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Worldviews, Religion, and the Environment

A Global Anthology

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Humans, Nature, and Modernity

As THE ESSAYS in the preceding chapter all pointed out, the prevailing ethic toward the natural environment within the post-Enlightenment Western worldview has been one of domination and control. Because these essays have also shown that domination represents only one possible interpretation of the inherited tradition, one may ask why and how this particular interpretation prevailed.

Many have sought an answer to this question in the blending of science and technology that began in Europe in the seventeenth century, a period known as the *Enlightenment*. Whereas previously Western science had been mainly speculative, many important thinkers of the Enlightenment increasingly sought to apply scientific knowledge to real-life situations. This approach is part of a broader developing worldview commonly known as *modernity*.

The modernist worldview arose in part from the thought of the European Renaissance, in particular the tendency to exalt human beings and their unique qualities, in some cases to the point of being nearly on a par with their creator. The mechanistic physics of Francis Bacon, René Descartes, and Isaac Newton portrayed the world not as something organic but as a machine—dead matter that could be taken apart, studied, and ultimately understood. Especially in the work of Bacon, Man's quest to master, comprehend, and use nature for his own ends is often expressed through the metaphor of violating a woman, forcing her to unveil her secrets and to do her master's will.

This aggressive and sexist imagery has made a deep impression on feminist critics such as historian Carolyn Merchant, who suggests that Bacon's intellectual agenda reflected the interests of "the middle-class male entrepreneur" at the expense of nature, women, and the lower classes. Merchant gives Bacon a large share of the credit (or blame) for the modern scientific approach to investigation, characterized by laboratory methods that involve manipulation, dissection, and scrutiny.

Implicit in Bacon's vision of mastery over nature is the modernist notion of *progress*, the idea that humanity is moving ever forward toward some lofty goal. Some have argued that the very idea of progress depends on a teleology such as that provided by Christianity; even today it is often difficult, at least for Westerners, to deconstruct the notion of progress and examine the assumptions it implies.

Contemporary modernist writers on the environment, who are often characterized as technological optimists, tend to take these assumptions for granted. For them, there is no question that humankind is capable of exercising ever greater dominance over nature, that it will inevitably continue to do so in the future, and that human beings are capable of determining whether the changes brought about by the use of new technologies will be beneficial or not. Their faith in technology and human progress is rooted in the humanis-

tic positivism of the Enlightenment thinkers, as are their attitudes toward nature as primarily a supplier of resources for human use. In the latter respect, such views can be seen as a logical extension of the managerial approach advocated by Gifford Pinchot, a forester who became the first director of the United States Forest Service in the early part of the twentieth century.

The Renaissance theme of human uniqueness and faith in human abilities to meet all challenges is prominent in the writing of journalist Gregg Easterbrook, who presents himself as one who sees through the pessimism of much contemporary environmentalist rhetoric. Although his vision for a New Nature that is made better by humans seems very futuristic, its tone and underlying ethos almost exactly mirror those found in classic utopian works such as Francis Bacon's *The New Atlantis.*

Media critic Jerry Mander does not share the modernist optimism and faith in salvation through technology. He sees the technological worldview as being undemocratic, serving only the interests of those in power. Noting that the twentieth century has seen history's greatest and most rapid proliferation of new technologies being introduced in the virtual absence of any public debate, he calls for a more cautious approach in which the likely changes and possible dangers of new technologies would be weighed and considered by society at large before they are adopted.

Philosopher David R. Loy takes Mander's critique a step further. Whereas Mander sees a disappearance of the sacred in modern life, Loy feels rather that we have wrongly made sacred what does not deserve to be sacred. Echoing the diagnoses of White and Nasr, Loy characterizes the crisis of modern society as a crisis of misplaced values. Whereas overt references to religion are largely absent from the writings of Easterbrook and other advocates of modernity, Loy unveils and deconstructs the quasi-religious assumptions and value systems underlying the modern economistic worldview. In doing so, he shows the darker side of human progress and calls into question the assumption that modernity represents the highest achievement in human development.

Dominion over Nature

CAROLYN MERCHANT

DISORDERLY, ACTIVE NATURE WAS SOON forced to submit to the questions and experimental techniques of the new science. Francis Bacon (1561–1626), a celebrated "father of modern science," transformed tendencies already extant in his own society into a total program advocating the control of nature for human benefit. Melding together a new philosophy based on natural magic as a technique for manipulating nature, the technologies of mining and metallurgy, the emerging concept of progress and a patriarchal structure of family and state, Bacon fashioned a new ethic sanctioning the exploitation of nature.

Bacon has been eulogized as the originator of the concept of the modern research institute, a philosopher of industrial science, the inspiration behind the Royal Society (1660), and as the founder of the

inductive method by which all people can verify for themselves the truths of science by the reading of nature's book.[1] But from the perspective of nature, women, and the lower orders of society emerges a less favorable image of Bacon and a critique of his program as ultimately benefiting the middle-class male entrepreneur. Bacon, of course, was not responsible for subsequent uses of his philosophy. But, because he was in an extremely influential social position and in touch with the important developments of his time, his language, style, nuance, and metaphor become a mirror reflecting his class perspective.

Sensitive to the same social transformations that had already begun to reduce women to psychic and reproductive resources, Bacon developed the power of language as political instrument in reducing female nature to a resource for economic production. Female imagery became a tool in adapting scientific knowledge and method to a new form of human power over nature. The "controversy over women" and the inquisition of witches—both present in Bacon's social milieu—permeated his description of nature and his metaphorical style and were instrumental in his transformation of the earth as a nurturing mother and womb of life into a source of secrets to be extracted for economic advance.

