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THE CONSERVATIVE CHARACTER OF SCIENCE AND TECHNOLOGY

Carolyn Iltis

(B)7 MERCHANT

Carolyn Iltis has just completed a year as visiting lecturer in the Collegiate Seminar Program at the University of California at Berkeley (see NEWS & NOTES). This fall she will be teaching in the Natural Sciences Interdisciplinary Program at the University of San Francisco. In addition to her innovative teaching, she has published and presented numerous papers on the history of science. This paper, which follows, was originally an invited paper presented to the American Physical Society, Anaheim, California, January 1975.

ABSTRACT

The ways in which science and technology can function as a conservative force both in current social and political problems as well as in history is one of several themes being explored in a University of California, Berkeley science and society course, "The Technological Culture." The theoretical framework for the course develops the presuppositions of mechanical and holistic philosophies of nature and investigates the manner in which world views can articulate and justify the social and political interests of certain groups of people. Examples studied include seventeenth century society and the rise of the mechanical world view, the interactions between technology and the state today, and the "energy crisis." Alternative uses of technology and views of nature are also explored. The course is part of a program of intensive seminars for undergraduates who participate in faculty research investigations of current social issues and their theoretical historical roots. The interdisciplinary character of the research problems is emphasized by the collaboration of faculty and teaching fellows from two different but complementary fields. Pedagogical methodology includes the use of small student task forces to develop areas of the larger investigation, emphasis on writing and research methods, individual student research papers as well as a group seminar report, and group self-evaluation.

In the face of today's energy crisis, environmental deterioration, population explosion, and an anti-science sentiment in the general public, many science teachers are attempting to bring social issues into the teaching of scientific concepts. Often this is done by pointing out the beneficial uses of science, medicine, and technology along with their potential for solving world problems--the technological fix. Another method focuses on legal controls, government agencies, and policy making groups to control runaway technology. Still another stance is to save science by demonstrating that pure science is itself neutral and is distinct from its technical applications. These approaches neglect the social and political causes of technological problems and their historical development.

Through my own courses on science and society I have become increasingly interested in the ways in which science is used to reinforce the interests of those groups and classes in positions of power in today's society and to militate against the concerns of the poor and powerless. As an historian of science with a research field in 17th century science, I have looked for the origins of the scientific world view in this same conflict of class interests.

The significance of this approach is that it demonstrates the ways in which scientific theories and world views can be developed by social classes and therefore have a political component which reflects their needs and justifies their economic interests. Thus the mechanical view of nature generated in the 17th century was an interlocking complex of mechanical laws, a corpuscular theory of matter, and philosophical assumptions concerning the law of identity and the certainty of the mathematical method. Politically it functioned to legitimate the uses of machine technology by a rising capitalist middle class.

This mechanistic mode of viewing the world spawned in the 17th century has continued to dominate and justify technological, political motives and methods in the U.S. today. The philosophical and political meaning of the mechanistic model as it developed during the scientific revolution and its implications for our present society are one of the themes being explored in my course, "The Technological Culture." This course is part of a program of intensive seminars designed to investigate current social problems and their historical theoretical roots. It relates 17th century scientific developments to the problems of science and society today.

The scientific revolution has been glorified by scientists, historians, and humanists alike as the emergence of a rational objective empirically verifiable and reproducible methodology, through the technical application of which humanity could improve its social conditions and progress towards a better life. Almost universally, Galileo's science of mechanics has been hailed as the breakthrough in the mathematical description of motion, Bacon's New Atlantis as the model of a scientific research institute where the empirical investigations of scientific administrators are turned into useful applications for the betterment of mankind, and Descartes' mathematical method as the objectification of the world of quantities and the banishment of qualities and teleology from the analysis of nature. Finally according to scientific folklore, Isaac Newton, the lad from Lincolnshire, son of a yeoman farmer who went to Cambridge University presented to the world, in the Principia Mathematica, the supreme synthesis of all these new progressive trends and set science--its method and the mechanical world view--on a firm basis as the paradigm for future research. Those scientists and historians who have dealt with the internal history of the discoveries attributed to these great scientists, or the psychological motivations behind their published work, or even the social factors leading to the formation of scientific societies have by and large accepted the objectivist value-free ethos introduced by this 17th century scientific world view, the validity of its interpretation of nature, and the glorification of the role of science in today's society.

If instead of asking questions about the scientific revolution whose answers serve to perpetuate this social eulogizing of science in the service of mankind, we ask questions based on other more radical social and political assumptions, we arrive at a quite different interpretation of the scientific revolution which points up the emergence of science as a conservative social force, a role which it still plays today. The class structure and political context out of which the 17th century mechanical world view emerged provides the basis for this reinterpretation.

