Artificiality and Enlightenment: From Sociobiology to Biosociality

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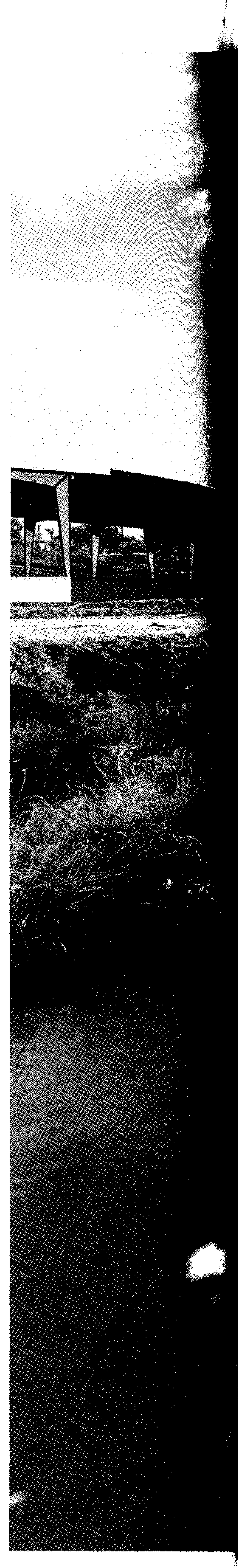


Worldly Genetics: Artificiality and Enlightenment

Michel Foucault identified the distinctively modern form of power as "bio-technico-power." Biopower, he writes, designates "what brought life and its mechanism into the realm of explicit calculations and made knowledge-power an agent of transformation of human life." Historically, practices and discourses of biopower have clustered around two distinct poles: the "anatomopolitics of the human body," the anchor point and target of disciplinary technologies, on the one hand, and a regulatory pole centered on population, with a panoply of strategies concentrating on knowledge, control and welfare, on the other.[1] My current work turns on a new articulation of the discourses and practices of biopower, currently symbolized by, but not restricted to, the Human Genome Initiative.[2] In this paper, I shall sketch some of the ways in which I believe the two poles of the body and the population are being rearticulated into what could be called a postdisciplinary rationality.[3]

In the annex to his book on Michel Foucault — entitled "On the Death of Man and Superman" — Gilles Deleuze presents a schema of three "force-forms," to use his terminology, which are roughly equivalent to Michel Foucault's three epistemes. In the classical form, *infinity* and *perfection* are the forces shaping beings; beings have a form toward which they strive, and the task of science is to represent correctly the table of those forms in an encyclopedic fashion. In the modern form, *finitude* establishes a field of life, labor and language within which Man appears as a distinctive being, who is both the subject and object of his own understanding, but an understanding that is never complete because of its very structure. Finally, here in the present day, a field of the *surhomme* — which I prefer to call the "afterman" — in which finitude, as empiricity, gives way to a play of forces and forms that Deleuze labels "*fini-illimité*."[4] In this new constellation, beings have neither a perfected form nor an essential opacity. The best example of this "unlimited-finite" is DNA: an infinity of beings can and has arisen from the four bases out of which DNA is constituted. François Jacob, the Nobel Prize–winning biologist,

Polluted New River, Calexico, California, 1989.
Robert Dawson

makes a similiar point when he writes, "a limited amount of genetic information in the germ line, produces an enormous number of protein structures... in the soma.... [N]ature operates to create diversity by endlessly combining bits and pieces."[5] Whether Deleuze has seized the significance of Jacob's facts remains an open question. Still, it is intriguing when something as cryptic as Rimbaud's formula that "the man of the future will be filled with animals" takes on a perfectly material meaning — as we shall see when we turn to the concept of model organism in the new genetics.[6]

Deleuze convincingly claims that Foucault lost his wager that it would be the language of the anthropological triad — life, labor, language — that would open the way for a new episteme, washing the figure of Man away like a wave crashing over a drawing in the sand. Foucault himself acknowledged that his prediction had been wrong when, a decade after the publication of *The Order of Things*, he mocked the "relentless theorization of writing," not as the dawning of the new age but as the death rattle of an old one.[7] Deleuze's claim is not that language is irrelevant but rather that the new epochal practices are emerging in the domains of labor and life. Again, whether Deleuze has correctly grasped the significance of these new practices remains to be seen; regardless, they are clearly important. It seems prudent to approach these terms heuristically, taking them singly and as a series of bonded base pairs — labor and life, life and language, language and labor — to see where they lead.

My research strategy focuses on the practices of life as the most potent present site of new knowledges and powers. The logical place to examine these changes is the Human Genome Initiative (sponsored by the National Institutes of Health and the Department of Energy), whose mandate is to produce a map of our DNA. The Initiative is very much a technoscience project in two senses. Like most modern science, it is deeply imbricated with technological advances in the most literal way, in this case the confidence that qualitatively more rapid, accurate and efficient machinery will be invented if the money is made available (this is already happening). The second sense of technological is the more important and interesting one: the object to be known — the human genome — will be known in such a way that it can be *changed*. This dimension is thoroughly modern; one could even say that it instantiates the definition of modern rationality. Representing and intervening, knowledge and power, understanding and reform, are built in, from the start, as simultaneous goals and means.