Bacon's roots can be found in middle-class economic development and its progressive interests and values. His father was a middle-class employee of the queen, his mother a Calvinist whose Protestant values permeated his early home life. Bacon took steps to gain the favor of James I soon after the latter's ascent to the throne in 1603. He moved from "learned counsel" in 1603 to attorney general in 1613, privy councillor in 1616, lord keeper in 1617, and, finally, lord chancellor and Baron Verulam in 1618. His political objectives were to gain support for his program of the advancement of science and human learning and to upgrade his own status through an ambitious public career.[2]

Bacon's mentor, James I, supported antifeminist and antiwitch-craft legislation. During the "controversy over women," females had challenged traditional modes of dress considered as appropriate to their place in society. In Holland, for example, young women were criticized for wearing men's hats with high crowns. In England, the title page of a work called *Hic-Mulier or The Man-Woman* (1620) showed a woman in a barber's chair having her hair clipped short, while her companion outfitted herself in a man's plumed hat.[3] In an attempt to keep women in their place in the world's order, King James in that same year enlisted the aid of the clergy in preventing females from looking and dressing in masculine fashions: "The Bishop of London had express commandment from the king to will [the clergy] to inveigh vehemently against the insolence of our women, and their wearing of broad-brimmed hats, pointed doublets, their hair cut short or shorn, and some of them [with] stilettos or poinards . . . *the truth is the world is very much out of order.*"[4] (Italics added.)

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Bacon was also well aware of the witch trials taking place all over Europe and in particular in England during the early seventeenth century. His sovereign, while still James VI of Scotland, had written a book entitled *Daemonologie* (1597). In 1603, the first year of his English reign, James I replaced the milder witch laws of Elizabeth I, which evoked the death penalty only for killing by witchcraft, with a law that condemned to death all practitioners.[6]

It was in the 1612 trials of the Lancashire witches of the Pendle Forest that the sexual aspects of witch trials first appeared in England. The source of the women's confessions of fornication with the devil was a Roman Catholic priest who had emigrated from the Continent and planted the story in the mouths of accused women who had recently rejected Catholicism.

These social events influenced Bacon's philosophy and literary style. Much of the imagery he used in delineating his new scientific objectives and methods derives from the courtroom, and, because it treats nature as a female to be tortured through mechanical inventions, strongly suggests the interrogations of the witch trials and the mechanical devices used to torture witches. In a relevant passage, Bacon stated that the method by which nature's secrets might be discovered consisted in investigating the secrets of witchcraft by inquisition, referring to the example of James I:

> *For you have but to follow and as it were hound nature in her wanderings, and you will be able when you like to lead and drive her afterward to the same place again.* Neither am I of opinion in this history of marvels that superstitious narratives of *sorceries, witchcrafts, charms,* dreams, divinations, and the like, where there is an assurance and clear evidence of the fact, should be altogether ex-

> cluded. . . . howsoever the use and practice of such arts is to be condemned, yet from the speculation and consideration of them . . . a useful light may be gained, not only for a true judgment of the offenses of persons charged with such practices, *but likewise for the further disclosing of the secrets of nature. Neither ought a man to make scruple of entering and penetrating into these holes and corners, when the inquisition of truth is his whole object—as your majesty has shown in your own example.*[7] (Italics added.)

The strong sexual implications of the last sentence can be interpreted in the light of the investigation of the supposed sexual crimes and practices of witches. In another example, he compared the interrogation of courtroom witnesses to the inquisition of nature: "I mean (according to the practice in civil causes) in this great plea or suit granted by the divine favor and providence (whereby the human race seeks to recover its right over nature) *to examine nature herself* and the arts upon interrogatories."[8] Bacon pressed the idea further with an analogy to the torture chamber: "For like as a man's disposition is never well known or proved till he be crossed, nor Proteus ever changed shapes till he was *straitened* and *held fast,* so nature exhibits herself more clearly under the *trials* and *vexations* of art [mechanical devices] than when left to herself."[9]

The new man of science must not think that the "inquisition of nature is in any part interdicted or forbidden." Nature must be "bound into service" and made a "slave," put "in constraint" and "molded" by the mechanical arts. The "searchers and spies of nature" are to discover her plots and secrets.[10]

This method, so readily applicable when nature is denoted by the female gender, degraded and made possible the exploitation of the natural environment. As woman's womb had symbolically yielded to the forceps, so nature's womb harbored secrets that through technology could be wrested from her grasp for use in the improvement of the human condition:

> There is therefore much ground for hoping that there are still laid up in the womb of nature many secrets of excellent use having no affinity or parallelism with anything that is now known . . . only by the method which we are now treating can they be speedily and suddenly and simultaneously presented and anticipated.[11]

Bacon transformed the magical tradition by calling on the need to dominate nature not for the sole benefit of the individual magician but for the good of the entire human race. Through vivid metaphor, he transformed the magus from nature's servant to its exploiter, and nature from a teacher to a slave. Bacon argued that it was the magician's error to consider art (technology) a mere "assistant to nature having the power to finish what nature has begun" and therefore to despair of ever "changing, transmuting, or fundamentally altering nature."[12]

The natural magician saw himself as operating within the organic order of nature—he was a manipulator of parts within that system, bringing down the heavenly powers to the earthly shrine. Agrippa, however, had begun to explore the possibility of ascending the hierarchy to the point of cohabiting with God. Bacon extended this idea to include the recovery of the power over nature lost when Adam and Eve were expelled from paradise.