Although time prohibits a full scholarly development of this viewpoint, let me briefly indicate the approach such an investigation takes toward major figures of the scientific revolution as Bacon, Descartes, Gassendi, Hobbes, and Newton, before turning to their implications for science today.

Francis Bacon rose to power in England in the early decades of the 17th century under James I, a monarch whose political policies were substantially more conservative than those of his predecessor Elizabeth I and who as James VI of Scotland had written a treatise against witchcraft and demonology. In the early years of his reign he altered his predecessor's mild witch laws by imposing the death penalty on anyone found practicing witchcraft and passed antifeminist laws against insolent women found wearing the broad brimmed hats, pointed doublets and short hair of the male citizenry. A middle class controversy over women and an outbreak of witch trials whose victims were mainly lower class women occurred during Bacon's early years of association with James I, the repercussions of which may be seen in his analysis of the natural world.

Bacon's writings reveal a new type of metaphor used to describe nature which had previously been viewed as a nurturing mother in whose womb grew the crops and metal ores necessary for human survival. Bacon states that nature's womb harbors secrets which must be wrested from her grasp. Men must not scruple to "penetrate into her holes and corners," to examine nature with interrogations and "to conquer her, subdue her and shake her to her foundations..." She should "be bound into service," "put in constraint" and "molded by the mechanical arts." Nature should thus be put on the rack and tortured to reveal her secrets, an attitude strongly reminiscent of the witch trial procedures rampant at the time. The justification for the domination and control of nature therefore appeared in conjunction with Bacon's empirical method.

The idea that nature could be dominated was strengthened and supported by the revival of the atomic theory which viewed nature as dead passive particles, and the development of the mechanical world view beginning in the late 1720's and 1730's in France. This philosophy was introduced by Marin Mersenne, Pierre Gassendi, and Rene Descartes, all of whom were in close communication and reacting to rapidly changing French social conditions. Their ideas appeared during the same years in which there were numerous peasant uprisings over food shortages and revolts against government tax increases. This was the period of growth of absolutism under Richelieu and with whose intellectual circles the mechanical philosophers had important connections.

Mersenne, Gassendi, and Descartes developed their philosophy in reaction to ideas of the hermetic philosophers, magicians, Rosicrucians, naturalistic philosophers, skeptics, and atheists which were perceived by them to be socially and intellectually dangerous. Paracelsus and Campanella, for example, identified with the peasants and lower classes. Bruno held heretical anti-hierarchical ideas about religion and nature, and the Rosicrucian philosophy was dedicated to the exposure and improvement of social conditions and the healing of the impoverished sick.

The mechanical philosophy segmented the world into inert passive particles, viewed change as the rearrangement of these inactive parts, held force to be external to matter rather than internal and hypothesized that motion was ultimately supplied by God who created and supervised the world. The machine metaphor reinforced the need for stability, identity, and external control as an antidote to the unstable social conditions. The political implications of this philosophy were pointed out by Descartes who wrote to Mersenne that a king sets up laws in his kingdom just as God sets up laws in nature. They were further developed by Hobbes,who in reaction to the chaos, anarchism, and "masterless men" rampant during the English Civil war argued that an artificial state, the Leviathan, must be instituted to prevent the chaos wrought by men living in the state of nature.

Isaac Newton was born in 1642 as the English civil war was breaking out and the chaos it wrought formed the social setting of his boyhood. Amid the fight between Royalists and Parliamentarians another fundamental confrontation was occurring between the propertied landholders and lower class laborers, craftspeople, peddlers, and landless peasants turned wanders by the enclosure of common lands. The Restoration of Charles II in 1660 which brought a return to the values of the old monarchy was soon followed by the granting of a Charter to the Royal Society, and the beginnings of the institutionalization of science in England. David Kubrin's pamphlet entitled "How Sir Isaac Newton Helped Restore Law'n Order to the West," demonstrates the ways in which emphasis on the study of science, cosmology, and natural law can reinforce the sought-after stability in the social order. Major intellectual developments in the search for certainty in 17th century law and science occurred simultaneously, often through collaboration among scientific virtuosi and lawyers who were Royal Society members.

The cosmological metaphor of the universe as a vast clocklike machine, the motion of whose parts was orderly and predictable reflected the increased use of machines in the mining and textile industries. The machine metaphor, utilized to explain the motions of the human body and of animals, reinforced the use of human labor as parts of a growing industrial machine system. The protestant ethic sanctioned the accumulation of capital and profit by the elect, those chosen for salvation.

