435 The mass production of organic food as desired by Walmart and other big chains is impossible and necessitates much weaker guidelines for growing organic food which allows for some chemical fertilizers or pesticides.

the conditions required to grow organic crops. Transnational corporations have patents on the recombinant DNA in the GM seeds they market, which makes it illegal to save, trade or sell seeds from the plants grown. Seed selection and exchange is intrinsic to organic and other traditional forms of farming. This is another way, this time legal rather than ecological, that high-tech industrialized farming can destroy the conditions necessary for organic farming. While producing both types of crops may appear on the surface as "democratic" by providing farmers a choice of production methods and consumers a choice between products, eventually both farmers and consumers will be faced with little or no choice at all.

In this analysis, "contextual" is used in a very limited sense. The idea that "truth is a local and temporary construction which is relevant only in the light of its potential to support action,"[436] a notion common in the social sciences, is not without its problems. One of these problems, illustrated in this conflicted policy suggestion, is that local claims and truths are made independently and in isolation from one another. The relationships between the two types of farming are not taken into consideration, which would necessitate some analysis of the philosophical, political and practical differences between them.

Even though the attempt is to include different ways of knowing in *Vision Assessment*, the fact that there are citizens, farmers and scientists who are calling for moratoriums and bans on the release of GMO's into the environment is completely ignored. The technology is assumed to be inevitable and neutral. This assumption is related to the rather optimistic view that any technology can be made more democratic

[436] John Grin, "Vision Assessment to Support Shaping of Twenty-first Century Society?" In *Vision Assessment: Shaping Technology in the Twenty-first Century,* ed. John Grin and Armin Grunwald, 17 (Heidelberg and New York: Springer Berlin, 2000).

by altering its use and context. When technology assessment does not include the option of not introducing a technology at all, it provides a certain degree of job security for professionals. If experts disagree on the interpretations of the experimental findings or potential risks, well then, we just need more research. The process is endless. However, we could ask the “mob,” and perhaps be a little more fearful of the consequences of genetic engineering than democratic processes.

CHAPTER 5:

THE TRAGEDY OF HUBRIS

James C. Scott, who studies the tensions between traditional and modern agriculture brought on by globalization and modernization, characterizes one of the "tragedies of high modernism" as hubris.[437] In Greek tragedies, hubris is the fatal flaw of mortals who defy the wishes of the Gods, or who have the presumption to act like Gods and assume their knowledge. For Scott, the modern context for hubris is the desire for the world to be moulded to modernist ideals and the attitude that Western civilization and science is superior to all other knowledge systems and forms of social organization.

> Authoritarian high modernist states in the grip of self-evident (and usually half baked) social theory have done irreparable damage to human communities and individual livelihoods.[438]

That "development" schemes by governments and non-governmental organizations around the world have failed to improve living conditions for the majority of the world's population has not seemed to dent the arrogance with which missionaries of modernism, even those with the best intent, displace people from land, force traditional communities into global monetary markets, exploit traditional knowledge and introduce toxins such as pesticides and insecticides into every last nook of habitable land and human intestine on our planet.

[437] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 342.

[438] Ibid., 340-1.

Humans as Gods

A part of modernist hubris for Scott is the idea that episteme is superior to more local and indigenous forms of knowledge. Abstract, universal and disembodied knowledge can only come from the bodiless omnipotence of a God. As humans, we only have a finite view of reality from the position of our body, Haraway argues. The "infinite vision" that modern science is supposed to give us, is a "god trick."[439] Similarly, Hacking describes the metaphysical position of science as a "God's eye view" of reality that can give us an understanding of the "essence of creation" and the "mind of god."[440] Many modern scientists would not describe their desire for advancing knowledge and gaining certainty as wanting to know the mind of god, but rather as seeking to deepen our understanding of the rules and laws by which nature organizes itself. But the latter is a secularized version of the former. As Noble and Leiss impress upon us, modern science cannot be understood outside of the religious and other historical contexts in which it developed.

Noble observes that one of the historical assumptions behind genetic engineering is the idea that, like Adam in Eden, humans can and should have "true dominion over creatures of the earth."[441] Prior to modern science, both God and humans were seen as being different, separate and superior to nature in both Christian and alchemical worldviews. These views flowed into the natural philosophy of the seventeenth century. According to one of the most well known alchemists, Paracelsus,

[439] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 180.

[440] Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 60.

[441] David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 172.

> Human nature is different from all other animal nature. It is endowed with divine wisdom and divine arts. Therefore we are justly called gods and the children of the Supreme Being.[442]

Icon of modern science Bacon concurs with his predecessor:

> We are agreed, my sons, that you are men...That means, as I think, that you are not animals on their hind legs but mortal gods.[443]

What God and humans were seen to have in common was the capacity for rationality by virtue of having a mind and consciousness. Nature was repetitive and static for early modern natural philosophers, and qualities such as transformation and motion and the capacity for will and design were "under the monopoly of conscious beings."[444] It was through the development of the mind and not manual labour that one could reach spiritual enlightenment and true knowledge of reality. Descartes in his *Discourse on Method* claims that a system of natural philosophy is only coherent if produced not just through the mind generally, but through one mind in particular.[445]

The evolutionary thinking that came with the nineteenth century, which ascribed some capacity for transformation and design to matter itself, left a confused and contradictory framework with which to approach natural phenomena. In biology, a "god's eye view"[446] largely became a "gene's eye view."[447] Despite the "Darwinism versus fundamentalism" or "science versus religion" rhetoric, the arrogant focus on human superiority and worship of rationality can be traced back into our Western metaphysical

442 Ibid., 36.

443 Ibid., 51.

444 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 110.

445 Ibid., 106.

446 Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 60.

447 This is science writer Connie Barlow's description of the perspective of biologists Richard Dawkins and E.O Wilson [Connie Barlow, ed., *From Gaia to Selfish Genes: Selected Writings in the Life Sciences.* (Cambridge: MIT Press, 1994), 195].

tradition. Neither theories of evolution nor the relatively recent discovery of the genetic similarity of all forms of life, which are both rather monumental intellectual developments in the history of modern science, have dented our over inflated sense of worth. Ironically, the human megalomania that helped develop modern science can be brought into question by modern science itself. Barry Commoner notes that not only did the human genome project undermine genetic determinism and its application to genetic engineering but also that

> The discovery that the human genome is not much different from the roundworm's led Dr. Eric Lander, one of the leaders of the project, to declare that humanity should learn "a lesson in humility." In the *New York Times*, Nicholas Wade merely observed that the project's surprising results will have an "impact on human pride" and that "human self-esteem may be in for further blows" from future genomic analyses, which had already found that the genes of men and mice are very similar."[448]

Unfortunately, despite repeated discoveries in science that illustrate in greater and greater detail our intimacy with and dependence on other forms of life, humility is lacking, and our modernist intimacy with and dependence on technologies take precedence to everything else on the planet.

Natural Philosophers as Gods

Despite the common opposition between science and religion made today, natural philosophers saw themselves as priests. Early modern thinkers did not think that science and Christianity should conflict. As Galileo had explained, theologians interpret

[448] Barry Commoner, "Unraveling the DNA Myth: The Spurious Foundation of Genetic Engineering," *Harper's Magazine* 304, no. 1821 (2002): 42. Please note the assumption on the part of biologist Lander and journalist Wade that all of humanity shares Western civilization's attitude towards the relationship between humans and other organisms. North Americans can't even talk about humility without being arrogant.

the word of God through the Bible; natural philosophers interpret the word of God through the book of nature.[449]

To understand the workings of nature and creation, according to Robert Boyle, was to understand "the immutable workmanship of the omniscient architect."[450] According to the Freemason's constitution of 1719,

> Adam, our first parent, created after the Image of God, the Great Architect of the universe must have had the Liberal Sciences, particularly Geometry, written on his Heart... [451]

The taking of mathematics as the queen of the sciences and the reduction of scientific epistemology to quantitative calculations is correlated with this view of God, as is the ubiquitous understanding of the genome as a blueprint, "an architect's plan and builder's craft all in one..."[452] This metaphor still resonates. In expressing his desire to change and improve humanity, E.O. Wilson asks that society become the "architect of human evolution" through genetic engineering and cloning.[453]

Natural philosophers became priests and prophets in the sixteenth and seventeenth centuries. One of the founders of the Royal Society describes Descartes, Gassendi, Galileo, Brahe and Harvey as dwelling "in a higher region than other mortals."[454] For some (mainly engineers themselves), engineers in particular became the

449 Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: The University of Chicago Press, 1994), 305-6.

450 Boyle quoted in Noble, David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 63.

451 Ibid., 75.

452 Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995), xiv.

453 Quoted in Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World*. (New York: Penguin Putnam Inc., 1998), 171.

454 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 61.

"priests of the new epoch."[455] This new epoch, according to mechanical engineer George Babcock, is "when every force in nature and every created thing shall be subject to the control of man."[456] While this dream is impossible to realize, the attempts to bring on this epoch through atomic, nano, and rDNA technologies illustrate the obsession to control the smallest particles possible and construct new forms of matter like architects and engineers. This obsession not only applied to physical reality. Zygmunt Bauman also characterizes early modernity as "shaping [social] reality like architecture."[457]

With God separate from nature and humans separate from nature, modern natural philosophers could manipulate and attempt to control nature without profaning anything sacred. Noble describes one of the projects of the founders of modern science such as Bacon, Newton and Descartes as the recovery of the perfection that existed before the fall of Adam. They attempted to do so "with more hubris than humility." They not only wanted to love and imitate God, but to be like him.[458] Despite paying lip service to humility, Noble argues, both God and men were seen as creators, and it was man's mission to remake the world. And we have, from irrigating deserts to making mice glow in the dark. Genetic engineering is the ultimate technology for participating in creation and control and making things in our image. By this I mean the attempt to make other organisms more "efficient" by our cultural standards and forcing them to produce

455 Nineteeth century engineer George S. Morrison quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 95.

456 Quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 95.

457 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 47.

458 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 61.

substances they do not naturally produce by crossing ecological, organismal and genetic barriers.[459]

The path back to Eden was through reason and philosophy, which, according to Auguste Comte, would restore man to his place as "chief of the economy of nature…at the head of the living hierarchy."[460] The assumption was that in order to finish and perfect creation, nature must be dominated, not through labour, but through reason, science and technologies. How to finish God's work was the task of early European natural philosophers. The future was to hold "a fullness and plenty of all conveniences of life…and with much less labour and toil."[461] Historian Lynn White traces the tension between the idea of labour as a humble and noble path to salvation and the idea of salvation as a respite from labour in Christian traditions. The inner religious transformation through self-discipline was replaced with the more external "technological remediation."[462]

For example, the problem of food shortages and malnutrition that is faced by many populations can be approached as an issue of distribution, wastefulness in affluent countries and the political oppression and economic exploitation both between and within nations, or it can be viewed as a technological problem. The former is complicated, and making the world a more equitable place necessitates a great deal of

459 Take for example the attempt to make strawberries more resistant to frost by genetically modifying them to produce a protein commonly found in flounders that protect them from freezing. Genetic barriers are crossed by inserting a foreign gene into the strawberry genome, organismal barriers are crossed because fish and strawberry plants don't exchange genetic material in nature and the intent of the modification is to cross ecological barriers by allowing strawberries to be grown in areas with shorter growing seasons where the plants would not normally come to fruit.

460 Quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 84.

461 Ibid., 91.

462 Quoted in William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 29.

political will on the part of affluent countries. However, instead of exerting any self-discipline here in the West and changing our consumptive patterns and consequently our economic relationships with other countries, it has been suggested that we should change the biology of starving people. A.M. Chakrabarty, the first biologist to receive a patent on an organism, a bacterium capable of metabolizing oil, suggested in the early 1970's that *E. Coli* should be genetically modified to digest cellulose. His reasoning was that the majority of roughage in human diets is cellulose, which we cannot digest. He

> ...saw great promise in a technology that enabled people to utilize high-cellulose-content foods for their untapped calories. Vast populations in underdeveloped countries could have the flora of their intestines transformed so they could digest and obtain calories from vegetation that is inexpensive and plentiful but possesses little value as food.[463]

Let them eat wood! His idea was criticized by another scientist who pointed out potential health hazards of rDNA technology that was still in the process of being developed. However, the fact that Chakrabarty, a molecular biologist, had not investigated global economics, agriculture or nutrition was not an issue. The solution to one of humanity's greatest medical, political and economic problems is reduced to a technological fix: digestion by genetically modified bacteria. I find it extremely arrogant to suggest that the poor of the world should be biologically altered to eat otherwise inedible and non-nutritious foods.

Modernism as Path to Eden

Central to many critiques of modernism is the degree to which technological advancement is used to measure and compare cultures. Philosopher Robert B. Pippin

[463] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 119.

draws the line between modern and pre-modern by characterizing the preoccupation with expanding control over nature as "uniquely modern."[464] Because technology is so often taken to be the "proof" of progress,[465] the rather ethnocentric assumption that technological progress is a form of social evolution is not questioned enough. Noble too observes, "all things technological are the measure of modern enlightenment"[466] and later gives an example of how Puritan attitudes toward technology and agriculture developed within the context of speculations about "primitive man."[467] The "primitive man" the Puritans were conceptualizing represented humans prior to the fall when man exercised dominion over the works of God by virtue of the divine wisdom with which he had been endowed.[468] The "primitive" state of uncivilized aboriginal cultures was after the fall and not the same as the subject of Puritan speculation.

Cultures that do not have the same fetish for technologies as we do are seen as backward, underdeveloped and/or retarded by religion and superstition. The notion that creation is not yet finished not only applied to individual spiritual development and the manipulation of nature but also to the development of humankind in general. Just as natural philosophers were seen to be closer to God than the common people, Western civilization was seen to be the only form of civilization.

464 Robert B. Pippin, "On the Notion of Technology as Ideology," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 52 (Bloomington and Indianapolis: Indiana University Press, 1995).

465 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 77; and Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 9.

466 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 3.

467 Ibid., 54.

468 The emphasis is on *man*, lest we forget that it was Eve's fault that paradise (according to the Puritans) no longer exists on Earth.

The desire to return to Eden became more secular and constituted a large part of the development of both capitalism and socialism in the nineteenth century. While socialists Marx and Owen believed that people, not machines, change society, they still believed that machines offered a "respite from labour" necessary for a more just society. Marx saw "machines" (capitalist means of production) as "laying the material basis not only for capitalist accumulation but also for the social revolution that would signal the end of class society" and class exploitation.[469] Marx was deeply influenced by nineteenth century evolutionary thought, as were many intellectuals and scholars of his time. He did not question a common modernist assumption that the domination of nature is a stage in the development of the human species.[470]

Scott questions a similar linear evolutionary assumption that practical and local knowledge is a "precursor to modern science" and an inferior mode of reasoning and knowledge making.[471] Sociologist John Evans agrees and also questions two related "deep assumptions" of this "Western philosophical tradition."[472] One is the "natural progression" of human reason away from religion and towards rational and scientific reasoning. The other is that "substantive" rationality (which is experiential and non-reductionist) evolves into "formal" rationality (technical rationality or episteme). The overriding assumption is that only one form of rationality and only one type of relationship to nature must be dominant, and the relationship between these forms is linear. The rejection of pluralism in favour of linear progression can be found in the

469 Ibid., 87.

470 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 85.