Due to the Fall from the Garden of Eden (caused by the temptation of a woman), the human race lost its "dominion over creation." Before the Fall, there was no need for power or dominion, because Adam and Eve had been made sovereign over all other creatures. In this state of dominion, mankind was "like unto God." While some, accepting God's punishment, had obeyed the medieval strictures against searching too deeply into God's secrets, Bacon turned the constraints into sanctions. Only by "digging further and further into the mine of natural knowledge" could mankind recover that lost dominion. In this way, "the narrow limits of man's dominion over the universe" could be stretched "to their promised bounds."[13]

Although a female's inquisitiveness may have caused man's fall from his God-given dominion, the relentless interrogation of another female, nature, could be used to regain it. As he argued in *The Masculine Birth of Time,* "I am come in very truth leading to you nature with all her children to bind her to your service and make her your slave." "We have no right," he asserted, "to expect nature to come to us." Instead, "Nature must be taken by the forelock, being bald behind." Delay and subtle argument "permit one only to clutch at nature, never to lay hold of her and capture her."[14]

Nature existed in three states—at liberty, in error, or in bondage:

> She is either free and follows her ordinary course of development as in the heavens, in the animal and vegetable creation, and in the general array of the universe; or she is driven out of her ordinary course by the perverseness, insolence, and forwardness of matter and violence of impediments, as in the case of monsters; or lastly, she is put in constraint, molded, and made as it were new by art and the hand of man; as in things artificial.[15]

The first instance was the view of nature as immanent self-development, the nature naturing herself of the Aristotelians. This was the organic view of nature as a living, growing, self-actualizing being. The second state was necessary to explain the malfunctions and monstrosities that frequently appeared and that could not have been caused by God or another higher power acting on his instruction. Since monstrosities could not be explained by the action of form or spirit, they had to be the result of matter acting perversely. Matter in Plato's *Timaeus* was recalcitrant and had to be forcefully shaped by the demiurge. Bacon frequently described matter in female imagery, as a "common harlot." "Matter is not devoid of an appetite and inclination to dissolve the world and fall back into the old Chaos." It therefore must be "restrained and kept in order by the prevailing concord of things." "The vexations of art are certainly as the bonds and handcuffs of Proteus, which betray the ultimate struggles and efforts of matter."[16]

The third instance was the case of art (techné)—man operating on nature to create something new and artificial. Here "nature takes orders from man and works under his authority." Miners and smiths should become the model for the new class of natural philosophers who would interrogate and alter nature. They had developed the two most important methods of wresting nature's secrets from her, "the one searching into the bowels of nature, the other shaping nature as on an anvil." "Why should we not divide natural philosophy into two parts, the mine and the furnace?" For "the truth of nature lies hid in certain deep mines and caves," within the earth's bosom. Bacon, like some of the practically minded alchemists, would "advise the studious to sell their books and build furnaces" and, "forsaking Minerva and the Muses as barren virgins, to rely upon Vulcan."[17]

The new method of interrogation was not through abstract notions, but through the instruction of the understanding "that it may in very truth dissect nature." The instruments of the mind supply suggestions, those of the hand give motion and aid the work. "By art and the hand of man," nature can then be "forced out of her natural state and squeezed and molded." In this way, "human knowledge and human power meet as one."[18]

Here, in bold sexual imagery, is the key feature of the modern experimental method—constraint of nature in the laboratory, dissection by hand and mind, and the penetration of hidden secrets—language still used today in praising a scientist's "hard facts," "penetrating mind," or the "thrust of his argument." The constraints against penetration in Natura's lament over her torn garments of modesty have been turned into sanctions in language that legitimates the exploitation and "rape" of nature for human good. The seventeenth-century experimenters of the Academia del Cimento of Florence (i.e., The Academy of Experiment, 1657–1667) and the Royal Society of London who placed mice and plants in the artificial vacuum of the barometer or bell jar were vexing nature and forcing her out of her natural state in true Baconian fashion.[19]

Scientific method, combined with mechanical technology, would create a "new organon," a new system of investigation, that unified knowledge with material power. The technological discoveries of printing, gunpowder, and the magnet in the fields of learning, warfare, and navigation "help us to think about the secrets still locked in nature's bosom." "They do not, like the old, merely exert a gentle guidance over nature's course; they have the power to conquer and subdue her, to shake her to her foundations." Under the mechanical arts, "nature betrays her secrets more fully . . . than when in enjoyment of her natural liberty."[20]

Mechanics, which gave man power over nature, consisted in motion; that is, in "the uniting or disuniting of natural bodies." Most useful were the arts that altered the materials of things—"agriculture, cookery, chemistry, dying, the manufacture of glass, enamel, sugar, gunpowder, artificial fires, paper, and the like." But in performing these operations, one was constrained to operate within the chain of causal connections; nature could "not be commanded except by being obeyed." Only by the study, interpretation, and observation of nature could these possibilities be uncovered; only by acting as the interpreter of nature could knowledge be turned into

power. Of the three grades of human ambition, the most wholesome and noble was "to endeavor to establish and extend the power and dominion of the human race itself over the universe." In this way "the human race [could] recover that right over nature which belongs to it by divine bequest."[21]

The interrogation of witches as symbol for the interrogation of nature, the courtroom as model for its inquisition, and torture through mechanical devices as a tool for the subjugation of disorder were fundamental to the scientific method as power. For Bacon, as for Harvey, sexual politics helped to structure the nature of the empirical method that would produce a new form of knowledge and a new ideology of objectivity seemingly devoid of cultural and political assumptions.