We can begin to see how mechanism represented an ideology which unified scientific, religious, and political theory and which justified and supported the needs of a progressive rising middle class of entrepreneurs whose interests required the domination of nature and of people. A scientific world view can thus function as a conservative social force helping to maintain the stability sought after by the elites in power and to militate against social change and the assumption of control by the lower classes.

Despite developments in quantum and particle theory on the frontiers of physics in this century, the mechanistic model continues to guide technological and industrial development today. In The Technological Society, Jacques Ellul has pointed to the techniques of economics and the mechanic organization of specialties inherent in and entailed by the machines and mathematical methods themselves. The calculating machine, punch card machine, microfilm, and computer transform statistical methods and administrative organization into specialized agencies centered around one or more statistical categories.

Econometric models and stochastics are techniques used to operate on the statistical data in order to analyze, compare, and predict. Attempts to predict reactions by the public through the stochastic calculus of probabilities may make a public informed of its conformation to a trend act in the inverse manner.

> "But the public," says Ellul, "by so reacting falls under the influence of a new prediction which is completely determinable...It must be assumed however that one remains within the framework of rational behavior. The system works all the better when it deals with people who are better integrated into the mass...whose consciousness is partially paralyzed, who lend themselves willingly to statistical observations and systematization."

The attempt to reduce human behavior to statistical probabilities and to condition it by such psychological techniques as those developed by B. F. Skinner are manifestations of the pervasiveness of the mechanistic mode of thought developed by the 17th century scientists. The technological scientific elite constitutes a separate society with access to private knowledge and vocabulary attained through years of specialized training, which excludes even the well educated public and renders democratic decision-making virtually inadmissable.

Technology today primarily serves the interests of the corporate entrepreneurial class and the state through the symbiotic relation between government and industry. Economic and political stability can be maintained through defense contracts parcelled out to large corporations and subsidiary industries and the participation of representatives from both spheres in technical construction and implementation decisions. University scientists such as the Jason Committee who advised the Pentagon on the construction of the electronic battlefield in Vietnam help to perpetuate these interests by accepting military and industrial consulting fees.

Today's energy crisis furnishes an example of the ways in which entrepreneurial interests result in environmental deterioration and the neglect of the needs of the working public. Out of the 1976, $1, 237,000,000 budget of the Energy Research and Developmental Administration (ERDA), $1,000,000,000 went to the development of nuclear fission (80.8%). Government support for nuclear power and the policy that nuclear fission is a safe energy source feeds the shorter time scale for the appearance of large short-term corporate profits in the fission power industry. Fusion and solar power research account respectively for only 9.7 percent ($120 million) and 4.6 percent ($57 million) of EDRA funds. Fusion and solar power research have been virtually ingnored because implementation of these sources requires enormous capital outlay and much longer amortization

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[1] Jacques Ellul, The Technological Society (New York: Random House, Vintage books, 1964), p. 165.

of capital.

Geothermal funds amount to only $28 million, or 2.3 percent of the budget. Government leases for California lands containing potentially cheap, geothermal energy sources in the last two years have been bought by the major oil companies. Shell Oil bid close to $5 million for the initial lease of 2340 acres of government geothermal reserves. Others went to Union Oil of California, Signal Oil, and Occidental Petroleum, with all bids going to less than one dozen oil companies. The two exceptions were a California rancher and a Northern California Public Power Agency. Today oil corporations not only control the U.S. oil reserves, but also 72 percent of the natural gas, 50 percent of the uranium, and 30 percent of the coal reserves in this country.[2]

Although the blame for the energy crisis has been placed on the public, the need for these large energy expenditures has been created and built up by corporate growth and board room decision making. But the energy shortages to come will mainly affect the lower and middle classes.

The mechanistic ideology of the 17th century still functions to support the manipulation of the public into the need for increased energy through corporate expansion and the deterioration of the environment to meet these ends.

The mechanistic model also determines the prevailing mode of science teaching where the teacher is the expert and the student a passive receptor of certified knowledge. Science and society courses present a challenging opportunity to break away from this technique of control over both information and people.

In the Collegiate Seminar Program (a group of small intensive 10-15 unit seminars) students and teachers participate in the learning process together by defining the course as an investigation in which all members are interested in participating. Students and faculty both take part in the generation of new courses. As convenor of the class the teacher has background, perspective, and leadership ability, but does not necessarily know the answers to the problem at hand. The teacher may present initial reading suggestions, but as the course proceeds, the internal energy and collective interests of the group help to determine the direction of the investigation. Both students and teacher may suggest readings and take responsibility for the sharing of relevant information. The participation of students in the teaching process helps to build self-confidence and break down hierarchical barriers to learning.