471 James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 327.

472 J. H. Evans, *Playing God? Human Genetic Engineering and the Rationalization of Public Bioethical Debate* (Chicago: University of Chicago Press, 2002), 24.

absolutism of early modern natural philosophy and the reductionism of dominant nineteenth century evolutionary theory. Absolutists and reductionists rarely accept, much less try to explain, how different but equally stable and functional biological, social and knowledge systems can exist at the same time.

In the debate between "constructivists" and "realists" about the historical contingency of science, as Hacking characterizes it, the issue revolves around whether an alternative science could have developed that is "equivalent" to modern science.[473] In this context the constructivists are arrogant in assuming, first, that the development of alternative science has not already happened in the Western tradition, ignoring, for example, Romanticism, and secondly, in assuming that other non-Western cosmologies that currently exist are not viable approaches to reality. This is despite the stability of ancient traditions such as homeopathy and acupuncture, which come from cultural frameworks that differ from our own.

Realists are equal, if different, in their arrogance. In the context of discussing how some scientists are "troubled" by the idea that scientific theories are historically contingent, Hacking quotes a Nobel prize-winning physicist:

> Any intelligent alien anywhere would have come upon the same logical system as we have to explain the structure of protons and the nature of super novae.[474]

According to Richard Dawkins, the question "aliens will ask to assess the level of civilization" is "have they discovered evolution yet?"[475]

[473] Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 78.

[474] Sheldon Glashow quoted in Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 75.

[475] Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 196 (Cambridge: MIT Press, 1994).

It is assumed that aliens, and all human beings, should care about the structure of protons or mechanisms of evolution as much as modern scientists do. True to the "universality" of episteme, not only is the desire for a detailed technologically mediated knowledge of the organization of matter assumed to be of general human interest but of equal interest to all "intelligent" forms of life in the universe. Other cultures are being judged according to their knowledge of what specialists deem important. Hacking describes the logic of scientific realists: "We could have stayed with Zen, but if a successful physics took place, then it would inevitably have happened in something like our way."[476] Is our physics successful, and if so, for whom and with what effects?

According to Leiss, one of the historical tendencies that helps explain "the growing influence of the idea of human domination over nature in modern society" was the "qualitative change in the possibilities for the satisfaction of needs."[477] Historian Lynn White suggests that the change in attitude towards technology, nature and needs may have come as early as the middle ages with the introduction of agricultural technologies such as the heavy plow. The standards of land division changed from being based on subsistence to the capacity of the technology for making land as productive as possible. In regards to man, "Formerly he had been a part of nature; now he became an exploiter of nature."[478]

The more general aspect of modernity that this historical tendency represents is that "immediate human interest is suspended or annulled so that a process of

[476] Ian Hacking, *The Social Construction of What?* (Cambridge: Harvard University Press, 1999), 79.
[477] William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 187.
[478] White quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 12.

development driven by an autonomous inner logic can unfold."[479] This is also the logic behind the hegemony of episteme and mathematical reasoning, as pointed put by Toulmin, whereby the validity of an argument rested purely on "internal relations" which were separate from rhetoric, personal interests or historical and social context. The complexities of human behaviour, needs and interests simply cannot be addressed by either the universality of episteme or the singular goals of techne. Leiss points out as well that the local, "personal foundations of traditional economic behaviour" eroded and were replaced by the more abstract notion of a supply and demand market mechanism extended to a large geographical space. Social, political, economic and ecological relationships are governed by the same logic. We see nature and ourselves in the image of our creation, the machine.

Habermas suggests that the success of technology in satisfying human needs cannot be denied.[480] I do not deny this but the question of how technology is assessed needs to be asked. While Scott accepts that aiming for a singular goal is a valuable tool, the hegemony of techne is a problem.[481] Scott gives the example of modern agriculture, which may aim to increase the number of bushels produced while decreasing the costs of production, but the needs of the community, culture, human health, biodiversity, and environmental sustainability have not been considered, much less met.[482]

Habermas is discussing technology in a general sense as a "species interest," as he puts it, rather than a specific culture's or class's interest. Tool making and using is a

[479] William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), xix.

[480] In Steven Vogel, "New Science, New Nature: The Habermas-Marcuse Debate Revisited," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 29 (Bloomington and Indianapolis: Indiana University Press, 1995).

[481] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 345.

[482] Ibid., 321.

defining feature of human beings. The Promethean gift of fire, hunting and agricultural tools and musical instruments are ubiquitous in human cultures. Many other organisms build dwellings and turn natural objects into tools, but there is an enormous qualitative difference between turning natural objects into tools and the human capacity for creating complicated tools and processes which we use to further manipulate and combine natural objects and substances for the purposes of healing, poisoning, self-expression and self-destruction.

For this reason Andrew Feenberg suggests that technology "is not a universal dimension of modernity."[483] However, Feenberg also brings attention to the fact that "technology" should not be conflated with "high technology" or those specific technological developments that have occurred in the West in the past century. These technologies are distinct for their "unprecedented consequences."[484] Also, the distinction between modern technologies and non-modern ones does not lie in the general creation and use of them but rather in the societies that produce them. The "West" or modern western societies cannot only be defined in part by the rapid development of tools and machines but also by being " outright modeled after them."[485]

The Totality of Things

I agree with Mircea Eliade's generalization that "concepts of material progress and the conquest of nature through science and technology crystallized in the nineteenth

483 Andrew Feenberg, "Substantive Rationalization: Technology, Power, and Democracy," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 5 (Bloomington and Indianapolis: Indiana University Press, 1995).

484 Ibid., 17.

485 Historian Howard P. Segal referring to the technological constitution of American society. Quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 98.

century" and are at the root of capitalist, liberal and Marxist ideologies.[486] Leiss feels that this generalization is confusing and "misses the main point" that in any ideology there are contradictory features "which must be transcended."[487] I agree that all theories, worldviews and ideologies have contradictions, but I do not think that all of them can be transcended. For example, philosopher Steven Vogel describes two positions in Western Marxism that he thinks are irreconcilable. One is that nature is a social category and the other is that social theories and theories of nature should be separate.[488]

Understanding nature as a social category means that we cannot explain or describe an objective reality. Latour recounts an interview with a scientist concerned with constructivist and relativist critiques of science who asks, "Do you believe in reality"?[489] While the question may seem strange, some constructivists and post-modernists appear to ignore physical reality, or the reality we experience through our bodies. In their extremes, both realists and constructivists can't seem to grasp that the world can be both an idea and a rotating ball of water, rock and magma at the same time. Scholars in both camps want to claim that they understand the nature of reality to the exclusion of everyone else. Winner observes that many people are not happy with the definition of nature as "the totality of things,"[490] which is a rather Romantic notion.

486 Quoted in William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 43.

487 Ibid., 43.

488 Steven Vogel, "New Science, New Nature: The Habermas-Marcuse Debate Revisited," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 23-4 (Bloomington and Indianapolis: Indiana University Press, 1995).

489 Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 4.

490 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986). The definition of nature as the "totality of things" comes from Ralph Waldo Emerson's essay "Nature."

This unhappiness with the definition of nature as totality not only relates to natural phenomena but social phenomena as well. Ernesto Laclau suggests that society cannot be discussed as a totality.[491] But this does not automatically mean that, "society is not a valid object of discourse" as post modernist Derrida asserts.[492]

I interpret this post-modern view of totality as hubris. Both social and natural scientists accept the impossibility of describing totality, but the idea of "a whole" be it a society, an organism, an ecosystem or a universe that is always a part of the totality of all things can be a part of our discourse and our descriptions of the parts we study. It brings our attention to the limitations of our explanations. Perhaps then we can avoid what Adolf Portmann observes of his biologist peers, which is that they "cannot resist the temptation to explain the unknown whole through its parts,"[493] even if they have some awareness of the impossibility to do so.

In 1961 ultra-reductionist Ernst Mayr wrote:

> Every system is so rich in feedbacks, homeostatic devices and potential multiple pathways that a complete description is quite impossible. Furthermore, the analysis of such a system would require its destruction and would thus be futile.[494]

The awareness of this limitation of scientific methodology among scientists goes back much further. Pope Urban VIII was particularly fond of the "fable of the sound" described by Galileo in *The Assayer* published in 1623. The fable brings attention to the limitations and destructiveness of natural philosophy. The fable tells

491 Discussed in Michele Barrett, "Ideology, Politics, Hegemony: From Gramsci to Laclau and Mouffe," in *Mapping Ideology*, ed. Slavoj Zizek, 247 (London and New York: Verso Publications, 1994).

492 Derrida quoted in Ibid., 247.

493 Adolf Portmann, *New Paths in Biology,* trans. A.J. Pomerans (New York and London: Harper and Row Publishers, 1964), 148.

494 Ernst Mayr, "Cause and Effect in Biology," *Science*, 134 (1961): 1505.

> the story of a man who hears a certain sound and tries to discover its origin. Each time he thinks he has found its real cause, he hears the sound again and again and realizes that there was yet another way which nature produced it. By following this same sound through a number of different causes, this man eventually finds a cicada. He thinks that, finally, he has a chance to find the real cause of the sound and decides to perform a "crucial experiment."

> At length, lifting up the armour of its chest and seeing beneath this some thin, hard ligaments, he believed that the sound was coming from the shaking of these, and he resolved to break them in order to silence it. But everything failed until, driving the needle too deep, he transfixed the creature and took away its life with its voice, so that even he could not make sure whether the song had originated in those ligaments.[495]

The awareness of the limitations of our knowledge has not resulted in any humility towards the objects of our studies. Genetic engineering is based upon a foundation of limited understanding of nature. One would think that this should make us rethink what we are unleashing on ourselves and the environment.

The problem is that despite our acceptance of the "impossibility of any appeal to one unchanging nature underlying all of our different accounts and rating scientific theories against the truth," contemporary scholars like Steven Vogel claim that "there is neither any sense in nor any need for the idea of noumenal nature underlying the socially constructed one."[496] I agree with the former statement, that we cannot describe or explain noumenal nature, but I disagree that we do not need the idea that one exists. We must be constantly reminded, "the human mind does not encompass the world," as

[495] Quoted in Mario Biagioli, *Galileo, Courtier: The Practice of Science in the Culture of Absolutism* (Chicago: The University of Chicago Press, 1994), 301.

[496] Steven Vogel, "New Science, New Nature: The Habermas-Marcuse Debate Revisited," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 33 (Bloomington and Indianapolis: Indiana University Press, 1995). A noumenal nature is "nature-in-itself."

Keller insists, "it is itself a part of that world, and no amount of self-reflection provides an escape from that limitation."[497]

Nature Is Mute under Torture

As if directly responding to the fable of the sound, Goethe protested against destructive forms of experimentation by asserting, "nature is mute under torture."[498] The idea that nature is not "obliged to make sense to us," Keller observes, "is relegated to an outmoded era of German romanticism, seen as a last stand against the triumphal progress of scientific enlightenment."[499] There are several other aspects of treating Romanticism as a "mark of imbecility"[500] that relate to the hubris inherent in modernist tendencies.

Vogel frames his discussion of the two ways of understanding the relationship between the natural and the social in the Marxist tradition by comparing the views of Habermas and Marcuse. Marcuse believed that science and technology did not have to be violent and exploitive. In order to be harmonious with nature, the "new science" would have to be oriented toward qualities inherent to nature rather than the inherently exploitive qualities of capitalism. The problem lies in how to access and understand what is "inherent to nature" and what is not. Nature, according to Habermas, cannot be a communicative partner. In regards to Marcuse's view, Vogel writes

[497] Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 295.

[498] W. Heitler, *Goethe's Way of Science: A Phenomenology of Nature* (New York: State University of New York Press, 1998), 65.

[499] Evelyn Fox Keller, *Making Sense of Life: Explaining Biological Development with Models, Metaphors and Machines* (Cambridge: Harvard University Press, 2002), 295.

[500] Jacques Barzun, *Darwin, Marx, Wagner: Critique of a Heritage* (Chicago: The University of Chicago Press, 1958), 16.

> It is a dream of nature with whom we could speak, a nature that is itself a moral agent and with whom a reciprocal moral relation is a possibility. Like all romanticism it correctly rejects the claims of Science to intellectual hegemony, but incorrectly thinks it can only do so by rejecting Science's validity.[501]

Romantics like Goethe used the metaphor of communication to explain the process of observation and discovery. While other scholars such as McClintock or Einstein did not use the specific metaphor of communication, they described their own processes of observation and discovery in a similar fashion to Romantic natural philosophers.[502]

Outside of modern science, cultures with animistic cosmologies and shamanistic traditions also describe their relationship to nature as a communicative one.[503] Just because scholars such as Vogel and Habermas have not experienced such relations with nature does not mean that it is impossible for all of humanity.

To assume that peoples of animistic cultures have imaginary friends or hallucinations is ethnocentric. David Suzuki has dedicated a large part of his career as a scientist and a broadcaster to illustrating the similarities between contemporary science and aboriginal knowledge of local environments. The tremendous pharmacological knowledge of traditional peoples around the world has been exploited by Western societies for centuries. Like the methods of Goethe and McClintock, the ways in which traditional peoples describe their ways of knowing are dismissed, even though their knowledge is accepted and used.

501 Habermas quoted in Steven Vogel, "New Science, New Nature: The Habermas-Marcuse Debate Revisited," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 37 (Bloomington and Indianapolis: Indiana University Press, 1995).

502 Keller defines McClintock's and Einstein's approach to the "oneness of nature" as "a form of mysticism" and brings attention to the respect that physicists, such as Schroedinger, Bohr and Oppenhiemer had towards the cosmologies of Buddhism and Hinduism [Evelyn Fox Keller, *The Century of the Gene* (Cambridge: Harvard University Press, 2000), 201-5.].

503 Different cultures have varying forms of divination and ways contacting nature spirits for knowledge and guidance.

In his discussion of different forms of environmental movements, Winner describes the view of "nature as a source of intrinsic good" as necessitating a change in the "aesthetic, ethical and metaphysical grasp" of our Western and modernist relationship to nature.[504] We have no hope, according to this view, "if we have no feeling for natural creation outside their instrumental value."[505] Coming out of environmental movements are two forms of "social advice," one is "love" and the other is to pressure for "strong state control."[506] Feenberg makes a similar observation about environmental movements.