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MECHANISM AND THE NEW ATLANTIS

The scientific research institute designed to bring progress to Bensalem, the community of the *New Atlantis,* was called Salomon's House. The patriarchal character of this utopian society was reinforced by designating the scientists as the "Fathers of Salomon's House." In the *New Atlantis,* politics was replaced by scientific administration. No real political process existed in Bensalem. Decisions were made for the good of the whole by the scientists, whose judgment was to be trusted implicitly, for they alone possessed the secrets of nature.

Scientists decided which secrets were to be revealed to the state as a whole and which were to remain the private property of the institute rather than becoming public knowledge: "And this we do also, we have consultations, which of the inventions and experiences which we have discovered shall be published, and which not: and all take an oath of secrecy for the concealing of those which we think fit to keep secret, though some of those we do reveal sometimes to the state, and some not."[22]

The cause of the visit to the governor by a scientist from the distant Salomon's House, which resulted in a conference with the visitors to Bensalem, was shrouded in secrecy. No father of the institute had been seen in "this dozen years. His coming [was] in state, but the cause of his coming [was] secret."

The scientist father was portrayed much like the high priest of the occult arts, the Neoplatonic magus whose interest in control and power over nature had strongly influenced Bacon. He was clothed in all the majesty of a priest, complete with a "robe of fine black cloth with wide sleeves and a cape," an "undergarment . . . of excellent white linen," and a girdle and a clerical scarf, also of linen. His gloves were set with stone, his shoes were of peach-colored velvet, and he wore a Spanish helmet.

The worship to be accorded to the scientist was further enhanced by his vehicle, a "rich chariot" of cedar and gilt carried like a litter between four richly velveted horses and two blue-velveted footmen. The chariot was decorated with gold, sapphires, a golden sun, and a "small cherub of gold with wings outspread" and was followed by fifty richly dressed footmen. In front walked two bareheaded men carrying a pastoral staff and a bishop's crosier.

Bacon's scientist not only looked but behaved like a priest who had the power of absolving all human misery through science. He "had an aspect as if he pitied men"; "he held up his bare hand as he went, as blessing the people, but in silence." The street was lined with people who, it would seem, were happy, orderly, and completely passive: "The street was wonderfully well kept, so that there was never any army [which] had their men stand in better battle array than the people stood. The windows were not crowded, but everyone stood in them as if they had been placed."

Bacon's "man of science" would seem to be a harbinger of many modern research scientists. Critics of science today argue that scientists have become guardians of a body of scientific knowledge, shrouded in the mysteries of highly technical language that can be fully understood only by those who have had a dozen years of training. It is now possible for such scientists to reveal to the public only information they deem relevant. Depending on the scientist's ethics and political viewpoint, such information may or may not serve the public interest.

Salomon's House, long held to be the prototype of a modern research institute, was a forerunner of the mechanistic mode of scientific investigation. The mechanical method that evolved during the seventeenth century operated by breaking down a problem into its component parts, isolating it from its environment, and solving each portion independently. Bacon's research center maintained separate "laboratories" for the study of mining and metals, weather, fresh- and salt-water life, cultivated plants, insects, and so on.

The tasks of research were divided hierarchically among the various scientists, novices, and apprentices. Some abstracted patterns from other experiments, some did preliminary book research, some collected experiments from other arts and sciences; others tried out new experiments, or compiled results or looked for applications. The interpreters of nature raised the discoveries into greater observations, axioms, and aphorisms. This differentiation of labor followed the outlines of Bacon's inductive methodology.

In the laboratories of Salomon's House, one of the goals was to recreate the natural environment artificially through applied technology. Large, deep caves called the Lower Region were used for "the imitation of natural mines and the producing of new artificial metals by compositions and materials."[23] In another region were "a number of artificial wells and fountains, made in imitation of the natural sources and baths." Salt water could be made fresh, for "we have also pools, of which some do strain fresh water out of salt, and others by art do turn fresh water into salt."

Not only was the manipulation of the environment part of Bacon's program for the improvement of mankind, but the manipulation of organic life to create artificial species of plants and animals was specifically outlined. Bacon transformed the natural magician as "servant of nature" into a manipulator of nature and changed art from the aping of nature into techniques for forcing nature into new forms and controlling reproduction for the sake of production: "We make a number of kinds of serpents, worms, flies, fishes of putrefaction, where of some are advanced (in effect) to be perfect creatures like beasts or birds, and have sexes, and do propagate. Neither do we this by chance, but we know beforehand of what matter and commixture what kind of those creatures will arise."

These examples were taken directly from Della Porta's *Natural Magic* (1558), the second book of which dealt specifically with putrefaction and the generation of the living organisms mentioned by Bacon—worms, serpents, and fishes. The chapter dealing with putrefaction had discussed the generation of canker worms from mud, so that "we may also learn how to procreate new creatures."[24] "Serpents," wrote Della Porta, "may be generated of man's marrow, of the hairs of a monstrous woman, and of a horsetail, or mane," while "certain fishes," such as groundlings, carp, and shellfish, "are generated out of putrefaction." New beasts and birds could be generated through knowledge and carefully controlled coupling.

Della Porta also set down instructions as to how to produce a new organism in a series of trials. Such creatures "must be of equal pitch; they must have the same reproductive cycle, and one must be equally "as lustful as the other." Furthermore "if any creatures want appetite . . . we may make them eager in lust."