My initial stance toward the Initiative and its associated institutions and practices is rather traditionally ethnographic: neither committed nor opposed, I seek to describe what is going on. I follow Foucault when he asks, "Shall we try reason? To my mind nothing would be more sterile. First, because the field has nothing to do with guilt or innocence. What we have to do is analyze specific rationalities rather than always invoking the progress of rationalization in general."[8] My ethnographic question is: How will our social and ethical practices change as this project advances? I intend to approach this question on a number of levels and in a variety of sites. First, there is the Initiative itself. Second, there are adjacent enterprises and institutions in which and through which new understandings, new practices and new technologies of life and labor will certainly be articulated — prime among them the biotechnology industry. Finally, the emergence of bioethics and environmental ethics lodged in a number of different institutions will bear scrutiny as a key locus of discursive reform.

The Human Genome Initiative

What is the Human Genome Initiative? A genome is "the entire complement of genetic material in the set of chromosomes of a particular organism."[9] DNA is composed of four bases that bond into two kinds of pairs wound in the famous double helix. The current estimate is that we have about three billion base pairs in our DNA; the mouse has about the same number, while corn or salamanders have more than thirty times as many base pairs in their DNA as we do. No one knows why. Most of the DNA has no known function. It is currently held, not without a certain uneasiness, that 90 percent of human DNA is "junk." The renowned Cambridge molecular biologist, Sydney Brenner, makes a helpful distinction between "junk" and "garbage." Garbage is something used up and worthless, which one throws away; junk, though, is something one stores for some unspecified future use. It seems highly unlikely that 90 percent of our DNA is evolutionarily irrelevant — but what its precise relevance could be remains unknown.

Our genes, therefore, constitute the remaining 10 percent of the DNA. What are genes? They are segments of the DNA that code for proteins. Genes apparently vary in size from about ten thousand base pairs up to two million base pairs. Genes, or at any rate most human genes known today (1 percent of the presumed total), are not simply spatial units in the sense of a continuous sequence of base pairs; rather, they are regions of DNA made up of spans called "exons," interspersed by regions called "introns." When a gene is activated — and little is known about this process — the segment of DNA is transcribed to a type of RNA. The introns are spliced out, and the exons are joined together to form messenger RNA. This segment is then translated to code for a protein.

We don't know how many genes we have. It is estimated that Homo sapiens has between fifty thousand and one hundred thousand genes — with a rather large margin of error. We also don't know where most of these genes are — neither which chromosome they are found on nor where they are located on that chromosome. The Initiative is designed to change all this: literally to map our genes. This poses two obvious questions: What is a map? And who is the "we" of "our" genes?

For the first question, then: At present there are three different kinds of maps — linkage, physical and sequence. Linkage maps are the most familiar to us from the Mendelian genetics we learned in high school. They are based on extensive studies of family genealogies (the Mormon historical archives provide the most complete historical documentation, and the French have a similar project) and show how linked traits are inherited. Linkage maps show which genes are reinherited and roughly where they are on the chromosomes. This provides a helpful first step for identifying the probable location of disease genes in gross terms — but only a first step. In the hunt for the cystic fibrosis gene, for example, linkage maps narrowed down the area to be explored before other types of mapping completed the task.

There are several types of physical maps: "a physical map is a representation of the location of identifiable landmarks on the DNA."[10] The discovery of "restriction enzymes" provided a major advance in mapping capabilities. These proteins serve to cut DNA into chunks at specific sites. The chunk of DNA can then be cloned and its makeup chemically analyzed and then reconstructed in its original order in the genome. These maps are physical in the literal sense that one has a chunk of DNA and one identifies the gene's location on it (these have been assembled into "libraries"). The problem is to locate these physical chunks on a larger chromosomal map. Cloning techniques involving bacteria were used for a number of years, but new techniques, such as "in situ hybridization techniques," are replacing the more time-consuming cloning techniques.

Polymerase chain reaction reduces the need for cloning and physical libraries. It is necessary to clone segments of DNA in order to get enough identical copies to analyze, but this multiplication can now be done more rapidly and efficiently by having the DNA do the work itself, as follows: first, one constructs a small piece of DNA, perhaps twenty base pairs long, called a "primer" or oligonucleotide, which is then commercially made to specification. The raw material from which one takes the base pairs (to be assembled like Lego blocks) is either salmon sperm or the biomass left over from fermentation processes. A particularly rich source are the by-products of soy sauce (hence the Japanese have an edge in this market). This DNA is refined into single bases, or nucleosides, and recombined according to the desired specifications at a cost of about one dollar per coupling in a DNA synthesizer. The nucleosides could all be made synthetically, but it is currently cheaper given the small quantities needed — most primers are about twenty bases long — to stick to salmon sperm and soy sauce biomass. The current world production of DNA for a year is perhaps several grams, but as demand grows there will be a growing market for the oligonucleotides, custom-made strips of DNA. As Gerald Zon, a biochemist at Applied Biosystems, Inc., put it: The company's dream is to be the world's supplier of synthetic DNA.[11]

Two primers are targeted to attach themselves to the DNA at specific sites called "sequence-tagged sites" (STS's). These primers then simply "instruct" the single strand of DNA to reproduce itself without having to be inserted into another organism — this is the polymerase chain reaction (PCR). So, instead of having physically to clone a gene, one can simply tell one's friends in Osaka or Omaha which primers to build and where to apply them, and they can do the job themselves (eventually including the DNA preparation, which will be automated). The major advantage of the PCR–STS technique is that it yields information that can be described as "information in a database": "No access to the biological materials that led to the definition or mapping of an STS is required by a scientist wishing to assay a DNA sample for its presence."[12] The computer would tell any laboratory where to look and which primer to construct, and within twenty-four hours, one would have the bit of DNA one is interested in. These segments could then be sequenced by laboratories anywhere in the world and entered into a data base. Such developments have opened the door to what promises to be "a common language for physical mapping of the human genome."[13]

Sequencing means actually identifying the series of base pairs on the physical map. There is ongoing controversy about whether it is necessary to have the complete sequence of the genome (after all, there are vast regions of junk whose role is currently unknown), the complete set of genes (what most genes do is unknown) or merely the sequence of "expressed" genes (that is, those genes whose protein products are known). While there are formidable technological problems involved in all this, and formidable technological solutions appearing with the predicted rapidity, the principles and the goal are clear enough. "The technical means have become available to root the physical map of the human genome firmly in the DNA sequence itself. Sequence information is the natural language of physical mapping."[14] Of course, the database is not a language but a computer code, and by "natural" our scientist probably means "currently most useful."

