In Proceedings of the Sixth Annual Meeting of the National Association of Science, Technology and Society, pp. 67-76 (1991)

THE SOCIAL STRUCTURE OF NATURE

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Nature is reacting to the activities of modern society in unique and largely unexpected ways. These reactions are in some ways surprising since human society has traditionally been ascribed a minor role in determining the course of natural processes. Though society has long discarded its wastes in nature, the "predominant view in the natural sciences was that life on Earth is primarily passive, responding to nonliving forces like volcanic eruptions, severe storms, droughts, and even drifting continents" (Schneider, 1989:6). While this conception of passivity is under increasing challenge, the "critical importance of human involvement seems to have been lost" in many of the recent physical and biological debates of global change (Price, 1989: 42). In those rare instances where attention is given to interactive relationships, discussion of the social and political character of human organization and activities is strangely absent. Thus, the few cases in which global warming has been portrayed in terms of nature-society interactions rely almost exclusively on units of carbon (or other chemicals) emitted per person or per unit of economic activity to characterize and measure the relationship. But the energy-environment-development nexus cannot be captured by studying the chemical content of energy-based industrial emissions alone. Indeed, the social content - the political economy - of this nexus is likely to be key to unravelling the sources and responses to global change. Perhaps the most difficult challenge is to consider whether nature is undergoing a process of social capture which eventually may make it in effect a social sub-system subject to political attitudes and ideologies, and a functioning part of the world political economy. Although the present energy- environment-development regime is only about 300 years old (dating to the spread of a coal economy, steam technology and wage labor), it has reached a level of sophistication which may render its operations a threat to several million years of climate, biological and social evolution.

SOCIAL STRUCTURE AND NATURE

Three hundred years of industrialization have rendered social and ecological relations[1] largely commodity-based. Human existence transpires within a reality of production and consumption of commodities which together release into the air and water and deposit on plants and the soil pollutants more numerous than we probably know and, certainly, more complex in their effects than we understand. This reality is structured and motivated by the logics of technology and capital; environmental consequences are, at best, a residual concern. We depend for our lives and our experience of life upon a collective capacity to produce goods and services and upon individual capacities to obtain and consume goods and services, as though nature was incidental to the human drama. As Mumford argued, society has become a "megamachine" with its members existing as so many machine parts. In the technological milieu, natural experience has all but evaporated except as an "emotional good."

There have been concerted efforts to develop social analyses which can both characterize the commodification process and challenge its hegemony over social and ecological relations. But even the most comprehensive social frameworks conceive only the possibility of social activities which degrade the environment. Structural transformation of the environment is presumed to be beyond the reach of social influence. Theories of Western political economy,

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[1]Social relations refers here to individual and collective relations among human beings; while ecological relations refers to the interaction of humanity with all other forms of life and with the natural order as a whole.

for example, are regarded by many as among the most extensive in social analysis in their critical examination of social power and exploitation. But even in this comprehensive social framework, the rules or laws of nature are understood to operate literally outside the laws of social motion (as Marx termed them).

The analytic boundary between society and nature assumed in theories of political economy does not preclude conception of relations between the two. But efforts in this direction need to observe the difference between nature-society relations and putatively social ones (especially, political and economic relations). For example, it is possible to develop a structural analysis of social activities producing pollution: social behaviors can be conceived as structurally organized to continuously disrupt or degrade "environmental quality"; and changes in social structure can be shown as necessary to remedy the pattern of polluting behavior. Such an analysis, though, leaves intact the distinction between society and nature as phenomenal structures.

Natural inquiry in its most general form likewise observes an analytic boundary between the two spheres. The influence of human beings on natural operations and vice versa, is recognized in the paradigms of biology, chemistry and physics. But again, the architectures of social and natural order are understood as maintained by relations and rules which are distinct to each sphere. In this respect, natural inquiry, like its social counterpart, operates on a premise of dual realities - one social and one natural. Implicit in the dual-realities premise, from a social point of the view, is the assumption of the permanence of nature, particularly as a reservoir for social activities. It is presumed that virtually anything can be socially practiced and repeated with the principal environmental consequences being a natural disturbance or degradation of environmental quality. To speak about environmental "spillover effects," "externalities" and "social costs," it is essential to the very logic of the language in which these ideas are conceived that one can reliably believe in the natural reservoir as, in effect, bottomless; and that the problems of environmental disruption or degradation, eventually, can be internalized within the social structure. This does not preclude social catastrophe - the starvation of large populations, the spread of epidemics, annihilation of societies or even the human species - but, ultimately, such disasters are confined to their social sphere. The permanence of nature is not obviated or negated by human disasters.

The natural point of view is similarly predicated on nature's analytic permanence. Only with this characteristic can nature provide the grounds, literally, for validation/falsification of the supposed rules and laws of natural order, the epistemological centerpiece of this mode of inquiry. We cannot think about natural order within the reigning paradigms without, at the very least, assuming a distinct order for nature. Indeed, for most practitioners of natural inquiry, a hierarchy of orders is implied between the natural and the social, with the former setting, broadly, the conditions and constraints for actions in the latter, a so-called ecology of order.