> Some hold out for the pious hope that people will turn from economic to spiritual values in face of the mounting problems of industrial society. Others expect enlightened dictators to bite the bullet of technological reform even if a greedy populace shirks its duty. It is difficult to decide which of these solutions is more improbable, but both are incompatible with democratic values.[507]

I have a problem with characterizing "spiritual values" as undemocratic, although I agree that embracing the type of values held by movements such as deep ecology is improbable.[508] The spiritual values espoused by some environmentalists are based on what they understand the relationship between humans and nature to be. According to them we are one species among many and "there is no good reason to suppose that our species has any special right to rule the rest of creation; nothing but sheer hubris

504 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 130.

505 Ibid., 134.

506 Ibid., 136.

507 Andrew Feenberg, "Substantive Rationalization: Technology, Power, and Democracy," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 13.

508 Environmentalists are far from unified in regards to how we should go about preserving or living within our natural environments in a more sustainable fashion, or for that matter, what "sustainable" even means.

supports that prejudice.[509] However, the economic and instrumental values of industrial society are also based in a particular view of what the relationship between humans and nature is and that is one of ownership, domination, exploitation and the right to use and rule nature. This view has a basis in the philosophical separation of humans and nature, and God and nature that has religious roots. I do not just see a conflict between instrumental and spiritual values, but rather a conflict between different spiritual values.

The inclusion of "spiritual values," emotions and morality in political decisions does not make political processes undemocratic; it makes them conflict ridden, difficult, complex and impossible to reach consensus. But these aspects of human interests and behaviour are real, and ignoring them or repressing them does not solve any problems.

Many indigenous and traditional peoples (and not a few other citizens) around the world oppose genetic engineering in its medical and agricultural applications based on their relationships to nature, which are inseparable from their "spiritual values," love, and in animistic cultures, worship of nature. What do we do with indigenous peoples who oppose genetic engineering on the grounds that it profanes the sacred? How do we share this world with them? In excluding them from making decisions about technologies that have global consequences, are we in the West not being grossly hypocritical by ignoring the religious foundation of modern science and the cultural and historical origins of our views of "rational" decision-making? I think that nothing in our system will change unless a profound respect, gratitude and humility towards our ecological commons develop however improbable that may be in a North American context.

509 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 132. Winner is describing the position of some environmentalists; he does not state this as his own opinion.

It is difficult to argue that an enlightened dictatorship is probable or compatible with democratic values because of its very definition. An argument for "strong state control" becomes difficult as well when one considers what Winner calls "the hollowness of modern citizenship" meaning the "paucity of citizen roles and lack of opportunities for direct participation in politics" in general, not just technology policy-making.[510] All citizens can seem to hope for is for politicians, bureaucrats and experts to represent their interests, especially in regards to health and environmental hazards. It is the responsibility of health authorities to use their specialized knowledge to determine what products and industrial processes people and the environment can be safely exposed to. It does not bode well for democracy that some government researchers who actually take this responsibility to heart have to become whistle-blowers.

The results of a series of Canadian polls and focus groups conducted on biotechnology reveal that many of them want a regulatory system that relies on expert opinion, and many also felt that as laypeople they did not know enough to make effective decisions on such highly technical and complex matters such as genetic engineering.[511] However, this trust is contingent upon the guarantee that experts be independent and not represent industrial interests.[512] This position cannot be described as wanting an enlightened dictatorship, but rather as wanting "strong state control by enlightened experts."

510 Langdon Winner, "Citizen Virtues in a Technological Order," in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay, 73 (Bloomington and Indianapolis: Indiana University Press, 1995).

511 Government of Canada, *Public Opinion Research into Biotechnology Issues Third Wave,* Executive Summary Presented to the Biotechnology Assistant Deputy Minister Coordinating Committee (BACC) Government of Canada by Pollara Research and Earncliff Research and Communications, December 2000, http:/biotech.gc.ca/docs/engdoc/3Wavexec-e.html, ¶ 28.

512 Ibid.

In the face of rapid technological development and commercialisation, the position of the majority of those citizens polled is rational, however it is far from ideal. It does not take into consideration the conflicts even among independent specialists and scientists, nor the limitations of modern Western science in assessing and predicting risks and hazards.

Morality and Regulation

Two aspects of science that are underdeveloped are its morality and its regulation. While early modern natural philosophers felt that they could be like gods in the co-creation of the world, they left two aspects of knowledge making with their god. Bacon warned his peers to avoid the arrogance of alchemists in their claim to moral knowledge:

> It was the ambitious and proud desire of moral knowledge to judge good and evil, to the end that man may revolt from God and give laws to himself, which was the form and manner of the temptation.[513]

And henceforth natural and moral knowledge, facts and values, and the natural and social sciences have been seen as separate. In his 1998 undergraduate textbook under the section "morality and ethics," evolutionary biologist Douglas J. Futuyma explains

> The theory of natural selection, of incessant competition and struggle, of individual self interest as the motive force of adaptive evolution, paints a dark picture of "Nature red in tooth and claw," as dark and aesthetically unappealing, perhaps, as untrammeled capitalism...Neither natural selection nor any other theory of natural science can provide a code of ethics.[514]

[513] William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 51-52.

[514] Douglas J. Futuyma, *Evolutionary Biology*, 3rd ed. (Sunderland, MA: Sinauer Associates Inc., 1998), 363.

Similarly, in the preface to Richard Dawkins' book, *The Selfish Gene*, neo-Darwinist John Maynard Smith warns the readers

> It is a book about the evolutionary process – it is not about morals, or about politics, or about the human sciences. If you are not interested in how evolution came about, and cannot conceive how anyone could seriously be concerned about anything other than human affairs, then do not read it, it will only make you hopelessly angry.[515]

Yet Dawkins himself suggests that

> Philosophy and the subjects known as "humanities" are still taught almost as if Darwin had never lived. No doubt this will change in time.[516]

You see, even if evolutionary theories are not inherently codes of ethics, this does not exclude them from being used in this way. Biologist Verne Grant states in his textbook on evolution that

> The knowledge, implications and warnings of evolutionary biology have been available for years, but have been ignored by the people who run governments, as well as large segments of the citizenry. Meanwhile the human condition is not improving, and the big problems are not being solved under the leadership of traditional governments. Obviously evolutionary biology must get into public affairs. For the lessons of evolutionary biology are the concerns of everybody.[517]

Consider one of the lessons of evolutionary biology that Grant describes eighteen pages prior to the above quote.

> A troop consisting of mainly smart monkeys is likely able to cope more successfully with problems of the world around it than a neighbouring competitor troop of stupid monkeys.[518]

Besides the inadvertent implication that our current governments are troops of stupid monkeys because they are not coping successfully with the problems of the

[515] John Maynard Smith quoted in Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 195 (Cambridge: MIT Press, 1994). .

[516] Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 196 (Cambridge: MIT Press, 1994).

[517] Verne Grant, *Organismic Evolution* (San Francisco: W.H. Freeman and Co., 1977), 378.

[518] Ibid., 360-1.

world, we see here that orthodox scientists want it both ways. They want morality/politics and science to be kept separate, but then they say, " evolutionary biology must get into public affairs." They say that scientific theories are immune from social influences, but then they say that science should influence society. They think that the *social* regulation of *science* is unnecessary but that the *scientific* regulation of *society* is.

The idea that God is the final arbiter and judge of how far human intellectual and technological "advancement" should go, which relieves mere mortals of the duty of regulating their own activities and creations, has been secularized as a "self-protective assertion of science."[519] It is a way for scientists to maintain control over the regulation of their research. However, I was surprised to read about the number of geneticists and scientists who support human genetic engineering who are born again Christians. This includes the director of the Human Genome Project, Francis Collins. Collins is also a member of the American Scientific Association (ASA). According to the organization's "Statement of Faith"

> All members of the ASA must sign a doctrinal statement of faith in which they agree to "accept the divine inspiration, trustworthiness, and authority of the Bible in matters of faith and conduct" and identify themselves as "stewards of God's Creation.[520]

These scientists maintain that God makes the moral decisions and sets the limits on research. In regards to the use of gene therapy on humans, "God will ensure" geneticist and physiologist Donald Munro assures us, "that we don't go too far afield."[521]

519 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 96.

520 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 194. Quotation from the "Statement of Faith" Membership Application, American Scientific Association.

521 Donald Munro quoted in David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 196.

Most scientists advocate a strict separation between science and religion but are largely blind to the logical connections and compatibilities that exist between reductionist science and Christianity.[522] For example, while Lewontin refers to Vandana Shiva as a "cult figure," a "cheerleader," and objects to her inclusion of "religious morality" in her opposition to genetic engineering,[523] he does not include a discussion of the rather large number of white male Christian scholars who link their enthusiasm for genetic engineering to their religious beliefs. I am not suggesting that Shiva is immune from critique. Rather, I want to point out that while I have not read everything Lewontin has written, I have not seen him express such patronizing and rude language towards Western scholars, even his nemesis at Harvard, E.O. Wilson.

Wilson describes his moment of discovering natural selection as an organizing principle for nature as a religious one.

> You know, in a typical epiphany or conversion, the individual says something along the lines of 'I discovered God. Jesus came into my life.' But the outcome of all this is that the individual sees the unity in the universe...he sees a purpose for the universe of which he is a small part...and that brings a certain very profound peace...I think that discovering something of a unifying idea gives you a sense of having a key, not to the universe but to the big chunk of it that matters most to you.[524]

Similarly, Lovelock wrote of Gaia (before he switched to calling his theory geophysiology) "she is of this Universe and conceivably a part of God...we are a part of her."[525] Both Wilson and Lovelock experience a "religious consciousness" that is not

[522] There are incompatibilities as well. Neither science nor Christianity is monolithic and unified.

[523] R. C. Lewontin, "Genes in the Food!," in *It Ain't Necessarily So: The Dream of the Human Genome and Other Illusions*, 259-60 (New York: New York Review of Books, 2001).

[524] Quoted in Robert Wright, "Three Scientists and Their Gods," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 161 (Cambridge: MIT Press, 1994).

[525] James Lovelock, "The Ages of Gaia," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 42 (Cambridge: MIT Press, 1994).

defined by a particular belief system but rather the feeling of being a part of something much larger.[526] Philosopher Wilhelm Dilthey expresses a rather Romantic sentiment by defining "higher or overall understanding" as seeing "how things fit into a whole."[527] It is in this way that religious consciousness can contribute to understanding.[528] It can be a part of our epistemological processes.

Yet only the proponents of the Gaia hypothesis are accused of seeking "philosophical solace." The reductionists are not.

> We live in a world of profound and sweeping mystery, a world endowed with intelligence and with a kind of meaning and containing scattered clues, though no definitive evidence, of higher purpose. This much can be said without the help of Gaia, and not much more along these lines can be said with her help. So if she is going to earn a lasting place in Western discourse, it should be strictly on scientific merit; we shouldn't buy into the Gaia hypothesis for the sake of philosophical solace.[529]

Supporter of the selfish gene theory, biologist W. Ford Doolittle asks "is it mean-spirited to question a socially useful metaphor?"[530] The issue is not with the phenomena that the Gaia hypothesis addresses or the validity of the research findings inspired by this hypothesis. It is with the notion of Gaia itself and that Lovelock suggested upon first introducing the hypothesis that "Gaia may turn out to be the first religion to have a

526 The term "religious consciousness" is used by Wilhelm Dilthey, *Selected Works Volume III: The Formation of the Historical World in the Human Sciences*, eds. Rudolf A. Makkreel and Frithjof Rodi (Princeton and Oxford: Princeton University Press, 2002), 20.

527 Ibid., 14.

528 Ibid., 20.

529 Robert Wright, "The Great Divide", in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences,* ed. Connie Barlow, 248 (Cambridge: MIT Press, 1994).

530 F. Ford Doolittle, "Questioning a Metaphor," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences,* ed. Connie Barlow, 236 (Cambridge: MIT Press, 1994).

testable scientific theory embedded in it."[531] Lovelock himself has moved away from the rhetoric of Gaia. As Dorian Sagan describes, the switch is from

> "Gaia" – the Greek name for the Mother of the Titans to "geophysiology – a name in which the mythological nature of the Greek conception of the Earth (Gaea) is buried as the prefix (geo) of a scientific –sounding word.[532]

While many scholars seek solace in secularization, science cannot get rid of its mythological and religious roots. In *The Dialectical Biologist*, Lewontin and Levins point out that an adequate "biometeorology" to help explain the dialectical relationship between organisms and their environments is lacking. Considering the main theme of their work revolves around the ways in which organisms both create and are created by their environments, the type of "biometeorology" that they were looking for is similar to the types of empirical and computer-modeling work inspired by the Gaia hypothesis. Lovelock first proposed his idea in 1979; and Lewontin and Levins published their work in 1985.I can only speculate as to whether they knew about it or not, but I have never seen any reference to Gaia in Lewontin's work. Even the hardcore reductionist Doolittle sees the benefit of Lovelock's work in ecology, but it is the concept of Gaia herself that poses a problem.[533] Similarly, John Maynard Smith asserts

> I do not agree with the theories proposed by Lovelock, Margulis and Gould, but I am fascinated by the phenomena they discuss. What we need to do is think about those phenomena with hard-nosed reductionism...[534]

[531] James Lovelock, "The Ages of Gaia," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 36 (Cambridge: MIT Press, 1994).

[532] Dorion Sagan, "In Defense of Writing," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 240 (Cambridge: MIT Press, 1994).

[533] F. Ford Doolittle, "Questioning a Metaphor," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 236 (Cambridge: MIT Press, 1994).

[534] John Maynard Smith, "The Way Forward," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 239 (Cambridge: MIT Press, 1994).

This is said despite the olive branch that Lynn Margulis extends towards reductionist biologists in the form of a conceptualization of Gaia as the Natural Selector. Both are the result of "thirty million types of organisms and the environmental consequences of their presence."[535] The olive branch is not enough. The metaphor of Gaia is for sissies who can't handle nature, red in tooth and claw, dogs eating dogs and the real world where only the fittest survive.

The rejection of the Goddess takes place in both the natural and the social sciences. Even Haraway, who goes so far as to suggest that we "strike up non-innocent conversations" with the world, chooses to call this "coyote discourse." We do not, she thinks, have to "lapse" into appeals of the primal mother.[536] First of all, the metaphor of the earth as a mother is once again cross-cultural, and one rarely hears the epithet "father nature." Is "lapsing" suggestive of going backwards? Furthermore, as Haraway points out herself, the coyote is the trickster, the joker and has a sense of humour in North American First Nations cosmology. Coyote does not have the same power of creation and destruction as the earth as mother. Coyote is a masculine character. Coyotes are endemic to North America and do not exist in all parts of the world (whereas mothers are everywhere). Coyote just isn't as big as Gaia.