Still, even when the whole human genome is mapped and even when it is sequenced, as Charles Cantor, senior scientist at the Department of Energy, has said, we will know nothing about how it works.[15] We will have a kind of structure without function. Much more work remains to be done, and currently is being done, on the hard scientific problems: protein structure, emergent levels of complexity and the rest. (Remember, the entire genetic makeup of a human being is found in most of our cells, but *how* a cell becomes — and remains — a brain cell instead of a toe cell is not known.) What we will have a decade from now is the material sequence of the *unlimited-finite*, a sequence map of three billion base pairs and between fifty thousand and one hundred thousand genes.

As to the second question: Whose genome is it? Obviously, not everyone has exactly the same genes or, for that matter, junk DNA — if we did, we would presumably be identical (and probably extinct). There was some debate early on in the project as to exactly whose genome was being mapped; there was a half-serious proposal to have a very rich individual finance the analysis of his own genome.[16] The problem is now shelved — literally — in the clone libraries. The collective standard consists of different physical pieces mapped at centers around the world. Cantor has pointed out that given the way genes are currently located on chromosomes (linkage maps), the easiest genome to map and sequence would necessarily be composed of the largest number of abnormal genes. In other words, *the pathological would be the path to the normal*.

Interestingly, all of the sequenced genes need not come from human beings. Genomes of other organisms are also being mapped. Several of these organisms, about which a great deal is already known, have been designated as model systems. Many genes work in the same way, regardless of the living being in which they are found. Thus, in principle, wherever we find a specific protein we can know what DNA sequence produced it. This "genetic code" has not changed during evolution and, therefore, many genes of simpler organisms are basically the same as human genes. Since, for ethical reasons, many simpler organisms are easier to study, much of what we know about human genetics derives from the model genetic systems such as yeast and mice. Fruit flies have proved to be an extremely useful model system. "One DNA sequence, called the 'homeobox', was first identified in the genes of fruit flies and later in those of higher organisms, including human beings."[17] This short stretch of nucleotides (in a nearly regular sequence) appears to play a role in turning genes on and off.

Comparisons with even simpler organisms are useful in the identification of genes encoding proteins essential to life. The elaboration of protein sequences and their differences has led to new classifications and a new understanding of evolutionary relationships and processes. An Office of Technology Assessment report laconically asserts the utility of comparisons of human and mouse DNA sequences for the "identification of genes unique to higher organisms because mice genes are more homologous to human genes than are the genes of any other well characterized organism."[18] Rimbaud's mysterious claim that "the man of the future will be filled with animals" indeed seems sound — if we interpret it to mean that we would know in some detail how we have evolved and what we have retained and added in the process.

From Stigma to Risk: Normal Handicaps

My educated guess is that the new genetics will prove to be an infinitely greater force for reshaping society and life than was the revolution in physics, because it will be embedded throughout the social fabric at the microlevel by medical practices and a variety of other discourses. The new genetics will carry with it its own distinctive promises and dangers.[19] Previous eugenics projects have been modern social projects cast in biological metaphors. Although their social effects have ranged from public hygiene to the Holocaust, none had much to do with the serious speech acts of biology, even if they were all pervaded with discourses of truth.[20] Sociobiology, as Marshall Sahlins and others have shown, is a social project: from liberal, philanthropic interventions designated to moralize and discipline the poor and degenerate, to *Rassenhygien* and its social extirpations, to entrepreneurial sociobiology and its supply-side social sadism, the construction of society has been at stake.[21] Eugenics was frequently professed by reputable, extremely well placed scientists, but — I want to assert here, and I argue the point elsewhere — the specific projects themselves did not emerge from within scientific practice: they were never *dans le vrai*, to use Georges Canguilhem's telling phrase.

In the future, the new genetics will cease to be a biological metaphor for modern society and will become instead a circulation network of identity terms and restriction loci, around which and through which a truly new type of autoproduction will emerge, which I call "biosociality." If sociobiology is culture constructed on the basis of a metaphor of nature, then in biosociality, nature will be modeled on culture understood as practice. Nature will be known and remade through technique and will finally become artificial, just as culture becomes natural. Were such a project to be brought to fruition, it would stand as the basis for overcoming the nature/culture split.