We have found that breaking down the seminar into small student task forces to handle parts of a larger problem can be a very successful teaching technique. During a 2-3 hour seminar meeting small groups of 3-4 people can meet separately for 15-20 minutes to generate facts and data around one of the interlocking themes for the day's discussion. When the groups return to pool information a joint analysis of the particular question under investigation is possible. These small groups can be less alienating to shy students.

Since the program requires extensive writing with one long research paper per quarter, small workgroups formed around related topics encourage the sharing of information and resources. In addition to individual research projects each seminar, at the end of every quarter, pre

An important aspect of seminar work is the process of criticism--self-criticism, held at the end of every class or during the session if called for by a member. Its purpose is to raise consciousness of the group discussion dynamics and improve ways of operating together. The teacher may suggest things she or he could have done differently, point out positive dynamics, and accept criticisms by students for talking too little or too much. Students may point out to other students ways in which they hindered or helped the discussion. Shy students can be asked if they would like to be encouraged to participate or would prefer to be left alone.

Goals of the program are the creation of a non-alienating learning community in which decision making is a group process.

[2]Source: Small Business Committee, 92nd Congress, 1971.

These methods suggest an alternative view of society and of nature, the presuppositions of which may be called holistic. This theory holds that all parts of a group or system are of equal value and mutually connected with every other part in an organic whole. The whole is greater than and more important than the sum of the parts. The internal source of activity makes the system autonomous, dynamic, constantly in flux, and adaptable. Change is a continuing process arising from internal tensions rather than from external manipulation and control of the parts.

On a natural level, holism preserves the integrity of the ecological environment, recycles wastes, and does not take profits from nature. On a social level it makes regions and communities autonomous with control over their own energy sources, technology, and means of production. Technology can benefit all people rather than the favored few. On a political level, decision making is an internal community process where all voices are heard.

MOCK APPLE PIE: THE CONVENTIONAL TEACHER IN AN UNCONVENTIONAL PROGRAM

Roger L. Welsch

In our first issue we featured three articles originally published in THE CENTENNIAL EXPERIENCE: Faculty Perspectives of a Cluster College, edited by Gene Harding, University of Nebraska-Lincoln. Here is a fourth article from this collection. Roger L. Welsch is an assistant professor of English at the University of Nebraska- Lincoln. He has written widely on Plains folklore.

Mock Apple Pie

Break in pieces one and one-half soda crackers and pour over them a cup of cold water; let it stand while making the paste. Put in a pie plate with a little nutmeg, add a cup of sugar and the juice of one lemon, vinegar may do.

<u>Nebraska Farmer</u>, January, 1877

In spite of all apparent logic, some tastes--for apple pie and conventional lecture-teaching, for example--persist in an openly hostile, unyielding matrix. In the nineteenth Century Plains pioneers insisted on eating apple pie even where there were no trees, much less apple trees. So, they devised the recipe above. It is not very good pie and it tastes only remotely like apples, but it was the principle of the thing that mattered. They were accustomed to apple pie, not groundcherry pie or Jerusalem artichoke pie or wild plum pie. They were comfortable with <u>apple</u> pie, even if the resemblance consisted more of the semantics than the reality.

To some observers the persistence of such concepts, in spite of all apparent logic, is stupid at best, an obstruction to progress at worst. To them, all change is progress. To others, no change is progress, and they resist every innovation as inherently bad. In the case of education, I do not think I am overstating either case.

As a folklorist however I am used to being surprised, but increasingly my surprise is at the amount of truth in the second view. I am more and more amazed at how little change represents true progress. That is why I could not write the lead sentences of the two paragraphs above without adding the hedge-phrase "in spite of all apparent logic." I am struck more and more, as I dig deeper into pioneer and Indian life of the nineteenth century, not so much by its primitive or superstitious quality but instead by its fundamental soundness and, conversely, by the truly "superstitious" nature of the scientist's--or perhaps better, technician's-skepticism.

Two examples of some recent surprises, representative of several hundreds of similar experiences I have had in the past fifteen years of folklore research:

1) Planting by the Moon :

It is a well known and widely spread belief that underground crops, like potatoes, are to be planted in the waning moon, so that the moon will not "pull" the growth upward, and above ground crops should be planted in the waxing moon, so that the full moon <u>will</u> "pull" the crop upward, "like it does the tides." Well, those of us who know our way around this technological age can easily explain how the mass of the