My defence of Gaia is in part a rebellion to the blindness to anthropomorphic metaphors in modern biology as well as to the rejection of the feminine principle in scientific discourse. For example, the focus on DNA blurs the importance of the maternal cell in the development of an embryo. In one of the extreme forms of preformationism in

[535] Lynn Margulis, "Biologists Can't Define Life," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 238 (Cambridge: MIT Press, 1994).

[536] Donna Haraway, "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective" in *Technology and the Politics of Knowledge,* eds. Andrew Feenberg and Alistair Hannay (Bloomington and Indianapolis: Indiana University Press, 1995), 189.

the seventeenth century, the homunculus, a tiny fully formed human was contained in the sperm, which needed the passive cell only as a nutritive body.[537]

Noble also comments on not just the lack but also the threat of the feminine in early modern scientific discourse. God was seen as the father of the universe and Adam as the father of all humans. Woman actually came from man. Noble refers to this as the "primordial masculine beginnings."[538] Take for example the title of Bacon's treatise of 1603, *The Masculine Birth of Time, Or the Great Instauration of the Dominion of Man over the Universe.*

If male and female principles are going to be invoked, then they must be with equal powers even if they have different characteristics and qualities. Mother earth cannot give birth on her own, she needs father sky (another common archetype) and his rain, heat and light to be fertile. In other words, the earth and the atmosphere are inseparable. The first order that arose from primordial chaos in many mythologies was the division of male and female principles from an androgynous void.

As has been pointed out to me repeatedly when I get on my "what is the problem with Gaia" soapbox, it is best not to align oneself with those pseudo-eastern philosophizing, half-baked quantum-thinking, culture appropriating, plastic dream catcher displaying, Zen meditating, yoga addicted, bongo beating, spirit channeling, self-proclaimed shaman urban hippies. I too have problems with the North American new age movement as it can be just as arrogant, self-centered and individualistic as its social context, the consumer culture. But if excluding the entire movement and its mish-mash

537 Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995), 38.

538 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 214.

of concepts and ideas means excluding the validity of the cosmologies of traditional peoples around the world, I will not do it. Modernist hubris is a greater problem.

CHAPTER 6:

THE TRAGEDY OF WANTING TO CHANGE THE HUMAN CONDITION

The second "tragedy" of modernism according to James C. Scott is the desire to change the human condition, which has led to one failed social engineering experiment after another.[539] Scott attributes these failures to the inability of technical rationality to "master chance and uncertainty" because it excludes non-technical elements, which are not measurable or quantifiable but are essential for a social system to function.[540] The desire to change the human condition and, more specifically, to "purify humans of their frailties" has its roots in Christian theology and early modern natural philosophy.[541]

The "priests of the new epoch" saw themselves in the image of God who was conceived as an engineer and architect. They envisioned a time "when every force in nature and every created thing shall be subject to the control of man."[542] The metaphor of genes as blueprints, or as Schroedinger analogized, "law code and executive

539 James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 342. I make a distinction between wanting to change the human condition and wanting to change human behaviour in specific contexts. The human condition is too large and complex to be understood and analyzed, which is why, as Scott illustrates, attempts to change it through large scale social engineering and other modernization projects (such as the green revolution) have failed. However, the desire to help others by supplying shelters for the homeless, building safe injection sites, better health care or other specific projects motivated by social justice and peace movements are aimed at changing specific contexts that have already been shown to have positive effects on people's health and behaviour. The difference does not lie in whether or not there are benevolent intentions; the difference lies in the scale.

540 Ibid., 321.

541 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 172.

542 Mechanical Engineer George Babcock quoted by Noble, Ibid., 95.

power…architect's plan and builder's craft in one,"[543] is extended to the notion of recombinant DNA technologies as "genetic engineering."

All atomic (and nano), chemical and genetic technologies illustrate the modernist obsession with splitting and rearranging the smallest particles possible in order to design and construct new forms of matter. But the dreams of the early modern natural philosophers such as Bacon were not limited to altering the organization of matter. Their dreams included a utopian vision of a form of social organization based on the same assumptions of precision, prediction, control, universality and perfection with which natural philosophers approached the organization of matter. The problem is that, as Toulmin, Leiss and Scott have all pointed out, epistemic and technical understandings of reality cannot account for the complexity of human behaviour and experience.

A common critique of social engineering projects is that they fail to take into consideration the complexity of social systems, human nature and interactions between people and their environments. Consequently the projects fail to function much less meet their utopian objectives. As Scott puts it, these projects "leave out essential elements" necessary for the proper functioning of a community.[544] Social engineering is conducted to meet a specific end, and there is a plan behind the project as in all forms of engineering. However, as Scott notes, such schemes invariably take into consideration only certain variables and factors, and there are always "contingencies beyond planners' grasp."[545] Winner expresses a similar assessment, stating "the excruciating subtleties of

[543] Evelyn Fox Keller, *Refiguring Life: Metaphors of Twentieth Century Biology* (New York: Columbia University Press, 1995), xiv.

[544] James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 351.

[545] Ibid., 334.

measurement and modeling mask embarrassing shortcomings in human judgment."[546] Winner suggests that we "must be humble" about these limitations, but for anything to change experts and policy makers must take these limitations seriously.

Nelkin and Lindlee observe that the continued attraction to reductionism, including genetic determinism, is that from a practical policy perspective, ignoring complexities makes for "institutional ease" and redefines issues and people so that they can be "managed."[547] Genetic determinism and its practical application in genetic engineering reflect the outdated dreams of rationalists. Understanding genes as deterministic agents "promises a reassuring certainty, order, predictability and control" of both human biology and social relations. In a time of uncertainty and risk, such promises are seductive. Not only, according to Nelkin and Lindlee, are these ideas seductive because of their "vague scientism" but also because of the attraction of their "potential for transforming the human condition and eliminating suffering."[548]

Political scientist John Grin lists several reasons why the promise of utopia has fallen out of favour.

a) The assumption that the world is controllable cannot be made.
b) A model of society based on the most recent scientific insights does not take into consideration that experts disagree.
c) Social problems cannot be reduced to scientific questions.

[546] Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 176.

[547] Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 165.

[548] Ibid., 31-32.

d) Human diversity cannot be denied, and the assumption that all will comply with an "ideal society" dreamt up be some cannot be made.[549]

Despite the fact that these issues as they apply to technology assessment and regulation are discussed in the social sciences, they are completely ignored by promoters of genetic engineering and sociobiologists who cling to a naïve and disturbing vision of the future. The first two points raised by Grin have been discussed in previous chapters because they relate to issues of certainty and disagreements among experts. I would like to focus on the latter two here.

The Reduction of Social Problems to Biological Questions

While many scholars in different disciplines bring attention to the limitations of scientific explanations of both human and non-human phenomena, sociobiologists and evolutionary psychologists have pushed in the opposite direction.[550] According to E.O Wilson,

> Scientists are nevertheless not accustomed to declaring any phenomena off limits, and recently there had been a renewed interest in analyzing...forms of social behaviour in greater depth as objectively as possible.[551]

As Nelkin and Lindlee point out, the language of objectivity (precise speech) in the rhetoric of genetic determinism "encourages the institutional use of genetic information

[549] Paraphrased from John Grin, "Vision Assessment to Support Shaping of Twenty-first Century Society?" In *Vision Assessment: Shaping Technology in the Twenty-first Century,* ed. John Grin and Armin Grunwald, 10 (Heidelberg and New York: Springer Berlin, 2000).

[550] Hilary and Steven Rose make three distinctions between sociobiology and evolutionary psychology in their introduction to *Alas, Poor Darwin* (New York: Harmony Books, 2000). First, they think evolutionary psychologists take a more aggressive stance concerning the role their view of human nature should play in social and public policy making. Secondly, unlike its predecessor, sociobiology, evolutionary psychology has become a part of university course curriculum in some psychology and anthropology departments. Thirdly, opposed to the 1970's when sociobiology was introduced, biological determinism is becoming more culturally acceptable.

[551] E.O. Wilson, "Human Decency is Animal," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 163 (Cambridge: MIT Press, 1994).

and discourages serious public scrutiny."[552] Critic of sociobiology Philip Kitcher agrees pointing out that the authority of the scientists propounding their views obscures the "unfounded speculations" and "socially harmful suggestions" of genetic determinism.[553] "When scientific claims bear on matters of social policy," Kitcher insists, "the standards of evidence and of self criticism must be extremely high."[554]

The logic that sociobiologists follow in bringing ethics and social problems into the biological arena is simply that all individual and collective human behaviour has a genetic basis and can therefore be understood and explained by reductionist biology. Similar to Descartes, who located the soul in the pineal gland of the central nervous system, the evolution of the "emotional control centres" in the hypothalamus and limbic system of the brain are of paramount importance for sociobiologists because they constrain and shape self-knowledge.[555] Because these systems evolved by natural selection, evolutionary biology becomes of paramount importance to ethical philosophers.[556] According to Wilson,

> The principal task of human biology is to identify and to measure the constraints that influence the decisions of ethical philosophers and everyone else, and to infer their significance through neurophysiological and phylogenetic reconstructions of the mind...In the process it will fashion a biology of ethics, which will make possible the selection of a more deeply understood and enduring code of moral values. [557]

[552] Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 164.

[553] Philip Kitcher, "Closing Arguments," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 189 (Cambridge: MIT Press, 1994).

[554] Ibid., 190.

[555] Philip Kitcher, *Vaulting Ambition: Sociobiology and the Quest for Human Nature* (Cambridge: MIT Press, 1985), 417.

[556] Ibid.

[557] E.O. Wilson, *On Human Nature* (Cambridge: Harvard University Press, 1978), 196.

While Wilson suggests that his approach is a complement to the study of cultural evolution in other fields, it will "alter the foundation of the social sciences."[558] One of the main critiques of sociobiology is that its assumptions allow for biologists to become experts on everything, psychology, sociology and philosophy. Philip Kitcher complains that sociobiologists feel that they can advance their theories of human freedom and morality "without considering what philosophers and other humanists have written on this subject."[559] These scientists think that, "on a wet Sunday afternoon," they can solve the problems that great thinkers throughout history have not been able to.[560] It is this hubris that gives them the faith that they can change and improve the human condition. However, what exactly the human condition or human nature is, is open to interpretation.

One of the assumptions of sociobiology is that human nature is predominantly aggressive, individualistic and competitive and that this must be controlled socially. If we want a more just and equitable society, we must change our instincts. For E. O. Wilson

> our primitive genes will therefore have to carry the load of much more cultural change in the future...genetic biases can be trespassed, passions averted or redirected, and ethics altered...to achieve healthier and freer societies.[561]

In other words, we are born sinners. Dawkins too, holds this view of humanity:

> If you wish, as I do, to build a society in which individuals cooperate generously and unselfishly towards a common good, you can expect little help from biological nature.[562]

558 Ibid.

559 Philip Kitcher, *Vaulting Ambition: Sociobiology and the Quest for Human Nature* (Cambridge: MIT Press, 1985), 395.

560 Ibid, 396.

561 E.O. Wilson, "Human Decency is Animal," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 175 (Cambridge: MIT Press, 1994).

562 Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 197 (Cambridge: MIT Press, 1994).

"We at least have the mental equipment," Dawkins concedes, "to foster our long-term selfish interests rather than merely our short-term selfish interests."[563] Redemption is possible, according to Dawkins, but only through mind and rationality and not through the inherently competitive, aggressive and selfish tendencies of the body and nature.

Understanding our species as inherently individualistic and selfish ignores the observation that not only are humans social, but, with very few exceptions, the family of primates is characterized by their social behaviour.[564] From an evolutionary perspective we are inherently social, and we have the capacity to create our social environment as a collective. Emile Durkhiem expressed this sentiment as "Human nature makes social life possible, but it does not produce it or give it its special form."[565] Human cultures are diverse in their forms of social organization. Even taking into consideration the ideological filters through which anthropologists observe and describe other cultures, a high degree of variation among cultures cannot be denied. Human beings are genetically far more similar than they are culturally. Our biology gives us flexibility in how we organize ourselves socially.

Marxist biologists Rose, Lewontin and Kamin take a far more sensible approach to human nature, by not opposing either the social and the natural, or rationality and biology:

> Our biology has made us into creatures who are constantly recreating our own psychic and material environments, and whose individual lives are

[563] Ibid., 222.

[564] Orangutans, for example, are solitary, but not because they are aggressive. They are quiet and gentle, making them attractive as pets (which is contributing to their endangerment in their own habitat).

[565] Emile Durkheim, "The Rules of Sociological Method," in *Classical Sociological Theory,* eds. C. Calhoun, J. Gerteis, J. Moody, S. Pfaff, K. Schmidt, and I. Virk, 124 (Malden MA: Blackwell Publishers Inc., 2002).

> the outcomes of an extraordinary multiplicity of intersecting causal pathways. Thus it is our biology that makes us free.[566]

These scholars are writing in response to sociobiologists such as Wilson and Dawkins. Both camps are trying "to point the way toward an integrated understanding of the relationship between the biological and the social"[567] but do so in different ways. For Rose, Lewontin and Kamin, ethics and free will are scientific issues because biological theories are ideological. Consequently, each theory is an implicit statement of what it is to be human and how we could (or for some should) be politically, socially and economically organized. The point for them is to illustrate the relationship between biological theories and political theories, not to insist that one should be used as a basis for the other. Sociobiologists, on the other hand, bring the discussion of ethics into science by framing it in Neo-Darwinian evolutionary theory. Everything is reduced to self-interest, self-preservation and perpetuation.

Levins and Lewontin ascribe the idea that the organism is alienated from its environment to Darwin's original evolutionary theory. Bourgeois economics also tends to ignore ecological principles, which are relevant to humans' relations with both their social and physical environments.[568] All organisms alter their environments, which in turn affect them. Ecology does not ignore heredity. However, one can describe, for example, the succession of different groups of organisms that occurs between a forest fire and the "climax" community that eventually creates the conditions conducive to having a fire without including any genetic details. One can assume that the whole structure of a

566 Steven Rose, R.C. Lewontin, and Leon .J. Kamin, *Not in Our Genes: Biology, Ideology and Human Nature*. (London: Penguin Books, 1984), 290.

567 Ibid.,10.

568 Richard Levins and R.C. Lewontin, *The Dialectical Biologist* (Cambridge: Harvard University Press, 1985), 9-11.

forest is written in millions of genomes if one wants to, but it is not necessary to understand ecological relationships. This is precisely why modern ecology can learn from the knowledge of traditional cultures, which contains the fruits of centuries of careful observation, experimentation, reflection and analysis, none of which required an intimacy with the details of modern genetics.