The *New Atlantis* had parks and enclosures for beasts and birds where just such experiments were performed: "By art likewise we make them greater or taller than their kind is, and contrariwise dwarf them, and stay their growth; we make them more fruitful and bearing than their kind is, and contrariwise barren and not generative. Also we make them differ in color, shape, activity, many ways."[25]

The scientists of Salomon's House not only produced new forms of birds and beasts, but they also altered and created new species of herbs and plants: "We have also means to make divers plants rise by mixtures of earths without seeds, and likewise to make divers new plants differing from the vulgar, and to make one tree or plant turn into another."

Rather than respecting the beauty of existing organisms, Bacon's *New Atlantis* advocated the creation of new ones:

> We have also large and various orchards and gardens, wherein we do not so much respect beauty as variety of ground and soil, proper for diverse trees and herbs. . . . And we make (by art) in the same orchards and gardens, trees and flowers to come earlier or later than their seasons, and to come up and bear more speedily than by their natural course they do. We make them by art greater much than their nature, and their fruit greater and sweeter and of differing taste, smell, color, and figure, from their nature.[26]

Della Porta had, again, given numerous examples of changing the colors and tastes of plants: a white vine could be turned into a black one, purple roses and violets could become white, and sweet almonds and pomegranates sour.

That such experimentation on animals and the creation of new species was ultimately directed toward human beings was intimated by Bacon: "We have also parks and enclosures of all sorts of beasts and birds, which we use not only for view or rareness

but likewise for dissections and trials, that thereby we may take light [i.e., enlightenment] what may be wrought upon the body of man. . . . We also try all poisons and other medicines upon them as well of chirurgery as physic."[27]

Much of Bacon's strategy in the *New Atlantis* was directed at removing ethical strictures against manipulative magic, of the sort found in Agrippa's *Vanity of Arts and Science* (1530), a polemic probably written for Agrippa's own self-protection, containing important arguments against transforming and altering nature. Just as Agricola had been obliged to refute Agrippa's views on mining in order to liberate that activity from the ethical constraints imposed by ancient writers, so Bacon was obliged to refute the constraints against the manipulation of nature. Agrippa had argued against tampering with nature and maiming living organisms:

> Those exercises appurtenant to agriculture . . . might in some measure deserve commendation, could it have retained itself within moderate bounds and not shown us so many devices to make strange plants, so many portentous graftings and metamorphoses of trees; how to make horses copulate with asses, wolves with dogs, and so to engender many wondrous monsters contrary to nature: and those creatures to whom nature has given leave to range the air, the seas and earth so freely, to captivate and confine in aviaries, cages, warrens, parks, and fish ponds, and to fat them in coops, having first put out their eyes, and maimed their limbs.[28]

Agrippa had further inveighed against the manipulators of nature who had tried to discover "how to prevent storms, make . . . seed fruitful, kill weeds, scare wild beasts, stop the flight of beasts and birds, the swimming of fishes, to charm away all manner of diseases; of all which those wise men before named have written very seriously and very cruelly."

Much of Bacon's program in the *New Atlantis* was meant to sanction just such manipulations, his whole objective being to recover man's right over nature, lost in the Fall. Agrippa had observed that after the Fall nature, once kind and beneficent, had become wild and uncontrollable: "For now the earth produces nothing without our labor and our sweat, but deadly and venomous, . . . nor are the other elements less kind to us: many the seas destroy with raging tempests, and the horrid monsters devour: the air making war against us with thunder, lightning and storms; and with a crowd of pestilential diseases, the heavens conspire our ruin."

In order to control the ravages of wild tempestuous nature, Bacon set as one of the objectives of Salomon's House the artificial control of the weather and its concomitant monsters and pestilences: "We have also great and spacious houses, where we imitate and demonstrate meteors, as snow, hail, rain, some artificial rains of bodies and not of water, thunder, lightnings, also generation of bodies in air, as frogs, flies, and diverse others." Tempests (like that produced by Shakespeare's magician, Prospero), could also be created for study by using "engines for multiplying and enforcing of winds."[29]

The Baconian program, so important to the rise of Western science, contained within it a set of attitudes about nature and the scientist that reinforced the tendencies toward growth and progress inherent in early capitalism. While Bacon himself had no intimation as to where his goals might ultimately lead, nor was he responsible for modern attitudes, he was very sensitive to the trends and directions of his own time and voiced them eloquently. The expansive tendencies of his period have continued, and the possibility of their reversal is highly problematical.

Bacon's mechanistic utopia was fully compatible with the mechanical philosophy of nature that developed during the seventeenth century. Mechanism divided nature into atomic particles, which, like the civil citizens of Bensalem, were passive and inert. Motion and change were externally caused: in nature, the ultimate source was God, the seventeenth century's divine father, clockmaker, and engineer; in Bensalem, it was the patriarchal scientific administration of Salomon's House. The atomic parts of the mechanistic universe were ordered in a causal nexus such that by contact the motion of one part caused the motion of the next. The linear hierarchy of apprentices, novices, and scientists who passed along the observations, experimental results, and generalizations made the scientific method as mechanical as the operation of the universe itself. Although machine technology was relatively unadvanced in Bensalem, the model of nature and society in this utopia was consistent with the possibilities for increased technological and administrative growth.

In the *New Atlantis* lay the intellectual origins of

the modern planned environments initiated by the technocratic movement of the late 1920s and 1930s, which envisioned totally artificial environments created by and for humans. Too often these have been created by the mechanistic style of problem solving, which pays little regard to the whole ecosystem of which people are only one part. The antithesis of holistic thinking, mechanism neglects the environmental consequences of synthetic products and the human consequences of artificial environments. It would seem that the creation of artificial products was one result of the Baconian drive toward control and power over nature in which "The end of our foundation is the knowledge of causes and secret motions of things and the enlarging of the bounds of human empire, to the effecting of all things possible."[30] To this research program, modern genetic engineers have added new goals—the manipulation of genetic material to create human life in artificial wombs, the duplication of living organisms through cloning, and the breeding of new human beings adapted to highly technological environments.