A crucial step in overcoming the nature/culture split will be the dissolution of the category of "the social." By "society" I don't mean some naturalized universal, which is found everywhere and studied by sociologists and anthropologists simply because it is an object waiting to be described; rather, I mean something more specific. In my recent book, *French Modern: Norms and Forms of the Social Environment*, I argue that if our definition is something like Raymond Williams's usage in the first edition of his book of modern commonplaces, *Keywords* — that is, the whole way of life of a people (hence open to empirical analysis and planned change) — then society and the social sciences are the ground plan for modernity.[22]

We can see the beginnings of the dissolution of modernist society happening in recent transformations of the concept of risk. Robert Castel, in his 1981 book, *La Gestion des risques*, presents a grid of analysis whose insights extend far beyond his specific concerns with psychiatry, shedding particular light on current trends in the biosciences.[23] Castel's book is an interrogation of postdisciplinary society, which he characterizes thus: first, a mutation of social technologies that minimize direct therapeutic intervention, supplanted by an increasing emphasis on a preventive administrative management of populations at risk; and second, the promotion of working on oneself in a continuous fashion so as to produce an efficient and adaptable subject. These trends lead away from holistic approaches to the subject or social contextualism and move instead toward an instrumentalized approach to both environment and individual as a sum of diverse factors amenable to analysis by specialists. The most salient aspect of this trend for the present discussion is an increasing institutional gap between diagnostics and therapeutics. Although this gap is not a new one, to be sure, the potential for its widening nonetheless poses a new range of social, ethical and cultural problems, which will become more prominent as biosociality progresses.

Modern prevention is, above all, the tracking down of risks — not in the sense of the result of specific dangers posed by the immediate presence of a person or a group, but rather, the composition of impersonal "factors" that make a risk probable. Prevention, then, is surveillance not of the individual but of likely occurrences of diseases, anomalies, deviant behavior to be minimized and healthy behavior to be maximized. We are partially moving away from the older face-to-face surveillance of individuals and groups known to be dangerous or ill (for disciplinary or therapeutic purposes), toward projecting risk factors that deconstruct and reconstruct the individual or group subject. This new mode anticipates possible loci of dangerous irruptions through the identification of sites statistically locatable in relation to norms and means. Through the use of computers, individuals sharing certain traits or sets of traits can be grouped together in a way that not only decontextualizes them from their social environment but also is nonsubjective in a double sense: it is objectively arrived at, and does not apply to, a subject in anything like the older sense of the word (that is, the suffering, meaningfully situated integrator of social, historical and bodily experiences). Castel names this trend "the technocratic administration of differences." Computerized series dissolve the traditional subject and retain only abstract givens as part of factors in a series. The target is not a person but a population at risk. As an AIDS-advocacy group in France put it: It is not who one is but what one does that puts one at risk. One's practices are not totalizing, although they may be mortal.[24]

Although epidemiological social-tracking methods were first implemented comprehensively in the tuberculosis campaign, they came to their contemporary maturity elsewhere. The distinction that Castel underscores as symptomatic of this change is that between *disease* and *handicap*. A "handicap," according to a French government report authored by the highly respected technocrat François Bloch-Laine, is "any physical, mental or situational condition that produces a weakness or trouble in relation to what is considered normal; normal is defined as the mean of capacities and chances of most individuals in the same society."[25] The concept of handicap was first used officially in England during World War II as a means of evaluating the available workforce in a way that included as many people as possible. Handicaps were deficits to be compensated for socially, psychologically and spatially, not illnesses to be treated — orthopedics not therapeutics. "The concept of handicap naturalizes the subject's history as well as assimilating expected performance levels at a particular historical moment to a naturalized normality."[26] True, this particular individual is blind or deaf or mute or short or tall or paralyzed, but can he or she operate the lathe, answer the telephone, guard the door? If not, what can we do to him or her, to the work or to the environment, that would make this possible? Performance is a relative term. Practices make the person; or rather, they don't — they just make practitioners.[27]

There is a large historical step indeed from the rich web of social and personal significations Western culture inscribed in tuberculosis to the inclusive grid of the welfare state, which has yet to inspire much poetry or yield a celebrated *Bildungsroman*. It has, however, increased life expectancy and produced millions of documents, many of them inscribed in silicon. The objectivism of social factors is now giving way to a new genetics and the beginnings of a redefinition and eventual operationalization of nature.

In a chapter entitled "What Is (Going) To Be Done?" in his book *Proceed with Caution: Predicting Genetic Risks in the Recombinant DNA Era*, Neil Holtzman documents the ways that genetic screening will be used in the coming years when its scope and sensitivity is increased dramatically by such technological advances as PCR, which will reduce cost, time and resistance. There are already tests for such conditions as sickle-cell anemia, and diagnostics for cystic fibrosis and Alzheimer's are on the horizon. These diseases are among the estimated four thousand single-gene disorders. There is a much larger number of diseases, disorders and discomforts that are polygenetic. Genetic testing will soon be moving into areas in which presymptomatic testing will be at a premium. Thus, Holtzman suggests that once a test is available for identifying a "susceptibility-conferring genotype" for breast cancer, earlier and more frequent mammograms would be recommended or even required (for insurance purposes).[28] He adds:

> Monitoring those with genetic predispositions to insulin-dependent diabetes mellitus, colorectal cancer, neurofibromatosis, retinoblastoma, or Wilms tumor for the purpose of detecting early manifestations of the disease might prove beneficial. Discovering those with genetic predispositions could be accomplished either by population-wide screening or, less completely, by testing families in which disease has already occurred.[29]

This remark involves a large number of issues, but the only one I shall underline here is the certain formation of new group and individual identities and practices arising out of these new truths. There will be, for example, neurofibromatosis groups who will meet to share their experiences, lobby for their disease, educate their children, redo their home environment, and so on — and that is what I mean by "biosociality." I am not discussing some hypothetical gene for aggression or altruism. Rather there will be groups formed around the chromosome 17, locus 16,256, site 654,376 allele variant with a guanine substitution. These groups will have medical specialists, laboratories, narratives, traditions and a heavy panoply of pastoral keepers to help them experience, share, intervene in, and "understand" their fate.