Rose, Lewontin and Kamin suggest, as do all critics of genetic determinism, that if we want to change our behaviour and become healthy, socially and physically, we should change our social environments and stop polluting our physical ones. This does not necessarily and automatically lead to cultural determinism. It is not contradictory to accept that hereditary diseases exist, but right now war, poverty and environmental degradation lead to far more illness and disability. Nor does this view require a rigid utopia or global social engineering project coming out of the minds of a few. We have no choice but to accept that there will always be unpredictability and a lack of certainty regarding the consequences of our actions. We know that we must change our consumption patterns qualitatively and quantitatively. The question remains as to whether we want to make changes as individuals and/or whether we have the political will to make changes collectively.

Changing Our Biology

The practical implication of the idea that we must change our biology in order to create a better society is eugenics. Natural selection is analogous to artificial selection. Nature is commonly understood as culling out and developing more fit, robust and efficient organisms as has been done in horticulture and animal husbandry by many human cultures. The question of what or who should exist and what qualities organisms (including humans) should or should not have are addressed by those carrying out breeding or genetic engineering programs. In the early twentieth century Eugenics was understood by some as a process of improvement to "the world's most valuable crop."[569] Regardless of whether the subjects are humans or corn plants, the basis of eugenics is "preventing reproductive uncertainty wherever possible."[570]

Genetic engineering perpetuates the dream of our species gaining divine powers of creation and control over nature. The desire for God-like perfection and control can be achieved by artificial reproduction such as tissue cultures, cloning, and embryo manipulation that *attempt* to decrease the role of chance and uncertainty. In this view, the womb should be a passive medium through which predetermined offspring are produced.

Some of the controversial technologies that are being used in the attempt to overcome reproductive uncertainty are genetic screening and *in vitro* fertilization. Genetic screening uses several of the tools also used in genetic engineering such as DNA probes and polymerase chain reaction (PCR) techniques and shares many of the same methodological uncertainties (see Chapter 3). For genetic screening, amniotic fluid, which contains fetal cells, can be sampled and can be "screened" for particular genetic mutations that are associated with the development of some diseases. While Down syndrome is always correlated with an extra chromosome, a disease like

569 Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 32. The authors are quoting lectures given by advocates of eugenics in the US in 1927. Hubbard and Wald also refer to this period as the "heyday" for Eugenics [Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 36].

570 David King, "Eugenic Tendencies in Modern Genetics," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, edited by Brian Tokar, 175 (London and New York: Zed Books, 2001).

hemophilia, which always involves a mutated blood clotting protein, can be linked to 115 different mutations in the protein's associated gene.[571] All screening methods carry some uncertainty and can only give probabilities whether a child will or will not have a disease associated with a genetic mutation.

Pre-implantation diagnosis is not currently in use but is in the process of being researched and developed. It would utilize both in vitro fertilization and screening methods. Several embryos are created outside the womb. When the embryos are at a six or eight cell stage, one or two cells are removed and are screened for genetic mutations. The parents then have a choice of which embryos to implant, based on the genetic characterization of these embryos. It is a matter of ongoing research and debate as to whether the removal of one cell will damage the embryo and affect its development.[572]

Pre-implantation diagnosis is a necessary step in the genetic engineering of human embryos or "germ-line therapy." Prior to implantation, an embryo is genetically manipulated for mutations that "require correction."[573] The gene therapy that is currently being used (as discussed in Chapter 3) is called somatic gene therapy and, unlike germ-line therapy, is only intended to correct protein production in the patient's body. It is not carried out to alter the genomes of the patient's potential children or grandchildren. Somatic gene therapy has led to deaths and serious side effects for reasons that are not

[571] Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 55.

[572] Ibid., 115.

[573] Ibid., 113.

entirely understood. That germ-line manipulation could be made into a predictable and safe therapy is highly speculative.[574]

Public support for eugenics does not require "an understanding or even an interest in heredity" because it addresses social interests and concerns.[575] It is socially determined ideas of perfection, frailties and weaknesses that serve as the foundation of eugenics, not the highly technical details of new reproductive and rDNA technologies. A eugenic society would be under the control of technicians, scientists and doctors, but with the compliance of the majority of the public. In the case of the new reproductive technologies, the desire for certainty that characterizes modern science translates into a desire for guarantees of healthy babies free of disease, disability or other disadvantages.

I have three main concerns about these technologies. The first one relates to the underlying assumptions of genetic determinism that justify them. Genes are critically involved in the creation of proteins, but because of post-transcription and post-translation processing, do not "code for" their structure and function entirely.[576] As outlined in Chapter 3, claims that genes can specify a disease, much less proteins are speculative. Claims that corrective genes can cure illnesses are also speculative and attempts to do so have caused deaths, cancer and disabilities.

[574] Ibid., 114. Currently *in vitro* fertilization has a twenty to forty percent success rate depending on the health and age of the mother. Combined with the uncertainty of screening and genetic engineering methods leads critics of GE to question whether pre-implantation diagnosis and germ-line therapy are worth the risks. See Sarah Sexton, "If Cloning is the Answer What is the Question? Genetics and the Politics of Human Health," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* ed. Brian Tokar, 167 (London and New York: Zed Books, 2001); and David King, "Eugenic Tendencies in Modern Genetics," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, edited by Brian Tokar, 177 (London and New York: Zed Books, 2001).

[575] Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 32.

[576] As discussed in chapter three, processes such as alternative splicing or the addition of molecules to a protein are carried out by enzymes and under cellular regulation, not regulation by the DNA molecule itself.

The second concern is that inherent to these technologies is the cultural predisposition to seek medical intervention in the form of biological and chemical manipulation as opposed to social and economic intervention.[577] In an era of brutal cutbacks to social and medical services in North America, external support for people, or parents with children, who have disabilities and illnesses is being eroded. Hubbard gives the example that a mother is seen to owe society a healthy baby, but society is not required to guarantee her or her child adequate housing and nutrition, which are absolutely crucial to raising healthy children regardless of how they are genetically endowed.[578] While many congenital and hereditary diseases are devastating to those carrying them and their families, poverty, malnutrition and pollution are social, economic and political problems, and their relationships to disease and illness, especially in the case of cancer, diabetes and infectious diseases, also must be addressed.

Third, the degree to which specialists mediate reproduction in our society is increasing with the development of recombinant DNA technology. This is a step towards creating a culture whereby scientists and physicians "become the managers of the medicalized society."[579] To suggest, as co-discoverer of the structure of DNA James Watson does, that "our fate is our genes"[580] puts our fate directly in the hands of those who think they understand how genes work and how to alter them.

[577] Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 195; and Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 60.

[578] Ruth Hubbard and Elijah Wald, *Exploding the Gene Myth: How Genetic Information is Produced and Manipulated by Scientists, Physicians, Employers, Insurance Companies, Educators, and Law Enforcers* (Boston: Beacon Press, 1999), 25.

[579] Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 195.

[580] Quoted in an interview by Leon Jaroff in "The Gene Hunt." Time 133, no. 12 (1989): 62.

Eugenics Old and New

Most critics of genetic determinism and genetic engineering make a distinction between the eugenic movements prior to WWII and contemporary eugenic ideals. The old eugenics was institutionalized. A set of standards and categories were created by experts and specialists, which were used to judge people on their "fitness." Based on their relative fitness they could be sterilized, incarcerated or not allowed to immigrate depending on the circumstances that brought them into contact with physicians or bureaucrats. Eugenics was embraced as a path to utopia and the perfection of our species. The early twentieth century eugenics lost popularity after WWII because of the general revulsion to the Nazi's application of its principles.

The old eugenics and notions of utopia focused on what a human collective should look like and how it should organize itself. The new eugenics, sometimes labeled "laissez faire eugenics," is much more individualistic and market driven. It is, however, as dangerous and destructive as the previous institutionalized form. Jeremy Rifkin calls the moral foundation of the new eugenics market based, leaving individual consumer choice as the organizing principle of society. He cites the standpoint of the editorial board of *The Economist* as an example.

> The proper goal is to allow people as much choice as possible about what they do. To this end, making genes instruments of such freedom, rather than the limits upon it is a great step forward.[581]

The notion of placing limits and initiating strict regulation of reproductive technologies is seen as an infringement of individual rights. Because we cannot predict what the

[581] Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World.* (New York: Penguin Putnam Inc., 1998), 144.

consequences of genetically manipulating humans will be, physically or socially, the "great step forward" is into the unknown.

As Beck expresses it, the new eugenics does not appear to be eugenics at all. This is because it is no longer "bureaucracies of oppression" that carry out eugenic ideals but rather technologies like genetic engineering that *appear* to be without violence, clinically neutral and free of ideology.[582] Advocates, physicians with good intentions or politicians promoting health, do not have to explicitly state or even believe in particular racial or social theories.[583] Despite all the references to choice and individual rights and freedom, Beck sees the promise of health and the arguments for curing diseases and guaranteeing healthy children "almost makes it impossible to decide against genetic technology."[584] How much of a choice is really involved? Brewster Kneen uses the term "moral blackmail" to describe the rhetorical tactics of proponents of genetic engineering that equate the opposition to the technology with opposing feeding the world or making people healthy. In both cases "the demand is global," Kneen writes, "but the appeal is individual."[585]

Rather than using incarceration, sterilization, or gas chambers, the new eugenics is based on our culturally highly valued notion of "choice," but at the core of eugenics is the desire to decrease the number of people with congenital and hereditary disorders. Amniocentesis, genetic screening and other forms of pre-natal testing, all of which lack certainty, are used in order to assess the sex and health of the child and predict possible

[582] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 97.

[583] Ibid., 98.

[584] Ibid., 100.

[585] Brewster Kneen, *Farmageddon: Food and the Culture of Biotechnology* (Gabriola Island, Canada: New Society Publishers, 1999), 17.

disabilities or diseases. In this way parents can decide whether they want to go through with the birth.

However, the choice is never "individual" inasmuch as doctors and specialists will give opinions, and social pressures and cultural assumptions will also influence the decision. Molecular biologist and editor of *GenEthics News* David King illustrates that the emphasis on parental choice is deeply flawed. First, he is disturbed with the practice of some obstetricians who refuse amniocentesis unless the woman agrees to a termination in advance.[586] Secondly, there is growing evidence that genetic counseling is directive and, not surprisingly, more so when parents have lower socio-economic backgrounds.[587] King refers to the conclusions of research to investigate the degrees to which genetic counseling can be directive and inconsistent, based on interviews, observations and recordings of actual genetic counseling sessions.[588]

One common argument for the application of eugenic principles is the cost of supporting disabled people. The disabled are seen as a burden on society and disabilities that require varying degrees of dependence are not differentiated. Within this perspective, parents who knowingly decide to have a child with a disability are much more easily held entirely responsible for the child, financially and emotionally, and may not be deemed worthy of social support.

Our society is fractured in its attitudes toward suicide, euthanasia and abortion, revealing that individual "choice" is more of a rhetorical tool than a social practice.

586 David King, "Eugenic Tendencies in Modern Genetics," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, edited by Brian Tokar, 173 (London and New York: Zed Books, 2001).

587 Ibid., 175; see Susan Michie et al., "Nondirectiveness in Genetic Counseling: An Empirical Study", *American Journal of Human Genetics* 60, no. 1 (1997): 40-47.

588 David King, "Eugenic Tendencies in Modern Genetics," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, edited by Brian Tokar, 177 (London and New York: Zed Books, 2001).

Choices are only allowed if mediated by physicians, specialists, counselors and other self-presumed experts on the human condition. Abortion and sterilization to prevent the birth of "defective" babies are examples of "negative" eugenics. Pre-implantation genetic diagnosis promises "positive" eugenics because parents do not only have the choice of whether a child is born, but which child. Any embryo found "defective" will be rejected. The embryos that are not chosen can be frozen and stored for future research use or discarded. As to whether this constitutes abortion associated with old eugenics is controversial and open to debate.

An easy distinction between "good" and "bad" genes is impossible. For example the gene mutation associated with sickle cell anemia is also correlated to resistance to malaria. As discussed in Chapter 3, the originally labelled "junk DNA" has been found to contain genetic elements that may be involved in the regulation of protein metabolism. We do not know enough, and may never know enough, to safely manipulate or eradicate genes judged faulty. We will undoubtedly create more problems than we think we are solving. Proponents of pre-implantation diagnosis usually do not include facts about the general limitations of genetic prediction or that more than half the attempts at *in vitro* fertilization are not successful.[589]

Instead of considering the quality of the world into which our children enter, eugenics embodies the opposite consideration. "We are entering a world where we have to consider the quality of our children" according to Bob Edwards, the embryologist who co-pioneered *in vitro* fertilization.[590] While some sociobiologists may have a vision of the

589 Sarah Sexton, "If Cloning is the Answer What is the Question? Genetics and the Politics of Human Health," in *Redesigning Life? The Worldwide Challenge to Genetic Engineering,* ed. Brian Tokar, 167 (London and New York: Zed Books, 2001).

590 Ibid., 164.

future and a concrete idea of what their ideal society is, it is not necessary for eugenicists to have any such vision. We merely need to fix our problems at the biological level, in the womb or outside of it, and society will spontaneously become better, without foresight or planning.

The Ideal Society[591]

My favourite attempt at envisioning a technological distopia is Aldous Huxley's novel, *Brave New World*, first published in 1931. The ubiquity of references to a "*Brave New World*" in the discourse on genetic engineering stems from Huxley's focus on biological technologies in the construction of his imaginary society. As he himself explains,

> The only scientific advances to be specifically described are those involving the application to human beings of the results of future research in biology, physiology and psychology. It is only by means of the sciences of life that the quality of life can be radically changed. The sciences of matter can be applied in such a way that they will destroy life or make the living of it impossibly complex and uncomfortable; but, unless used as instruments by the biologists and psychologists, they can do nothing to modify the natural forms and expressions of life itself. The release of atomic energy marks a great revolution in human history, but not (unless we blow ourselves to bits and so put an end to history) the final and most searching revolution. This really revolutionary revolution is to be achieved, not in the external world, but in the souls and flesh of human beings.[592]

[591] Please note that my entire examining committee suggested that I drop the next four sections, which constitute the remainder of the chapter. They are based on Huxley's *Brave New World,* which is "old hat." The references to the novel in discourse on genetic engineering relate specifically to the desire to biologically manipulate human beings. I wanted to bring attention to the fact that Huxley's novel relates to genetic engineering also as a critique of the social, cultural, economic and political context in which the desire for biologically manipulating humans is expressed. Instead of reducing this section to a couple of paragraphs, I have decided to give the reader a choice to continue or to skip these sections and go directly to my conclusion.

[592] Aldous Huxley, *Brave New World* (New York: Harper and Row Publishers Inc., 1969), ix-x.

Huxley had some prophetic insights. The last decade has experienced an explosion in the development and widespread use of psycho-pharmaceuticals, the refinement of psychological manipulation in advertising, the popularity of cosmetic surgeries, rapid advances in reproductive technologies and hundreds of gene therapy experiments. Writing in 1969, Huxley recognized how his 1931 novel resonated with the development of genetic engineering and its modernist milieu, but there is more that can be found in the novel of relevance to the eugenic threat behind applications of genetic engineering to human reproduction.