THE BACONIAN PROGRAM

The development of science as a methodology for manipulating nature, and the interest of scientists in the mechanical arts, became a significant program during the latter half of the seventeenth century. Bacon's followers realized even more clearly than Bacon himself the connections between mechanics, the trades, middle-class commercial interests, and the domination of nature.

Lewis Roberts lamented the unexploited state of Mother Earth in his *Treasure of Traffike, or a Discourse of Foreign Trade* (1641):

> The earth, though notwithstanding it yieldeth thus naturally the richest and most precious commodities of all others, and is properly the fountain and mother of all the riches and abundance of the world, partly . . . bred within its bowels, and partly nourished upon the surface thereof, yet is it observable, and found true by daily experience in many countries, that the true search and inquisition thereof, in these our days, is by many too much neglected and omitted.[31]

John Dury and Samuel Hartlib, followers of Bacon and organizers of the Invisible College (ca. 1645), forerunner of the Royal Society, connected the study of the crafts and trades to increasing wealth. One of Dury's objectives was to make observations of the inventions and sciences "as may be profitable to the health of the body, to the preservation and increase of wealth by trades and mechanical industries, either by sea or land; either in peace or war."[32]

The avowedly Baconian utopia "The Kingdom of Macaria," (1641), attributed to Hartlib but probably written by Gabriel Plattes, an English writer on husbandry and mining, was dedicated not merely to the "knowledge of causes and secret motions of things," as was the *New Atlantis,* but to the total agricultural, commercial, and medical improvement of society.[33] In Macaria, the king has improved his forests, parks, and lands "to the utmost"—bringing in huge revenues. Owing to the efforts of the council of husbandry, "the whole kingdom is become like to a fruitful garden, the highways are paved, and are as fair as the streets of the city." Any man who held more land than he could develop and improve was admonished and penalized for each year during which he continued to leave it unimproved, until at last "his lands be forfeited and he banished out of the kingdom, as an enemy to the commonwealth." A council of fishing was to establish laws "whereby immense riches are yearly drawn out of the ocean," while the councils of trade by land and sea were to regulate the number of tradespeople and encourage all navigation that "may enrich the kingdom."

The health of the inhabitants was maintained by a "college of experience, where they deliver out yearly such medicines as they find out by experience." As members of the Society of Experimenters, all were required to defend any new ideas before a Great Council, which judged the truth or falsity of the discovery. "If any divine shall publish a new opinion to the common people, he shall be accounted a disturber of the public peace and shall suffer death for it."

Dissent, not only in science but also in religion, would be avoided "by invincible arguments as will abide the grand test of extreme dispute." Rational scientific judgment would thus overcome the passions and individualism of religious sects and promote health, welfare, and commercial growth in Macaria.

The virtuosi of the Royal Society were interested in carrying out Bacon's proposal to survey the his-

tory of trades and augment their usefulness. The English divine Thomas Sprat, whose *History of the Royal Society* (1667) defended it against its critics, desired to extract from the "operations of all trades," their "physical receipts or secrets," their "instruments, tools, engines, [and] manual operations." He extolled "our chief and most wealthy merchants and citizens" who had added their "industrious, punctual, and active genius" to the "quiet, sedentary, and reserved temper of men of learning."[34]

Human dominion over nature, an integral element of the Baconian program, was to be achieved through the experimental "disclosure of nature's secrets." Seventeenth-century scientists, reinforcing aggressive attitudes toward nature, spoke out in favor of "mastering" and "managing" the earth. Descartes wrote in his *Discourse on Method* (1636) that through knowing the crafts of the artisans and the forces of bodies we could "render ourselves the masters and possessors of nature."[35] Joseph Glanvill, the English philosopher who defended the Baconian program in his *Plus Ultra* of 1668, asserted that the objective of natural philosophy was to "enlarge knowledge by observation and experiment . . . so that nature being known, it may be mastered, managed, and used in the services of humane life." To achieve this objective, arts and instruments should be developed for "searching out the beginnings and depths of things and discovering the intrigues of remoter nature."[36] The most useful of the arts were chemistry, anatomy, and mathematics; the best instruments included the microscope, telescope, thermometer, barometer, and air pump.

The harshness of Bacon's language was captured in Glanvill's descriptions of the methods of studying nature. Bacon had advocated the dissection of nature in order to force it to reveal its secrets. For Glanvill, anatomy, "most useful in human life, . . . tend[ed] mightily to the eviscerating of nature, and disclosure of the springs of its motion." In searching out the secrets of nature, nothing was more helpful than the microscope for "the secrets of nature are not in the greater masses, but in those little threads and springs which are too subtle for the grossness of our unhelped senses."

According to Glanvill, Robert Boyle's experimental philosophy had advanced "the empire of man over inferior creatures" by taking seriously "those things which have been found out by illiterate tradesmen" and by developing the "dexterity of hand proper to artificers." Glanvill advocated chemistry as one of the most useful arts, for "by the violence of [its] artful fires it is made [to] confess those latent parts, which upon less provocation it would not disclose." By chemical techniques, "nature is unwound and resolved into the minute rudiments of its composition."