Fate it will be. It will carry with it no depth. It makes absolutely no sense to seek the meaning of the lack of a guanine base because it has no meaning. One's relation to one's father or mother is not shrouded in the depths of discourse here, the relationship is material even when it is environmental: Did your father smoke? Did your mother take DES? Rest assured they didn't know what they were doing. It follows that other forms of pastoral care will become more prominent, in order to overcome the handicap and to prepare for the risks. These therapies for the normal will be diverse, ranging from behavior modifications, to stress management, to interactional therapies of all sorts.[30] We might even see a return of tragedy in postmodernist form, although we will likely not simply rail against the gods, but rather be driven to overcome our fates through more technoscience. The nineties will be the decade of genetics, immunology and environmentalism — for, clearly, these are the leading vehicles for the infiltration of technoscience, capitalism and culture into what the moderns called "nature."

Donna Haraway labels these changes "the death of the clinic": "The clinic's methods required bodies and works: we have texts and surfaces. Our dominations don't work by medicalization and normalization any more; they work by networking, communication redesign, stress management."[31] I only partially agree; a multiplication and complex imbrication of rationalities continue to exist. Obviously, older forms of cultural classification of bio-identity such as race, gender and age have no more disappeared than medicalization and normalization have — although the meanings and the practices that constitute them certainly are changing. Postdisciplinary practices will coexist with disciplinary technologies; post–social-biological classifications will only gradually colonize older cultural grids. Thus, Troy Duster has shown how testing for sickle-cell anemia has reinforced preexistent racial and social categories, even though the distribution of the gene is far wider than the African-American community.[32] In complicated and often insidious ways, the older categories may even take on a renewed force as the new genetics begins to spread not only in the obvious racism so rampant today but more subtly in studies of blacks' alleged higher susceptibility to tuberculosis. My argument is simply that these older cultural classifications will be joined by a vast array of new ones, which will cross-cut, partially supersede and eventually redefine the older categories in ways that are well worth monitoring.

Labor and Life

The emergence of modern food, that is, food industrially processed to emphasize uniformity and commodified as part of an internationalization of world agriculture and distribution, can be dated to the 1870–1914 period.[33] Industrial sugar refining and flour milling for the production of white bread was one of the first examples of a constructed consumer need linked to advertising, transportation expansion, a host of processing and preservation techniques — as well as, incidentally, the rise of modernism in architecture (for example, Buffalo's silos and Minneapolis's grain elevators, as Reyner Banham has shown in his *A Concrete Atlantis*[34]). With these changes, agricultural products were on their way to becoming merely an input factor in the production of food and food was on its way to becoming a "heterogeneous commodity endowed with distinctive properties imparted by processing techniques, product differentiation and merchandising."[35] These processes accelerated during World War I, which here, as in so many other domains, provided the laboratory conditions for inventing, testing and improving food products on a truly mass scale. Millions of people became accustomed to transformed natural products like evaporated milk as well as new foods like margarine, in which an industrially transformed product is substituted for a processed "rural" product — vegetable fats instead of butter, for example. Using methods developed in the textile industry, it was now possible not only to produce foods at industrial levels not constrained by "natural rhythms" or inherent biological qualities (even if people had bred for these) but even to get people to buy and eat them.

The cultural reaction against foods classified as "artificial" or "processed" was spearheaded in the years between the wars by a variety of lifestyle reformist groups, satirized by George Orwell. Ecological and environmental campaigns, conducted on a national scale by the Nazis with their characteristic vigor, agitated for a return to natural foods (especially whole-grain bread), the outlaw of vivisection, the ban of smoking in public places and the exploration of the effects of environmental toxins on the human genetic material and so on. Hitler, after all, did not smoke or drink and was a vegetarian.[36] As we have seen in recent decades, not only have the demand for wholesome foods and the obsession with health and environmentalism not meant a return to "traditional" products and processes — although the image of tradition is successfully marketed, few would advocate a return to the real thing with its infected water supplies, low yield and the like — but it has even accelerated, and will continue to accelerate, the improvement, the enculturization of nature drawing on tradition as a resource to be selectively improved.

Once nature began to be systematically modified to meet industrial and consumer norms — a development perhaps embodied best by the perfect tomato, the right shape, color, size, bred not to break or rot on the way to market, missing only the distinctive taste, to the dismay of some and the delight of others — it could be redescribed and remade to suit other biopolitical specifications, like "nutrition." The value of food is now cast not only in terms of how much it imitates whole natural food in freshness and look but in terms of the health value of its component constituents — vitamins, cholesterol, fiber, salt and so on. For the first time we have a market in which processed, balanced foods — whose ingredients are chosen in accordance with nutritional or health criteria — can be presented as an alternative superior to nature. Cows are being bred for lower cholesterol, canola for an oil with unsaturated fats: "once the basic biological requirements of subsistence are met, the 'natural' content of food paradoxically becomes an obstacle to consumption."[37]

Once this cultural redefinition and industrial organization are accepted, then "nature, whether as land, space, or biological reproduction, no longer poses a binding constraint to the capitalist transformation of the production process and the social division of labor."[38] Bernardo Sorj and his coauthors claim that "the rural labor process is now not so much machine-paced as governed by the capacity of industrial capitals to modify the more fundamental rhythms of biological time."[39] This process leads to increased control over all aspects of the food production process and efforts to make it an industry like any other. New biotechnological techniques working toward the industrial control of plant biology increase the direct manipulation of the nutritional and functional properties of crops, accelerating the trends toward rationalization and the vertical integration of production and marketing required for efficiency. Biotechnological advances like nitrogen fixing or the herbicide resistance of newly engineered plant (and eventually animal) species diminish the importance of land quality and the physicochemical environment as determinants of yields and productivity.