Reprogenetics

E.O. Wilson, who asserts that the social behaviour of all organisms has a genetic basis, suggests that we can alter human genetics in order to create ideal societies.[593] Furthermore, and as a justification of genetic manipulation, this process can occur in "bits and pieces."[594] Specializing in entomology, Wilson has a fondness for the social organization or, as he calls it, the "harmonious sisterhood" of ants and bees.[595] Indeed, there are similarities between colonies of social insects (Wilson's vision of the ideal society) and Huxley's vision.

First, reproduction is centralized. Communities of social insects have one mother, whom Western biologists label the "queen," who is fed, cleaned and entirely tended to as she produces hundreds of eggs. All members of an ant colony are sisters and brothers. Reproduction is also centralized in *Brave New World*, and all humans are test tube

593 E.O. Wilson, *On Human Nature*. (Cambridge: Harvard University Press, 1978), 208.
594 Ibid.
595 Ibid.

babies reared in laboratory nurseries. Each "batch" of humans destined for a particular social function are clones.

Second, the morphologically distinct "castes" of ant societies are not genetically distinct. Different batches of eggs are exposed to different pheromones and chemicals. The larvae then develop differently from each other and into what humans interpret as "soldiers," "workers," "drones" or future colony mothers depending on the function they are seen to serve in their miniature worlds.[596] That such distinct forms and different instinctual behaviours can be generated from practically genetically identical eggs is a fact that seems to be ignored by genetic determinists. While genetic engineering was outside of Huxley's prophetic grasp, the form of biological engineering used in the novel is the process of suspending embryos in various chemicals in order to enhance or stunt intellectual and physical development. In this way a hierarchical caste system was created. On top of this, the castes are brainwashed and undergo psychological treatment to ensure they stay in their socially defined boundaries. Huxley's version of biological engineering takes developmental biology and psychology into account and is more complex than the dream of sociobiologists to simply alter our genes assuming our psychology and sociality will merely unfold as determined by changes in the genome.

There are, however, important differences between ant colonies and any technologically mediated eugenic utopia. First of all, every colony has a mother and several fathers that fertilize eggs. As Noble traces through history, the early modern rationalists not only believed in "primordial masculine beginnings" but also that "women

[596] Sex can also be determined environmentally.

were a threat to the whole enterprise" of creating a rationally organized world.[597] In the current research and practice of new reproductive technologies, a great deal of control is conferred upon physicians, scientists and technicians. Regardless of whether the experts involved are male or female, the use of technologies in reproduction in order to predict and control the outcome of birth locates the womb as a site of uncertainty and potential social problems. (In *Brave New World*, the word "mother" is a cause of discomfort and embarrassment, perhaps like the use of "Gaia" in academic circles today). In Huxley's imaginary society all aspects of birth and parenting are carried out by technicians and supervised by scientists.

Secondly, while everyone is taken care of, meaning adequate food and shelter are provided in both social insect communities and *Brave New World*, power is not centralized in insect communities. Ensuring the maintenance of order in the eugenic society are senior technocrats of the "alpha" caste.

The diffusion of regulatory power and control in social insect communities, but also in many levels of organic systems from cells to ecosystems to the biosphere, is a difficult thing for reductionist biologists to grasp. Bees and ants are sometimes thought of as actually functioning as one organism because the individuals can only live as a tightly knit collective. We cannot discern an "alpha male" or pecking order in their communities. What we see is a division of labour where members may be morphologically different, but socially equal. Because of their ability to function collectively so beautifully, they produce intricate architecture in their hives and with ants, in particular, actually practice forms of agriculture and ranching.

[597] David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 219-220. See also David Noble's *A World Without Women: The Christian Clerical Culture of Western Science*, 1992 (New York, Alfred A. Knopf).

So ingrained is the notion of hierarchical power relationships as natural that determinists ascribe the rationality behind ant social order to genes which dictate their behaviour and responses. Without envisioning a command center issuing unidirectional orders, collective behaviour remains a mystery to reductionists.

Centralization and control over reproduction is thought to be necessary, in the minds of some scientists, in order to create a stable and predictable world. Molecular biologist Lee Silver prophesizes in his book *Remaking Eden, Cloning and Beyond in a Brave New World* that with the use of genetic engineering we will live in a world much like Huxley's novel. However, for Silver the main distinction between castes is not the qualitative differences between the biological manipulation of people, but rather whether they have been manipulated at all. He calls the two classes "Gen Rich," those who are "enhanced," and "Natural," those who have the misfortune of being naturally flawed and unperfected beings.

> All aspects of the economy, the media, the entertainment industry, and the knowledge industry are controlled by members of the Gen Rich class...In contrast, Naturals work as low-paid service providers or labourers...the Gen Rich class and Natural class will become the Gen Rich humans and the natural humans – entirely separate species with no ability to cross breed and with as much romantic interest in each other as a current human would have for a chimpanzee.[598]

While Silver is generous enough to include artists, musicians and businessmen in the Gen Rich class, without a doubt his ideas reflect the dream of rationalists throughout the modern period that "scientists would emerge as a new species and leave humanity behind,"[599] justifying the centralization of power in the hands of a scientific elite.

598 Lee Silver, *Remaking Eden, Cloning and Beyond in a Brave New World*. (New York: Avon Books, 1997), 4-7.

599 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 196.

It is important to note that Silver is neither alone in his ideas nor some marginalized crank.[600] Focusing on Christian scientists, Noble has found several geneticists who share Silver's dream. Emeritus professor of genetics at the University of Minnesota V. Elving Anderson justifies the use of genetic screening and gene therapy:

> The world does not need more humans, but perhaps it needs better humans, humans more disease resistant, genetically superior, more intelligent, sympathetic, moral and spiritual humans, better adjusted to and able to cope with their environment.[601]

For these scientists, it appears *Brave New World* is not a critique, but a template for designing (or engineering) the future of humanity. The way to this future is gaining control of heredity. "It is hard to find any legitimate basis for restricting the use of reprogenetics," Silver argues, "in a society that values human freedom above all else." [602] Besides being another example of emotional blackmail used by proponents of genetic engineering, Silver conflates the freedom to practice human genetic engineering (which is currently highly restricted) with "human freedom" in general. This is a rather large and arrogant conceptual leap.

600 The Board of Directors of the World Transhumanist Association (WTA) does not include any biologists, but is predominantly made up of academics in the fields of philosophy, sociology and computer science. Dr. Nick Bostrom, a philosophy professor at Oxford University, founded the association whose motto is "For the ethical use of technology to extend human capabilities." One of the declarations of the WTA is that

> Humanity will be radically changed by technology in the future. We foresee the feasibility of redesigning the human condition, including such parameters as the inevitability of aging, limitations on human and artificial intellects, unchosen [sic] psychology, suffering, and our confinement to the planet earth.

See the WTA website www.transhumanism.org.

601 David Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*, 98 (New York: Alfred A Knopf, 1997), 197. Remember that one of the lessons of evolutionary biology was that "A troop consisting of mainly smart monkeys is likely able to cope more successfully with the problems of the world around it than a neighboring competitor troop of stupid monkeys" [Verne Grant, *Organismic Evolution* (San Francisco: W.H. Freeman and Co., 1977), 360-1].

602 Lee Silver, *Remaking Eden, Cloning and Beyond in a Brave New World*. (New York: Avon Books, 1997), 9.

War and Stability

The highly rationalized social organization of *Brave New World* was developed in response to a long and brutal war. Huxley suggests that

> ...it is conceivable that we may have enough sense, if not to stop fighting altogether, at least to behave as rationally as our eighteenth century ancestors. The unimaginable horrors of the Thirty Years War actually taught men a lesson.[603]

The lesson was that for at least a hundred years in Europe after the war, politicians and generals showed at least some restraint in using "military resources to the limits of destructiveness."[604] This type of military restraint, Huxley continues, has not been exercised in the various wars of the twentieth century.[605] His interpretation resonates with Toulmin's interpretation of the rise of instrumental rationality stemming from the Thirty Years War,[606] and Leiss' observation that assessments of scientific and technological "progress" occur after every war.[607] In his analysis of the first conferences held by scientists on the safety of genetic engineering, Krimsky notes as well that the use of biological warfare in Vietnam had an impact on some scientist's perspective on the regulation of technological developments.[608] This historical tendency of re-evaluating society after war is reflected in Huxley's novel. The character of the "Controller" gives a short history lesson to a group of school children.

603 Aldous Huxley, *Brave New World* (New York: Harper and Row Publishers Inc., 1969), x.

604 Ibid. I would argue with Huxley that this restraint was not applied to various indigenous peoples "discovered" and consequently physically or culturally destroyed around the world during 18th and 19th century imperialism.

605 It could be argued that the limited use of stockpiled, chemical, biological and nuclear weapons in the 20th and 21st centuries are examples of restraint or it could be argued that stockpiling them is not a form of restraint considering their capacity for destruction and potential annihilation.

606 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 54-55.

607 William Leiss, *The Domination of Nature* (Montreal: McGill-Queen's University Press, 1994), 4.

608 Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy.* (Cambridge: MIT Press, 1985), 14-5, 340.

> The Nine Years' War, the great Economic Collapse. There was a choice between World Control and destruction. Between stability and...Liberalism...Every man, woman and child compelled to consume so much a year. In the interests of industry...Conscientious objection on an enormous scale. Anything not to consume. Back to nature.[609]

A whole series of dichotomies that have come to characterize modernity are reflected in the history of Huxley's fictitious society. The choices open to society are presented as romanticism or technocracy, nature or industry, destruction or control, and free will or stability and nothing in-between. E.O. Wilson goes as far as to suggest that this opposition is biological and not just an aspect of modern culture. In regards to "the two antipodal ideals of nature and machine, forest and city,"[610] Wilson suggests that

> the ambiguity of the opposing ideals was a superb strategy for survival...it enhanced the genetic evolution of the brain and generated more and better culture...Humanity accelerated toward the machine, heedless of the natural desire of the mind to keep the opposite as well.[611]

Within Wilson's perspective, regardless of whether it is destroying us, the machine wins out in the overwhelming Darwinian competition for the most robust social organization.[612]

In *Brave New World*, Ford was worshiped with the epithet "Our Ford" and in matters of psychology "Our Freud" was used. Freud thought that aggression is our "original, self-subsisting instinctual disposition."[613] As to whether "cultural development [will] succeed in mastering the disturbance of communal life by the human instinct of

609 Aldous Huxley, *Brave New World* (New York: Harper and Row Publishers Inc., 1969), 32-33. In the text several conversations are happening at once, but I only quote the speech by the Controller.

610 E. O. Wilson, *Biophilia* (Cambridge and London: Harvard University Press, 1984), 12.

611 Ibid, 13.

612 I disagree that accelerating towards the machine is a species trait. In order to "modernize and civilize" peoples of animistic cultures around the world, colonizing cultures committed genocide, took away their lands and way of life, broke their spirits, persecuted their healers and institutionalized and raped their children. It actually took a great deal of violence to destroy their relationships with nature.

613 Sigmund Freud, "Civilization and its Discontents," in *Classical Sociological Theory*, eds. C. Calhoun, J. Gerteis, J. Moody, S. Pfaff, K. Schmidt, and I. Virk, 273 (Malden, MA: Blackwell Publishers Inc., 2002).

aggression and self destruction," he did not know.[614] This view of human nature justifies the perceived dichotomy between world control and destruction.

Like Bauman's observation of contemporary society, life in the *Brave New World* is "organized around consumption."[615] The only option is to live on a reservation like the "savages." The characterization of the reservations is analogous to what pre-modern has come to represent in the minds of many rationalists: superstitious, backward, archaic, and irrational. Huxley makes use of the modernist assumption that there are only two choices for cultural development. These are, as Latour describes them, "disembodied rationalism" or "over-embodied irrationalism."[616]

The novel is shadowed by a dark fatalism that there are not any options available to humanity as a way out of the destructive and dehumanizing tendencies of modern industrialism. The reservations, modeled after colonized North American First Nations people, represent cultures that have been damaged by modernity and then excluded from participating in it in any respectful or democratic ways. In the novel, and I also think in reality, reservations have become anthropological zoos, separated social environments that remind modernity's chosen ones that history took a turn in the right direction in embracing industrialism and technological "progress."

Perhaps influenced by the cultural changes and attitudes of the 1960's, Huxley reconsiders the fatalistic choices presented in the novel. There is a third choice, he suggests, that lies in the decentralization of science and technology and their use in

614 Ibid, 279.

615 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 76.

616 Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 13.

more socially just ways.[617] Langdon Winner discusses the growing movement of hope in "appropriate" and "alternative" technologies in the sixties and seventies that was spawned by "uneasiness with the modern condition."[618] Unfortunately, as both Winner and Bauman observe of Western culture, our tendency to conflate abundance with freedom produces a corollary notion, that limiting industrialism and regulating technological development is oppositional to both freedom and progress.[619] Modern life is organized around consumption (much like *Brave New World*). Consequently, the appropriate technology movement, despite its original intent, came to encourage consumerism by merely providing showcases of products. The "American motto," as Winner calls it, that inventions will change the world, kept the desire for change in a technological context instead of inspiring alternative economic or social systems.[620]

The technological and eugenic society of *Brave New World* was constructed in response to war, disagreement and conflict. The founders of the new world eradicated conflict by enforcing homogeneity and standardization. For the founders, consensus must be established because the hegemony of instrumental rationality does not have an effective method of dealing with conflict, other than, as the history of science illustrates, ignoring it or repressing and ostracizing rebels. First, alternative theories to, and critics of, the dominant view exist in every period of history. Second, alternatives and critics are necessary for intellectual, social and political development. Third, the history of science

617 Aldous Huxley, *Brave New World* (New York: Harper and Row Publishers Inc., 1969), xiv.

618 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 67.

619 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 76; and Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 104.

620 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 73, 70.

shows that many heretics and rebels are eventually vindicated by the conventional wisdom they challenged. If these aspects of history are not critically reflected upon, then neither will alternative responses to unavoidable conflicts and disagreements be explored.

The caste structure In *Brave New World* is created by the production of clones, each caste being constituted by "batches" of biologically altered humans. While everyone is brainwashed to conform to social demands, each caste received specific instructions as to how to conform to their caste. The underlying assumption is that homogeneity is necessary for social stability even if it requires biological and psychological manipulation to achieve. This assumption is a modernist one. Bauman observes that the definition of "community" in contemporary modern society is a social group that is homogeneous, and that unity can only be achieved through similarity.[621] "Civility" and living with differences on a day-to-day basis is much more difficult than not.[622] One of Kitcher's critiques of sociobiology as a framework for ethics is that it is "completely insensitive" as to how to deal with individuals with competing interests[623] and "lacks any theory of resolution of conflicts."[624]

In the novel, those members of society who were "too self-consciously individual to fit into community life" or who were not "satisfied with orthodoxy" were sent away to an island.[625] On this island people were allowed to seek truth according to the ideal of scientific research. This may seem like a contradiction in a technological society.