In his "Experimental Essays" (1661), Boyle distinguished between merely knowing as opposed to dominating nature in thinly veiled sexual metaphor: "I shall here briefly represent to you . . . that there are two very distinct ends that men may propound to themselves in studying natural philosophy. For some men care only to know nature, others desire to command her" and "to bring nature to be serviceable to their particular ends, whether of health, or riches, or sensual delight."[37]

The new image of nature as a female to be controlled and dissected through experiment legitimated the exploitation of natural resources. Although the image of the nurturing earth popular in the Renaissance did not vanish, it was superseded by new controlling imagery. The constraints against penetration associated with the earth-mother image were transformed into sanctions for denudation. After the Scientific Revolution, *Natura* no longer complains that her garments of modestry are being torn by the wrongful thrusts of man. She is portrayed in statues by the French sculptor Louis-Ernest Barrias (1841–1905) coyly removing her own veil and exposing herself to science. From an active teacher and parent, she has become a mindless, submissive body. Not only did this new image function as a sanction, but the new conceptual framework of the Scientific Revolution—mechanism—carried with it norms quite different from the norms of organicism.

NOTES

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2. Farrington, *Francis Bacon,* p. 82. James Spedding,

The Letters and the Life of Francis Bacon, 7 vols. (London: Longmans, Green, Reader, and Dyer, 1869), vol. 3, pp. 56–66.

3. Louis Wright, "The Popular Controversy Over Women," in *Middle-Class Culture in Elizabethan England* (Chapel Hill: University of North Carolina Press, 1935), Chap. 13, pp. 493, 494; Anon., *Hic Mulier, or The Man-Woman, Being a Medicine to Cure the Coltish Disease of the Staggers in the Masculine-Feminines of Our Times* (London, 1620); Lucy Ingram Morgan, "The Renaissance Lady in England," unpublished doctoral dissertation, University of California at Berkeley, 1932.

4. "Letter of John Chamberlain," Jan. 25, 1620. Quoted in Wright, p. 493.

5. Thomas Overbury, *Miscellaneous Works,* ed. E. F. Rimbault (London: Smith, 1856), quotation on p. xxxvii; see also Spedding, *Letters and Life of Francis Bacon,* vol. 5, pp. 296–305, esp. 297, 298 n.; Violet A. Wilson, *Society Women of Shakespeare's Time* (London: Lane, Bodley Head, 1924), p. 205; Wright, p. 491.

6. James I, *Daemonologie* (New York: Barnes & Noble, 1966; first published 1597); Keith Thomas, *Religion and the Decline of Magic* (New York: Scribner's, 1971), p. 520; Wallace Notestein, *A History of Witchcraft in England from 1558 to 1718* (New York: Apollo Books, 1968), p. 101; Ronald Seth, *Stories of Great Witch Trials* (London: Baker, 1967), p. 83.

7. Bacon, "De Dignitate et Augmentis Scientiarum," (written 1623), *Works,* ed. James Spedding, Robert Leslie Ellis, Douglas Devon Heath, 14 vols. (London: Longmans Green, 1870), vol. 4, p. 296. The ensuing discussion was stimulated by William Leiss's *The Domination of Nature* (New York: Braziller, 1972), Chap. 3, pp. 45–71.

8. Bacon, "Preparative Towards a Natural and Experimental History," *Works,* vol. 4, p. 263. Italics added.

9. Bacon, "De Dignatate," *Works,* vol. 4, p. 298. Italics added.

10. Bacon, "The Great Instauration" (written 1620), *Works,* vol. 4, p. 20; "The Masculine Birth of Time," ed. and trans. Benjamin Farrington, in *The Philosophy of Francis Bacon* (Liverpool, England: Liverpool University Press, 1964), p. 62; "De Dignitate," *Works,* vol. 4, pp. 287, 294.

11. Quoted in Moody E. Prior, "Bacon's Man of Science," in Leonard M. Marsak, ed., *The Rise Of Modern Science in Relation to Society* (London: Collier-Macmillan, 1964), p. 45.

12. Rossi, p. 21; Leiss, p. 56; Bacon, *Works,* vol. 4, p. 294; Henry Cornelius Agrippa, *De Occulta Philosophia Libri Tres* (Antwerp, 1531): "No one has such powers but he who has cohabited with the elements, vanquished nature, mounted higher than the heavens, elevating himself above the angels to the archetype itself, with whom he then becomes cooperator and can do all things," as quoted in Frances A. Yates, *Giordano Bruno and the Hermetic Tradition* (New York: Vintage Books, 1964), p. 136.

13. Bacon, "Novum Organum," Part 2, in *Works,* vol. 4, p. 247; "Valerius Terminus," *Works,* vol. 3, pp. 217, 219; "The Masculine Birth of Time," trans. Farrington, p. 62.

14. Bacon, "The Masculine Birth of Time," and "The Refutation of Philosophies," trans. Farrington, pp. 62, 129, 130.

15. Bacon, "De Augmentis," *Works,* vol. 4, p. 294; see also Bacon, "Aphorisms," *Works,* vol. 4.

16. "De Augmentis," *Works,* vol. 4, pp. 320, 325; Plato, "The Timaeus," in *The Dialogues of Plato,* trans. B. Jowett (New York: Random House, 1937), vol. 2, p. 17; Bacon, "Parasceve," *Works,* vol. 4, p. 257.

17. Bacon, "De Augmentis," *Works,* vol. 4, pp. 343, 287, 343, 393.

18. Bacon, "Novum Organum," *Works,* vol. 4, p. 246; "The Great Instauration," *Works,* vol. 4, p. 29; "Novum Organum," Part 2, *Works,* vol. 4, p. 247.