Calgene, a leading California agrobiotech company based in Davis, is proud of its genetically engineered PGI Tomato seeds, whose fruit, their 1989 annual report boasted, is superior to a nonengineered control group. Calgene's engineering is no ordinary engineering, though, even by biotech standards: their tomatoes employ an "antisense" technique considered to be one of the cutting-edge achievements in the pharmaceutical and therapeutic fields. Antisense involves disrupting the genetic message of a gene by interfering with either the synthesis of messenger RNA or its expression, that is, before its instructions to make a protein are carried out. While the concept is simple, developing techniques refined and specific enough to achieve the desired results is not. Field trials, according to the annual report, "verified the ability of Calgene's antisense (AS-1) gene to reduce fruit rotting while increasing total solid content, viscosity and consistency."[40] The gene significantly reduces the expression of an enzyme that causes the breakdown of pectin in fruit cell walls and thereby decreases the shelf life.

"This new technology provides a natural alternative to artificial processing, which means that the tomatoes delivered to consumers in the future promise to be closer to homegrown in firmness, color and taste."[41] It looks good, it travels well and it may soon taste like what those who have still eaten old-style tomatoes think they should taste like.

Traditional tastes pose a challenge — not a threat — to technoscience: the more one specifies what is missing from the new product, the more the civilizing process proceeds.[42] Tomatoes aren't what they used to be? But you don't like bugs either? Let's see what can be done. A company in Menlo Park, California, is perfecting a bioengineered vanillin, one of the most complex of smells and tastes. Scientists are approaching museums armed with the PCR technique, which enables them to take a small piece of DNA and amplify it millions of times.[43] This recovered DNA could then, at least in principle, be reintroduced into contemporary products. If eighteenth-century tomatoes are your fancy, there is no reason a priori why one day a boutique biotech company aiming at the Berkeley or Cambridge market couldn't produce one that is consistently pesticide resistant, transportable and delicious for you — and those just like you. In sum, the new knowledges have already begun to modify labor practices and life processes in what Enlightenment botanists called "nature's second kingdom."[44]

In Praise of Artificiality and Enlightenment

What are we to make of all this? Before rushing to judgment, it seems wisest to proceed with both caution and élan in attempting to pose questions in a heuristic fashion. Fredric Jameson's powerful interpretation of the postmodern as the moment when capitalism penetrates into the unconscious and nature, can be supplemented by the insights of Donna Haraway and François Dagognet.[45] In the challenge to the discourse of nature and of the unconscious as the most embedded of givens, both Haraway and Dagognet see a potentially epochal opportunity extending beyond the dreary march of instrumentalization and objectification (although it is that as well). They see present today a Nietzschean potential to free us from some of our most enduring lies.

Haraway concludes her iconoclastic and enlightened 1985 "Manifesto for Cyborgs" by arguing that "taking responsibility for the social relations of science and technology means refusing an anti-science metaphysics, a demonology of technology, and so means embracing the skillful task of reconstructing the boundaries of daily life, in partial connection with others, in communication with all of our parts."[46] She applauds the subversion of "myriad organic wholes (e.g., the poem, the primitive culture, the biological organism)" and proclaims that "the certainty of what counts as nature — a source of insight and a promise of innocence — is undermined, perhaps fatally...." "The cyborg would not recognize the Garden of Eden...."[47] As with nature, so too with culture.

Dagognet, a prolific and fascinating French philosopher of the sciences, a materialist in the style of the eighteenth century — his latest book is in praise of plastics, but he has also written on the extraordinary diversity of leaf forms — identifies three major revolutions in our attitudes toward the world. The first was the possibility of a mechanization of the world, associated with Galileo, and the second was the French Revolution, which showed humanity that its institutions were its own and that, consequently, men could become "masters of the social tie." The third, which is now within our will, concerns neither the universe nor society but life itself.[48]

For Dagognet, the main obstacle to the full exploration and exploitation of life's potentials is a residual naturalism. He traces the roots of "naturalism" to the Greeks. The artisan or artist, it was held, imitates *that which is* — nature. Although man works on nature, he doesn't change it ontologically, because human productions never contain an internal principle of generation. This naturalism has endured. From the Greeks to the present, a variety of naturalisms have held to the following axioms: the artificial is never as good as the natural; generation furnishes the proof of life (life is autoproduction); homeostasis (autoregulation) is the golden rule.[49] Contemporary normative judgments continue to affirm the superiority of the biological, the insecurity of human works, the risks linked to artificiality and the certitude that the initial situation — the Golden Pond or the Rain Forest — was incomparably better.

Dagognet argues that nature has not been natural, in the sense of pure and untouched by human works, for millennia. More provocatively, he asserts that nature's malleability demonstrates an "invitation" to the artificial. Nature is a blind *bricoleur*, an elementary logic of combinations, yielding an infinity of potential differences. These differences are not prefigured by final causes, and there is no latent perfection-seeking homeostasis. If the word "nature" is to retain a meaning, it must signify an uninhibited polyphenomenality of display. Once understood in this way, the only natural thing for man to do would be to facilitate, encourage and accelerate its unfurling — thematic variation, not rigor mortis. Dagognet challenges us in a consummately modern fashion: "Either one adopts a sort of veneration before the immensity of 'that which is' or one accepts the possibility of manipulation."[50] The term manipulation carries with it the appropriate ambiguities implying both an urge to dominate and discipline as well as an imperative to improve on the organic. Confronting this complexity constitutes the challenge of artificiality and enlightenment.