621 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 168, 181.

622 Ibid., 104.

623 Philip Kitcher, *Vaulting Ambition: Sociobiology and the Quest for Human Nature* (Cambridge: MIT Press, 1985), 431.

624 Ibid., 433.

625 Aldous Huxley, *Brave New World* (New York: Harper and Row Publishers Inc., 1969), 154.

However the character of the Controller explains, “we can't allow science to undo its own good work. That's why we so carefully limit the scope of its researches.”[626] Just as the findings of the human genome project and genetic engineering research falsify the reductionist theoretical foundations that justified this research project in the first place, new and contradictory research might require fundamental cultural, social, economic and political change.

The problem with the desire to change the human condition is that first of all, unanimity on what the human condition is does not exist. Secondly, these views may change with time. Thirdly, our environment is not static. Wanting to “improve the human condition” assumes that either the world is stable and static or that we can maintain its stability in the face of potential changes.

The stability and equilibrium of the *Brave New World* is illusory, and, in fact, modernity is characterized by rapid change, instability and uncertainty. But the morality of industrial society embodied in our attempts to dominate and control nature is not changing, or at least nowhere near fast enough to change the direction in which we are heading – a place too polluted and poisonous for humans to inhabit. The synergy between the technological and social changes that we experience today serves to maintain and perpetuate, not change, the assumptions of modernity. Technological change is a conservative force. “Everything will stay the same and so we slide into a new society,” Beck comments on the drive for “constant innovation.”[627] Bauman justifies his description of contemporary modernity as “fluid” as opposed to early modernity that

626 Ibid., 155.

627 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 41.

was "solid," saying, "fluids are easier to shape than maintain."[628] Fluids change their form not their essence.

In comparing *Brave New World* and George Orwell's *1984*, Bauman notes that while the two worlds of these novels are opposed in their visions of future society, they are both tightly controlled by "supreme command offices."[629] In both novels supreme command is reified into one character who is the only one who knows the suppressed history and "truth" about their society. The "fears of their time," as well as the hopes, revolve around centralized power and control. During the "solid" modernity in which Huxley and Orwell lived, Bauman continues, Fordism and industrialism, accumulation and regulation "towered over living experience." This is reflected in Huxley's critique of capitalism and Orwell's fear of socialism.

The Significance of the Factory

The post war society of *Brave New World* is modeled after the ideal of Ford, and in fact the characters worship Ford. The Controller cited above is also called "his Fordship," and instead of uttering exclamations like "good Lord!" they say, "good Ford!" Fordist ideals influence the society of *Brave New World* in two ways. One is that, like science in our world, the history of humanity before the new society is repressed, and the other is that the society is modeled after a factory.

Ford's dictum that "History is bunk" is repeated with reverence by characters in the novel, and indeed their society is built upon a shallow story of the past. Their history is split into two periods, Before Ford and After Ford. In biology, especially sociobiology

[628] Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 8.
[629] Ibid., 53.

and Neo-Darwinism, there is a similar relationship with Darwin. Famous evolutionary biologists such as John Maynard Smith insist that all biologists "must start with Darwin" because he gave us "the only coherent biological theory we have."[630] But Darwin's theory is more than a biological theory; it is a theory of what it is to be human. Richard Dawkins asserts

> We no longer have to resort to superstition when faced with deep problems: Is there a meaning to life? What are we for? What is man? After posing the last of these questions eminent zoologist George Gaylord Simpson put it thus: "The point I want to make now is that all attempts to answer that question before 1859 are worthless and that we will be better off if we ignore them completely."[631]

The eugenic societies proposed by some biologists - and which are justified by the ideas of sociobiologists and "evolutionary psychologists" - are all based on a theory of evolution by natural selection. Their brave new world would "start" with and worship Darwin instead of Ford, or maybe both.

The social organization in *Brave New World* is based on a factory model. Bauman characterizes "solid" modernity as using the Fordist factory as a "metaphorical frame for human reality" in both capitalism and communism and on all levels: global, social and individual.[632] It is a metaphorical frame for biology as well.

> Since every recombinant mutant is a potential protein factory, the economic rights to these organisms became a primary concern to industrial and academic institutions.[633]

Similarly for Dawkins:

[630] John Maynard Smith, "The Way Forward," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 238 (Cambridge: MIT Press, 1994).

[631] Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 196 (Cambridge: MIT Press, 1994).

[632] Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 57.

[633] Sheldon Krimsky, *Genetic Alchemy: The Social History of the Recombinant DNA Controversy*. (Cambridge: MIT Press, 1985), 204.

> I prefer to think of the body as a colony of genes, and of the cell as a convenient working unit for the chemical industries of the genes.[634]

The cell can be both a factory and a society with a rationalized division of labour. For example in The *Complete Idiots Guide to Decoding Your Genes*, in a section titled "Learn about the mini-machinery inside your body," the authors give "job descriptions" for the main organelles of cells.

Cell Parts	**Job Description**
Cell membrane	Security guard: checks what goes in and out of the cell
Endoplasmic reticulum	Highway from the membrane to the nucleus
Ribosomes	Protein factories
Golgi apparatus	Storage and packaging center; stores or sends new protein traveling; "customizes" new proteins too
Lysosomes	"Demolition workers"; break down unwanted materials
Mitochondria	Powerhouses; generate energy for the cell
Nucleus	The "brains" or control center of the cell...[635]

To have control of the brains of the operation, as genetic engineers believe they have, is to have control over the modernized factory-society of the cell. In their critique of genetic screening, Nelkin and Lindlee interpret the suggestion that children who are

634 Richard Dawkins, "The Selfish Gene," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 215 (Cambridge: MIT Press, 1994).

635 These are truncated versions of their descriptions [Linda Tagliaferro and Mark V.Bloom, *The Complete Idiots Guide to Decoding Your Genes* (New York: Alpha Books, 1999), 47.].

"predisposed to criminal behaviour" should be isolated and subjected to genetic surgery as treating them "like defective cars recalled to the factory.[636]

In the *Idiot's Guide*, the factory is a double metaphor, where the cell is analogized to a society that is analogized to a factory. Despite the insistence of many Neo-Darwinian biologists that ethics, morality and politics are separate from nature, Neo-Darwinian sociobiologists take their template of the ideal society from nature, but only those aspects of nature that they interpret as having an instinctual (genetic) rationalized division of labour.

Scott sees a tragedy in the desire to change the human condition because it has led to social engineering experiments that have failed.[637] The desire to change agriculture and medicine with genetic engineering has also led to experiments and applications that have failed. There is a tragedy in the desire to change nature. The complexity of nature lies beyond the limits of theories and analogies. To combine social and genetic engineering is to combine their failures and magnify their tragedies.

636 Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 158.

637 James C. Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed.* (New Haven and London: Yale University Press, 1988), 342.

CONCLUSION:

GENETIC ENGINEERING AND THE PARADOXES OF MODERNITY

Based on the idea that the whole and its parts undergo similar developmental processes, Freud asks the question as to whether an "entire civilization can be neurotic" in ways parallel to the individual.[638] Like many other scholars, he points out that analogies between wholes and parts are both useful and dangerous.[639] The danger is in the tendency to both reify analogies as well as assume a causal relationship between the objects of comparison. To suggest that an entire civilization can be neurotic does not necessarily imply that it is the singular *cause* of psychological pathologies, but rather that it creates the conditions under which these illnesses take their form.

One common analogy is the comparison of modernity, and specifically capitalism, to cancer. They are both characterized by unregulated and uncontrolled growth. The highest rates of cancer are among industrialized nations largely due to the physical stresses of industrial labour, air and water pollution and the over-consumption of poor quality food the majority of which is contaminated with pesticides, herbicides or loaded with hormones. Modern industrialism creates the conditions that increase the

[638] Sigmund Freud, "Civilization and its Discontents," in *Classical Sociological Theory*, eds. C. Calhoun, J. Gerteis, J. Moody, S. Pfaff, K. Schmidt, and I. Virk, 278 (Malden, MA: Blackwell Publishers Inc., 2002).

[639] Ibid., 279.

probability of getting cancer, but it cannot account for predispositions and variations among individuals.

There are psychological stresses that come with modernity as well. Zygmunt Bauman suggests, "living among the multitude of competing values, norms and lifestyles is hazardous and commands a high psychological price."[640] The illness of society, Bauman continues, is different from the illness of individuals because we do not know how to diagnose social illness, nor do we know how to cure it. The modernist tendency to "focus on the individual" means that the collective is ignored and "left to its own fate."[641]

While not developed as a full argument, Anthony Wilden and Ulrich Beck both use mental illness as an analogy to describe aspects of modernity. Wilden characterizes academic faculties as "schizophrenic wards." Similar to Bauman's description of the psychological price to be paid for modernity, Wilden likens the "contradiction of values" and the disassociation between what scholars say and do to a state of schizophrenia.[642]

Ultimately, the scholarly realm cannot be separated from the larger cultural and social matrix of which its members are a part, and as such, suffer's from similar problems. Beck also describes the process of "words and deeds separating and marching in opposite direction" as "political schizophrenia."[643] While politicians promise, and many believe that it is possible, to maintain rapid and unregulated technological

640 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 213.

641 Ibid., 213-4.

642 Anthony Wilden, *System and Structure: Essays in Communication and Exchange,* 2nd ed. (London: Tavistock Publications, 1980), lii.

643 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 45-46.

development and commercialisation while protecting the natural environment, these two desires are in reality inherently oppositional.

"Progress" Bauman states, "is a notion that does not take history into account."[644] Schizophrenia is a mental illness that is characterized by a lack of psychic integration such that reactions to situations are highly inconsistent and easily contradict past behaviour. The fragmented self has a shattered memory and consequently, the individual is often unable to make connections between events that occur at different times and places. Even if the relationship between an action and its consequence is understood intellectually, the fragmented self lacks the integration to respond emotionally.[645] At other times the person becomes incomprehensibly hysterical. Aspects of this illness have been normalized in the modern Western world.

According to Beck, the inability to make connections between our actions and their consequences because we are "reduced to the moment" and not connected to the past or future is leading us down the path of ecological destruction.[646] We have become disassociated from our environments and ourselves. Bauman as well characterizes the experience of modernity as "instant living," where "we want to forget about the past and no longer believe in the future."[647] "Rational choice in an era of instantaneity" results in the pursuance of gratification while avoiding the consequences."[648] This is neither psychologically nor ecologically healthy.

644 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 132.

645 The definition and specific characterization of schizophrenia are far from agreed upon. This description is based on a mixture of reading various clinical descriptions and personal observation.

646 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 14.

647 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 123,128.

648 Ibid., 128.

Gregory Bateson uses the concept of the "double bind" to explain the schizophrenic state. He defines a double bind as a demand that a variable be increased to meet the demands of one stress, but simultaneously decreased to meet the demands of another stress.[649] The double bind is one form of stress inducing state that I find to be an apt characterization of the modern relationship between technology and our ecological commons, where technological solutions for the problems caused by past technologies come with their own set of problems. The experience of technological binds and paradoxes occurs on both the individual and collective level.

As individuals, we experience a tension between the realities and stresses of "earning a living" while striving to live in a more sustainable fashion within our environment.[650] It is not just our "use" of modern technologies that creates the tension, but the fact that they are so deeply integrated into our cultural and social systems. The degree to which our society is dependent on vehicles and information technologies, for example, make it difficult to envision a form of modernity that does not have them or even a personal lifestyle that does not require them.

The damage caused by oil extraction and production, the use of dams for electricity, the deforestation necessary for wood and paper production or the widespread use of fertilizers and chemicals in food production is a burden in industrialized countries that requires these industrial activities to maintain their way of life. Our growing knowledge of the consequences of our consumptive behaviour patterns is not being

[649] Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 209-210.

[650] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 37.

balanced by an appropriate and widespread change in these patterns. Our words and deeds march in different directions as they do in a schizophrenic state.

Many citizens are not aware of the degree of their involvement in the development of problematic products of modern biotechnology either by consuming genetically modified food, additives and drugs or by the amount of their taxes that go to supporting research and commercialisation. In regards to the collective, it is a source of pride for many citizens, not just politicians, that their *nation* maintains its "global competitiveness."[651] Within this perspective, if we don't continue to expend money and resources to keep ourselves on the forefront of medicine, agriculture, space exploration, communication and, now, bio and nano-technology developments, we will fall behind. We will become losers. In a culture where, as Wilden expresses it, "the metarule of competition constrains all other rules,"[652] it is easy to understand why constant technological innovation, regardless of the risks and hazards, is met with support rather than critical reflection. Political stability, according to Beck, is maintained by not encouraging thinking about the incommensurability between environmentalism and modern capitalism.[653] Instead, ever more destructive behaviour is normalized.

There are four paradoxes based on the privileging of the individual, the question of liability, the desire for certainty and changing definitions of property that characterize the schizophrenic aspects of modernity embodied in genetic engineering.

651 Ibid., 37.

652 Anthony Wilden, *System and Structure: Essays in Communication and Exchange,* 2nd ed (London: Tavistock Publications, 1980), lvi.

653 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 85.

Politics that Does Away with Politics

Latour suggests that modern "definitions of nature, society and the Body Politic were all produced together in order to create the most powerful and paradoxical of all power," and he describes it as "a politics that does away with politics."[654] In order to create a stable and equitable society that does not "fall into inhumanity" characterized by fundamentalism, brutality and war, Latour explains - and herein lays the paradox - we need to mimic the "inhumane laws of nature."[655] The laws of nature are "inhumane" for two reasons. One is the separation of the natural and the social that has characterized a dominant trend in Western philosophy. Second, the methodological approach of orthodox modern science is disembodied. What makes us human, our senses, our emotions and our subjective experience of our environment and ourselves is seen as an impediment to understanding reality. The modernist view is that only through disembodiment and disassociation can truth, or the laws of nature, be accessed.

For Latour, the fear of mob rule and the fear of uncertainty are connected. For those who fear it, we not only need not, but *should* not, exercise citizenship by engaging in democratic processes in order to make important decisions about where our society is heading. Beck makes this observation as well, specifically in regards to modern technologies. Politics is not the "central locus" where decisions about our collective social future are made, but rather individual consumer choice.[656]

[654] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies.* (Cambridge: Harvard University Press, 1999), 293.

[655] Ibid.

[656] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 74.

The paradox lies in the fact that while deregulation and privatisation are thought to promote personal and individual freedoms by some sectors of our society, they erode collective will and power by fragmenting them. The process of individualization, according to Bauman, "destroys the tools to implement its objectives," and in reality is actually an obstacle to autonomy and emancipation.[657] In a complete inversion, the necessary conditions of emancipation, dense social bonds and solidarity, are seen as the "obstacles."[658] Beck characterizes the relationship between equality/self determination and "progress" as inherently contradictory.[659] Like the automatons in the brave new world of Huxley, citizens are redefined by their role as individual consumers.