19. Alain of Lille, *De Planctu Naturae,* in T. Wright, ed., *The Anglo-Latin Satirical Poets and Epigrammatists* (Wiesbaden: Kraus Reprint, 1964), vol. 2, pp. 441, 467; Thomas Kuhn, "Mathematical vs. Experimental Traditions in the Development of Physical Science," *Journal of Interdisciplinary History* 7, no. 1 (Summer 1976): 1–31, see p. 13. On the Accademia del Cimentio's experiments see Martha Ornstein [Bronfenbrenner], *The Role of Scientific Societies in the Seventeenth Century* (reprint ed., New York: Arno Press, 1975), p. 86.

20. Bacon, "Thoughts and Conclusions on the Interpretation of Nature or A Science of Productive Works," trans. Farrington, *The Philosophy of Francis Bacon,* pp. 96, 93, 99.

21. Bacon, "De Augmentis," *Works,* vol. 4, p. 294; "Parasceve," *Works,* vol. 4, p. 257; "Plan of the Work," vol. 4, p. 32; "Novum Organum," *Works,* vol. 4, pp. 114, 115.

22. Bacon, "The New Atlantis," *Works,* vol. 3, subsequent quotations on pp. 165, 154, 155. On politics and science in "The New Atlantis," see Joseph Haberer, *Politics and the Community of Science* (New York: Van Nostrand Reinhold, 1969), pp. 46, 47; see M. E. Prior, "Bacon's Man of Science," in L. M. Marsak, ed., pp. 41–53; P. Rossi, *Francis Bacon,* Chap. 1. On critiques of technology, see John McDermott, "Technology: The Opiate of the Intellectuals," *New York Review of Books,* July 31, 1969; Theodore Roszak, *Where the Wasteland Ends* (Garden City, N.Y.: Doubleday, 1963), Chap. 2.

23. Bacon, "The New Atlantis," *Works,* vol. 3, quotations on pp. 157, 158, 159.

24. G. della Porta, *Natural Magic,* ed. D. J. Price (facsimile of 1658 ed., New York: Basic Books, 1957; first published 1558), pp. 27, 29, 31–40.

25. Bacon, *Works,* vol. 3, quotations on pp. 159, 158. Cf. Della Porta, pp. 59, 61, 62.

26. Bacon, *Works,* vol. 3, p. 158; Cf. Della Porta, pp. 61–62, 73, 74–75, 81, 95–99.
27. Bacon, *Works,* vol. 3, p. 159.
28. Henry Cornelius Agrippa, *The Vanity of Arts and Sciences* (London, 1694; first published 1530), pp. 252–53.
29. Bacon, *Works,* vol. 3, pp. 157, 158.
30. *Ibid.,* p. 156.
31. Lewis Roberts, *The Treasure of Traffike, Or A Discourse of Foreign Trade* (London, 1641). Quoted in Charles Webster, *The Great Instauration: Science, Medicine and Reform, 1626–1660* (London: Duckworth, 1975), p. 356; for more details on the Baconian program in mid-seventeenth-century England, the reader is referred to Webster's thorough, scholarly study.
32. Quoted in Walter E. Houghton, "The History of Trades: Its Relation to Seventeenth Century Thought," in *Roots of Scientific Thought* p. 361.
33. [Attributed to Samuel Hartlib], *A Description of the Famous Kingdome of Macaria,* intro. by Richard H. Dillon (facsimile ed., Sausalito, Cal.: Elan, 1961; first published 1641), quotations on pp. 4, 5, 8, 5, 2. On Gabriel Plattes as the probable author, see Charles Webster, "The Authorship and Significance of Macaria," in C. Webster, ed., *The Intellectual Revolution of the Seventeenth Century* (London: Routledge & Kegan Paul), pp. 369–85. See also Houghton, p. 361, and Webster, *Great Instauration,* pp. 87, 368–69.
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36. Joseph Glanvill, *Plus Ultra* (Gainesville, Fla.: Scholar's Facsimile Reprints, 1958; first published 1668), quotations on pp. 9, 87, 13, 56, 104, 10.
37. Robert Boyle, *Works,* ed. Thomas Birch (Hildesheim, W. Germany: Olms, 1965; first published 1772), vol. 1, p. 310. On Boyle's mechanical philosophy, see Marie Boas, "The Establishment of the Mechanical Philosophy," *Osiris* 10 (1952): 412–541; Frederick O'Toole, "Qualities and Powers in the Corpuscular Philosophy of Robert Boyle," *Journal of the History of Philosophy* 12 (July 1974): 295–316; Margaret J. Osler, "John Locke and Some Philosophical Problems in the Science of Boyle and Newton," unpublished doctoral dissertation, Indiana University, 1968; Robert Kargon, "Walter Charleton, Robert Boyle, and the Acceptance of Epicurean Atomism in England," *Isis* 55 (1964): 184–92.

The New Nature

GREGG EASTERBROOK

In 1993 the Russian Space Agency Glavkosmos placed into orbit a large parafoil mirror designed to reflect sunlight toward the dark hemisphere of Earth, transforming night into a false twilight with about the luminescence of three full moons. Such mirrors, Russian engineers thought, might someday shine on cities, replacing street lights with zero-pollution, zero-fuel illumination. Or the mirrors might be held on station, available to train on the sites of nighttime natural disasters or search-and-rescue emergencies. In principle a large network of space mirrors might banish darkness from the face of the Earth altogether, maintaining the night hemisphere in perpetual half-light.

For technical reasons the experiment failed, though engineers remain convinced such mirrors could function. Environmental opposition to further research was emphatic. Bill McKibben declared that space-reflected illumination would "constitute the single most offensive form of pollution yet devised by man," here defining sunlight as pollution if that light arrives when the sun does not normally