Notes

1. Michel Foucault, *The History of Sexuality*, vol. 1: *An Introduction*, trans. Robert Hurley (New York: Pantheon, 1978), p. 139. Special thanks to Vincent Sarich, Jenny Gumperz, Frank Rothschild, Guy Micco, Hubert Dreyfus and Thomas White.

2. *Mapping Our Genes, Genome Projects: How Big, How Fast?* (Washington, D.C.: Office of Technology Assessment, 1988).

3. For what it's worth, I don't think "postdisciplinary" can be equated with "postmodern."

4. Gilles Deleuze, *Foucault* (Paris: Minuit, 1986): "L'homme tend à libérer en lui la vie, le travail et le language" (p. 140). Foucault's version is found in *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage, 1966). On natural history in the Classical age, see Henri Daudin, *Cuvier et Lamarck: Les Classes zoologiques et l'idée de série animale* (Paris: Alcan, 1926). On the philosophical understanding of Man, see Jules Vuillemin, *L'Héritage kantien et la révolution copernicienne: Fichte, Cohen, Heidegger* (Paris: P.U.F., 1954).

5. François Jacob, *The Possible and the Actual* (New York: Pantheon, 1982), p. 39.

6. Deleuze, *Foucault*: "L'homme de l'avenir est chargé des animaux" (p. 141).

7. Michel Foucault, "Truth and Power," in Paul Rabinow, ed., *The Foucault Reader* (New York: Pantheon, 1984), p. 127; idem, *The Order of Things*, p. 387.

8. Michel Foucault, "The Subject and Power," in Hubert Dreyfus and Paul Rabinow, *Michel Foucault: Beyond Structuralism and Hermeneutics* (2d ed., Chicago: University of Chicago Press, 1983), p. 210.

9. *Mapping Our Genes*, p. 21.

10. Ibid., p. 30.

11. Interview with author, March 19, 1990.

12. *Mapping Our Genes*, p. 1434.

13. Maynard Olson, Leroy Hood, Charles Cantor and David Botstein, "A Common Language for Physical Mapping of the Human Genome," *Science* 245 (Sept. 29, 1989).

14. *Mapping Our Genes*, p. 1435. Natural languages exist in a context of culture and background practices. Codes are representational but only in the representation degree zero sense of transparency and definitional arbitrariness. I intend to deal with "language" and its relations with "labor" and "life" in another paper.

15. Charles Cantor, Opening Remarks, *Human Genome: I* (San Diego, Oct. 1, 1989).

16. If, as Allan Wilson and his team convincingly argue, there was an "original Eve," the mother of us all, in Africa about 200,000 years ago, there would be an argument to take an African genome as the standard from which other groups have varied: A. C. Wilson, E. A. Zimmer, E. M. Prager and T. D. Kocher, "Restriction Mapping in the Molecular Systematics of Mammals: A Retrospective Salute," in B. Fernholm, K. Bremer and H. Jornvall, eds., *The Hierarchy of Life* (Amsterdam: Elsevier, 1989), pp. 407–19.

17. *Mapping Our Genes*, p. 67.

18. Ibid., p. 68.

19. Both Daniel J. Kevles and John Heilbron agreed with the importance of the social impact of the Initiative. Heilbron: "Oh, a thousand times more important" (Feb. 14, 1990).

20. For this distinction, see Dreyfus and Rabinow, *Michel Foucault*, ch. 3.

21. Marshall Sahlins, *The Use and Abuse of Biology: An Anthropological Critique of Sociobiology* (Ann Arbor: University of Michigan Press, 1976); Robert N. Proctor, *Racial Hygiene: Medicine under the Nazis* (Cambridge, Mass.: Harvard University Press, 1988); Daniel J. Kevles, *In the Name of Eugenics: Genetics and the Uses of Human Heredity* (Berkeley: University of California Press, 1985); and Benno Muller-Hill, *Murderous Science: Elimination by Scientific Selection of Jews, Gypsies, and Others, Germany 1933–45* (Oxford: Oxford University Press, 1988).

22. Paul Rabinow, *French Modern: Norms and Forms of the Social Environment* (Cambridge, Mass.: MIT Press, 1989); Raymond Williams, *Keywords: A Vocabulary of Culture and Society* (New York: Oxford University Press, 1976).

23. Robert Castel, *La Gestion des risques, de l'anti-psychiatrie à l'après-psychanalyse* (Paris: Minuit, 1981).

24. The third term here is genetics. If, as is hinted at, there were a genetic component to AIDS susceptibility, then the equation would be more complex.

25. François Bloch-Laine, *Etude du problème général de l'inadaptation des personnes handicapées, la Documentation française* (1969), p. 111 (cited in Castel, *La Gestion des risques*, p. 117).

26. Bloch-Laine, *Etude*, p. 122

27. Credit is due to James Faubion for clarity on this point.

28. Tom White rightly underlines that all of these developments could be and most likely will be contested.

29. Neil A. Holtzman, *Proceed with Caution: Predicting Genetic Risks in the Recombinant DNA Era* (Baltimore and London: Johns Hopkins University Press, 1989), pp. 235–36.

30. Robert Castel, *Advanced Psychiatric Society* (Berkeley: University of California Press, 1986).

31. Donna Haraway, "A Manifesto for Cyborgs," *Socialist Review* 15.2 (March–April 1985), p. 69.

32. Troy Duster, *Backdoor to Eugenics* (London: Routledge, 1990).

33. A fuller treatment would have to deal with both husbandry and agriculture in evolutionary perspective. Thanks to Tom White for discussions on this and other points.

34. Reyner Banham, *A Concrete Atlantis: U.S. Industrial Building and European Modern Architecture, 1900–1925* (Cambridge, Mass.: MIT Press, 1986).