The implications of the new reproductive technologies are not seen as having eugenic implications by many of the proponents of these technologies. The old eugenics is understood as taking away individual choice, whereas these new technologies are seen as giving parents and society as a whole greater individual choice and freedom. However, these technologies require that decisions about which child or what kind of child be born and to whom be mediated by technicians, physicians and specialists. They become, as Nelkin and Lindlee call them, "managers of a medicalized society."[660] As critics of recombinant DNA reproductive technologies point out, the choice not to use these technologies becomes difficult. Jeremy Rifkin observes that while consumer choice appears benign, proponents of these technologies make it seem as if it is "cruel

657 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 52.

658 Ibid., 14.

659 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 74.

660 Dorothy Nelkin and M. Susan Lindlee, *The DNA Mystique: The Gene as Cultural Icon* (New York: W.H. Freeman and Company, 1999), 195.

and irresponsible not to let [these technologies] eliminate genetic disorders."[661] Beck as well suggests that the promise of healthy babies "makes free will slippery" by making it almost "impossible to decide against genetic technology altogether."[662] Such a decision is made to appear irrational and irresponsible. In the name of expanding free choice, the technology pushes society in the direction of eliminating such freedom.

A Morality that Does Away with Morality

The risks and contradictions posed by modernity are socially produced, but the duty to deal and cope with them is individualized.[663] Unfortunately, there are limitations to individual solutions to systemic and collective problems. One consequence is that we suffer from enormous gaps in liability and responsibility for widespread and long-term ecological damage created by industrial activity. It is difficult to ascribe blame. Bateson suggests that

> Rather than point the finger of blame at one or another of the parts of the whole system – the wicked doctors, the wicked industrialists, the wicked professors – we should take a look at the foundations and nature of the system itself.[664]

Because of the hegemony of reductionism, determinism and individualism, we simply do not know how to hold a collectively produced system accountable for its consequences. That a particular group of people, cannot be wholly held morally

[661] Jeremy Rifkin, *The Biotech Century: Harnessing the Gene and Remaking the World.* (New York: Penguin Putnam Inc., 1998), 139.

[662] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 100.

[663] Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 34.

[664] Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 295.

responsible for the suffering and damage caused by their activities is in itself a moral position, a form of morality that does away with morality.

"The greater the threat," Beck points out, "the less society is insured."[665] Herein lies the problem. With the introduction of new and powerful technologies like genetic engineering comes a greater need for insurance, protection and compensation for personal, environmental and economic damage, but such insurance simply does not exist and may, in fact, be impossible.

The whole notion of insurability is difficult to apply to the potentially apocalyptic consequences of atomic, chemical and genetic technologies. The logic of insurance requires strict rules of causality, which in turn necessitates finding an isolatable culprit (whether a particular corporation or a specific technology) to be held responsible. These criteria are impossible to apply to global environmental damage. However, even though limiting, strictly regulating or banning the application of destructive technologies would definitely be a start, if not a complete solution to reducing health hazards and ecological damage, demands for such precautionary actions are seen as nay-saying, doomsdaying and Luddite. Beck cynically describes the dominant reaction to calls for precautionary action "please protect the toxins from the people that are threatening them."[666] Bateson makes the same observation and labels it "making the world safe for the pathology."[667]

As many scholars have noted in regards to modern technologies, the burden of proof of safety and risk is inverted. Technologies are largely seen as innocent until proven guilty. Those who profit from technologies, who tend to conduct small-scale and

665 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 22-3.

666 Ibid., 92.

667 Gregory Bateson, *A Sacred Unity: Steps to an Ecology of Mind*, ed. Rodney E. Donaldson (San Francisco: HarperSanFrancisco, 1991), 296.

short-term studies, are currently required to assess the safety and other consequences of their innovations. Beck describes asking scientists (entrepreneurs) to prove their research (products) harmless as analogous to asking a suspected thief to pass judgement on his or her robbery.[668] This is not just irrational. It is hazardous.

A Science that Does Away with Science

Modern science is characterized by the adoption and dominance of the Platonic ideal of disassociating abstract theories from experience and the corruption of the senses.[669] We have had centuries to prepare for the separation between what we think, believe and say, and what we actually do. This is the primary reason the analogy of schizophrenia is invoked. Reductionist modern science has become so fragmented, specialized and alienated from living practice that it no longer follows the rules that it began with. “Science said goodbye to its logic,” says Beck, as the cornerstones of scientific rationality and methodology – repeatability and fallibility – are not applied to risk and safety assessment.[670] The problem, for example, with nuclear reactors is that theories regarding the safe operation of the technology can only be tested after it has been constructed.[671] This problem applies to field trials of genetic engineered crops as well.

First, there are too many uncontrolled variables in open experiments to be able to recreate them. In the case of genetically modified crops, the weather during the growing

668 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 105.

669 Steven Toulmin, *Cosmopolis: The Hidden Agenda of Modernity* (New York: The Free Press Macmillan Inc., 1990), 21-9.

670 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 106.

671 Ibid., 104.

season simply cannot be controlled. It can take years before it is observed how GMO's respond to different conditions. The widespread introduction of GM canola is an example of "production as research," an experiment that not only cannot be repeated, it cannot be undone, a critical issue that leads to the next part of the problem.

Second, the experiment itself has consequences that may be hazardous. While Monsanto and the Government of Canada have decided not to commercialise genetically modified wheat, field trials have been conducted in various parts of Canada. However, exactly where these trials have taken place and for how long is not a matter of public record despite demands by farmer's associations and even local politicians (an example of saving toxins from the people threatening them). Even though wheat is not as promiscuous as canola, having been released into the environment, it is impossible to guarantee that GM wheat genes have not been integrated into the collective wheat gene pool. Genetic material cannot be contained. Even risk assessment of genetic engineering leads to a bind. One has to introduce the products of genetic engineering into ecologies and bodies before certain risks can be uncovered. But the experiment itself could have destructive effects, as has been the case with gene therapy trials. While this point of view justifies a ban on field trials, I also think that it is debatable whether research trials conducted in greenhouses or other containment facilities can properly assess the safety of releasing GMO's into uncontrolled environments. This is not to say that contained experiments would not be useful.

Conducting contained experiments of GM crops would provide more evidence for illustrating how inherently hazardous genetic engineering is. The few feeding trials of genetically engineered foods to rats have shown that eating genetically engineered foods can be a health hazard and they do warrant more detailed study. However, the question remains open as to whether the results of the feeding trials thus far warrant policy changes such as mandatory labeling of foods containing GM products. As to how much evidence is required for labeling, or limiting the future commercialization of GMO's or banning GM crops altogether has not been agreed upon. How much research is enough and who decides?

This question not only applies to political action but to "paradigm shifts" in science as well. Thomas Kuhn has observed of "dominant paradigms" in the history of science contradictory evidence accumulates before they are radically altered or replaced. For example, scientists have been aware that the viral vectors used in gene therapy *could* insert themselves close to a cancer-promoting gene but thought that the chances were small because they presumed that viruses would land in random locations. Insertion close to or inside a gene could disrupt cellular metabolism in unknown ways and, if the insertion affected the regulation of cell growth and division, could cause cancer. With the discovery that viruses integrate themselves inside genes more than half the time researchers concluded that the health risks of gene therapy are "much higher than what we thought before." [672] While early critics of gene therapy may be vindicated, the conclusion of some of the researchers is that "rather than doom gene therapy," these findings "could provide clues to finding or designing safer viruses."[673] In this view, gene therapy itself is not being questioned, nor is the theoretical framework that led to the presumption than the chances of viral integration into genes were small.

The repeated failures of GM crops and unpredictable and variable results of genetic engineering experiments and trials motivates a refining of the method, not a

[672] Andrew Pollack, "Cancer Risk Exceeds Outlook in Gene Therapy," *New York Times*, June 13 (2003): A29.

[673] Ibid.

questioning of its theoretical foundations, and genetic determinism and reductionist biology remain dominant. This the third aspect of how "science does away with science." Genetic determinism is currently immune to falsifiability.

Fourth, despite the promise of greater certainty, safety, security and predictability coming from proponents of scientific and technological developments, the world is becoming less certain, less safe, less secure and less predictable. The paradox lies in the fact that desire for greater certainty through technologies like genetic engineering actually creates the conditions for its opposite.

While Beck illustrates this bind by focussing on our exposure to atomic and chemical technologies, Bauman makes the same observations in regards to everyday life in the modern condition. I do not think that it is just the specific consequences of particular technologies or the growing lack of job security or high divorce rates that are ecologically or psychologically hazardous. Rather, as Ivan Illich expresses it, it is the "monolithic, bureaucratic and expert centred" mode of organization itself that is "hazardous."[674] In the case of genetic engineering it is the relationships between life science corporations, university scientists and government regulatory agencies operating within a technophillic culture of expertise that is as much a problem as the technology itself.

Private Property that Does Away with Private Property

In the nineteenth century wealth production generated antagonisms between capital and labour. However, in the twentieth century, "systematic chemical, nuclear and

[674] Ivan Illich in *Medical Nemesis* quoted in Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 141.

genetic threats" have created "polarizations within capital and labour that cut across the social order."[675] Modern industrialism has developed to a point where pollution from one industry affects the economic existence of another. Through over-consumption, industries erode their own foundations.

Global capitalism is in the process of destroying itself and taking a great deal of the environment, and consequently human health, down with it. The Government of Canada and Monsanto's decision not to introduce GM wheat is not based on technical risk assessment, the opposition of wheat farmers, organic growers, environmental groups or the findings of public opinion polls. There was simply not enough of a market for it. As long as some of Canada's trading partners insist on labelling GM food, and as long as their citizens refuse to buy it because it is genetically modified, the government will likely conclude that we simply cannot afford to lose overseas wheat markets to the extent we lost our markets for canola. Markets regulate the introduction of technological innovations.

In the precedent setting case of Monsanto versus Percy Schmeiser, the farmer was held responsible for having GM canola (unintentionally) on his fields without Monsanto approval, despite the findings of how fast GM canola became a weed on the prairies. The Supreme Court of Canada's decision illustrates that intellectual property in the form of patents on genes are being given greater privilege than private property in the form of a family's farmland and a seed developer's enterprise. A gene, as explored in Chapter 3, is a concept used to explain how matter reproduces itself at particular moments within particular contexts. Genes are not isolatable, stable and solid entities.

[675] Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 28.

The fact that our courts found the ownership of a transitory biological moment more important and worthy of protection than the integrity of a family's farmland contaminated with unwanted and market threatening genetic pollution developed and released by corporate agri-business illustrates that our abstractions have become more real than our physical senses and our moral sensibility. This is what it means to have a mental illness.

All that Is Solid Melts into Air

These problems and paradoxes stem from the friction, tension and inconsistencies between what some scholars identify as early and late modernity. The condition of the latter is not made comprehensible by the former. Beck makes the distinction between early and late modernity specifically in regards to the logic of risk. "Modernization," he explains, "bursts the categories and the paths of industrial society that itself created."[676] For example, as discussed previously, he points out the difficulties of applying the concept of insurability, which necessitates an illustration of a causal relationship between an event and its consequences, to the widespread and long-term synergistic effects of modern technologies on human and environmental health. Bauman explains the difference between early or "solid" modernity and its later more "fluid" phase. The phases of modernity, like water and ice, have similar atomic components, but are organized differently. The former has stronger bonds and a more concrete form than the latter. We cannot understand the behaviour of a fluid if we are expecting it to behave like a solid.

676 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 48.

Mae Wan Ho describes the genome as "fluid," and along with geneticist Ricarda Steinbrecher, illustrates that the conceptualizations of the genome as solid and mechanical, like tinker-toys, do not adequately explain the dynamic and flexible characteristics of the genome and the cell as a whole. Furthermore, the application of the principles of solidity to fluid realities is hazardous. It is this process that leads to conditions that are psychologically hazardous as well as intellectually and political schizophrenic. Genetic engineering is merely one example of how destructive, arrogant, irrational and insane behaviour has become normal in the modern Technocosmopolis.

Automatic Pilot

Bauman, who develops the analogy between modernity and chemical states, also characterizes the early phase of modernity as having a "captain" and the later phase as being on "automated pilot."[677] In a technologically driven society, the automated pilot gives the illusion that we have a destination and that we have some insurance of being safely taken there. However, not everyone trusts the automatic pilot and would rather see our direction determined by social engagement and democratic processes of deliberation. Winner uses the analogy of "no one minding the store" to express concerns about our lack of social and political direction, as well as the massive ecological destruction.[678] For Beck, the pilot's seat is empty, and, consequently, we are "careening

677 Zygmunt Bauman, *Liquid Modernity* (Cambridge, England: Polity Press, 2000), 58.

678 Langdon Winner, *The Whale and The Reactor: A Search for Limits in an Age of High Technology.* (Chicago: The University of Chicago Press, 1986), 172.

out of control"[679] and engaging in a "game of chance involving the suicide of the human race."[680]

Zoologist W. Ford Doolittle also applies the concept of the automatic pilot to explain the differences between holism and reductionism.

> Gaia is the muse of many who care deeply about this planet. Is it mean spirited to question such a socially useful metaphor? I like to use my own metaphor to express the moral dilemma.
>
> It's as if we awoke in surprise to find ourselves at the controls of an over-booked jumbo jet hurtling through the night...the warning lights have all gone red...The passengers are divided, however, between those who think we are on automatic pilot (some even think that God is that automatic pilot) and those who fear we are already in a fatal nosedive. Both camps agree we must learn what all those buttons are –the first so that we might not inadvertently assume manual control, the second so that we can do just that, before it is too late. Learn we must, even though we will not be able to decide between these two points of view until dawn breaks, and we can see whether or not the ground below us is littered with wreckage.[681]

The problem with Doolittle's metaphor is that even if the "fatal nosedive" occurs, somehow he and the humans on board escape the wreckage. They are floating above it and are not a part of it. How is that possible? Have we died and become angels? In what way are we separate from the rest of nature?

I prefer Beck's interpretation of our condition as being "suicidal" because we are intricately interconnected and dependent on our natural environment. If we poison our planet, we poison ourselves.

679 Ulrich Beck, *Ecological Enlightenment: Essays on the Politics of Risk Society*, trans. Mark. A. Ritter (Atlantic Highlands, NJ: Humanities Press International Inc., 1995), 93.

680 Ibid., 50.

681 F. Ford Doolittle, "Questioning a Metaphor," in *From Gaia to Selfish Genes: Selected Writings in the Life Sciences*, ed. Connie Barlow, 236 (Cambridge: MIT Press, 1994).

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