35. David Goodman, Bernardo Sorj and John Wilkinson, *From Farming to Biotechnology: A Theory of Agro-Industrial Development* (Oxford, Eng.: Basil Blackwell, 1987), p. 60.

36. A good summary can be found in Proctor's *Racial Hygiene*, ch. 8, "The 'Organic Vision' of Nazi Racial Science."

37. Goodman et al., *From Farming to Biotechnology*, p. 193.

38. Ibid., p. 58.

39. Ibid., p. 47.

40. *Planning for the Future*, Calgene 1989 Annual Report, p. 14.

41. Ibid.

42. Keith Thomas, *Man and the Natural World: A History of the Modern Sensibility* (New York: Pantheon, 1983).

43. Norman Arnheim, Tom White and William E. Rainey, "Application of PCR: Organismal and Population Biology," *BioScience* 40.3 (1989), pp. 174–83.

44. François Delaporte, *Nature's Second Kingdom* (Cambridge, Mass.: MIT Press, 1982). I intend to treat animal engineering, transgenic beings and the like in another paper.

45. Fredric Jameson, "Postmodernism, Or the Cultural Logic of Late Capitalism," *New Left Review* 146 (July–Aug. 1984), pp. 53–92.

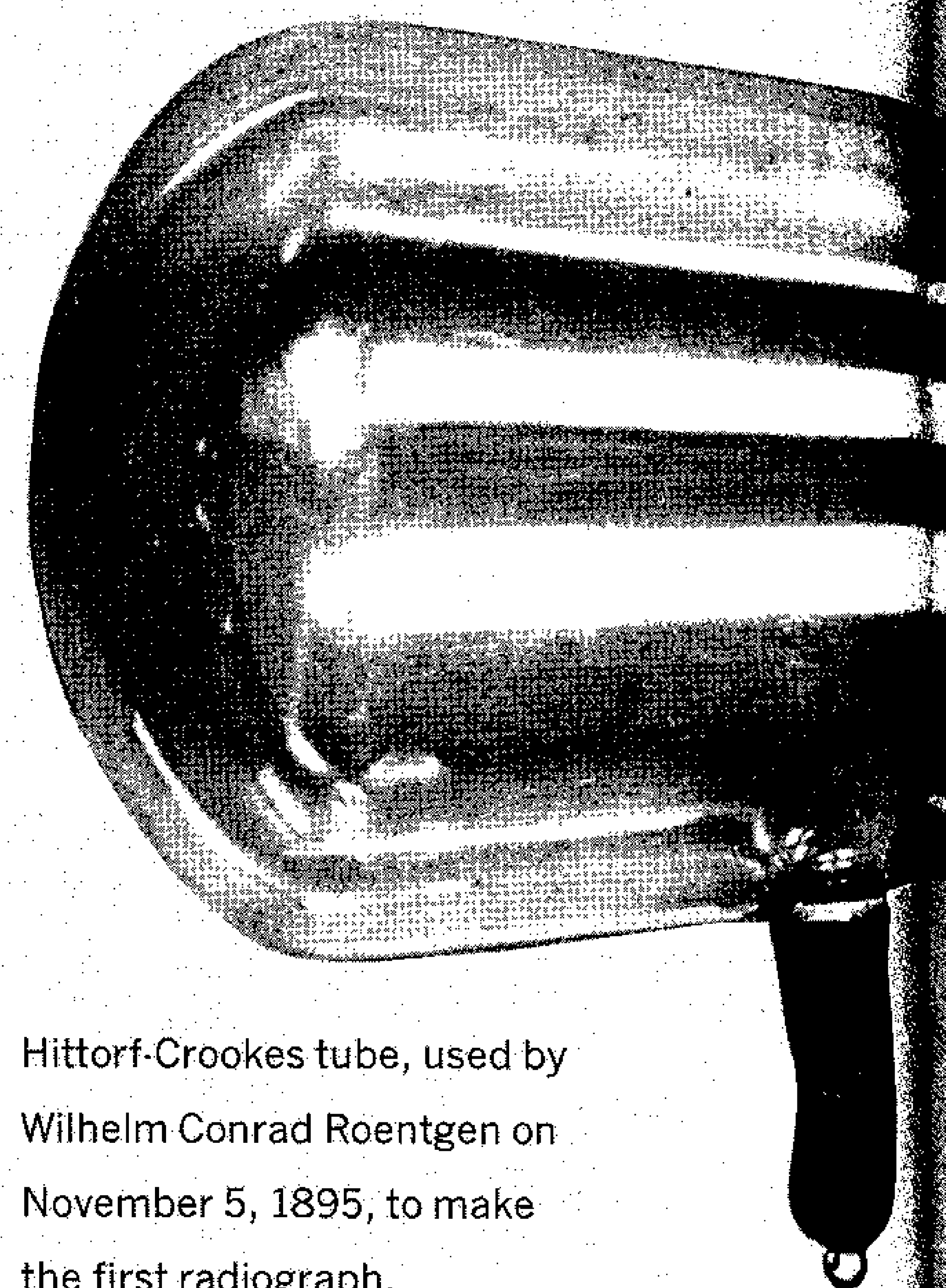
46. Haraway, "Manifesto," p. 100

47. Ibid., pp. 70, 67

48. François Dagognet, *La Maîtrise du vivant* (Paris: Hachette, 1988), p. 22.

49. Ibid., p. 41.

50. Ibid., p. 12.



Hittorf-Crookes tube, used by Wilhelm Conrad Roentgen on November 5, 1895, to make the first radiograph.