However, a range of "environmental" issues, including the rapid decomposition of stratospheric ozone and other changes in the chemical composition of the earth's atmosphere, point to the difficulties, to say the least, of maintaining the assumption of a dual reality - one natural, and one social - at the structural level. For our purposes, the most important scenario for the breakdown of the dual reality thesis is that the commodification process has functionally spread to the architecture of nature itself. In this possibility, the potential for social activity to affect its own context is thought to be great enough to redesign nature. This potential is in part an outgrowth or legacy of social behaviors under the structural guidance of industrial capital; and in part a result of the achievements of certain scientific and technological practices. Under this scenario, the forces of technology and capital are not limited to acts of natural disturbance or degradation. Rather, the very structure of nature is subjected to the design principles of these social forces. The contrast would be between capital- and technology-guided decisions to endanger the health of workers and whole communities by pollution practices at various industrial sites (which enhance profit, market position, etc.); and the collected practices of technological societies which in toto valorize a particular atmospheric chemistry (specifically, one richer in CO_2). The difference is fundamental. In the former case, a social structure- technological society - guides behaviors which adversely impact nature at the

behavioral level: air, water and human tissue are poisons to some degree. But the natural order which produces air, water and living matter is not itself altered; the effect of the pollution is too small to restructure nature. In the latter, social structure threatens to cause a different natural order to evolve. This interpretation conceives commodification as having breached the nature - society duality and is now encroaching on the structural organization of nature itself. This prospect lies beyond the theoretically possible for social and physical analysis as presently organized. Apparently, however, it is not outside the reality of contemporary energy-environment-development relations.

THE PHASES OF COMMODIFICATION

In this section, an analysis of the commodification process and its evolution through three phases is offered. As developed here, the three phases represent a process of maturation in energy-environment- development relations. The reach and range of commodification embedded in these relations successively expands and manifests an accretive quality in its evolution. We do not intend in this analysis to suggest that different relations underlie each phase; quite the contrary, we believe that a common core of relations can be detected across the three periods of order and change.

Carboniferous Capitalism

In this century's most comprehensive examination of Western urban industrial growth, Lewis Mumford argued that modern society has simultaneously lost all semblance of balance with the natural order while reducing the focus of human life to the mere production of things (Mumford, 1961). An alliance of science, capitalism and carbon power reorganized social order on the pervasive principle of *quantification* (Mumford, 1961: 570):

> Quantitative production has become, for our mass-minded contemporaries, the only imperative goal: they value quantification without qualification . In physical energy, in industrial productivity, in invention, in knowledge, in population the same vacuous expansions and explosions prevail.

The new social order produced goods at an unparalleled rate and magnitude, but also pollution of a type and scale hitherto unknown (Mumford, 1934: 168-169):

> In this [industrial] world the realities were money, prices, capital, shares: the environment itself, like most of human existence, was treated as an abstraction. Air and sunlight, because of their deplorable lack of value in exchange, had no reality at all. . . the reek of coal was the very incense of the new industrialism. A clear sky in an industrial district was the sign of a strike or a lock-out or an industrial depression.

The nature and contents of what Mumford called the "atmospheric sewage" of modern industry changed in the 20th century, but the chain of energy combustion-to-environmental degradation was not altered. The alliance of science and technology, the power complex, and the industrial economy ushered in a social order of environmental mining and pollution as a functional part of human progress. In effect, pollution was "normalized."

Lasting well into the 20th century, the phase of *pollution normalcy* is distinguished by its rationalization of nature as alternately a resource mine and a bottomless sewer into which the afterthought of industrial production could be deposited. The industrial degradation of nature, of course, did not exempt human life from the damage. Indeed, industrial tolerance for pollution presupposed that human suffering was a necessary part of the equation. As the air was fouled with technological and economic advance, 20th century cities, like their 19th century counterparts, were afflicted with the worst pollution. Circulated through an industrially-manufactured cloud of chemical waste (mostly energy-based), urban air worldwide exacted the price of modern existence - life threatened by the involuntary, heretofore

life-giving, act of breathing. Chronic bronchial, lung, circulatory and heart problems were and are the special mark of industrial civilization.

When the industrial elites worried at all about pollution or social health, it was to assure that popular efforts to address these problems were kept strictly local and posed no threat to profit-making. In this objective they were assisted by the "new thinking" of economics which abstracted environmental social abuse from the workings of the production regime, assigning them the residual status of an "externalities." In this treatment, those who profited from pollution or threatened human health were exempted from responsibility for cleaning up; society as a whole was to bear the burdens of progress. Policy and law followed the "analytic" view of the economists, giving institutional permission for the waters, land, air and the human body to be used as dumps.

The legitimation of pollution and disease, while a defining facet of early capitalism, must be understood within the broader context of the commodification of society. The target of capitalist development in its first century was the transformation of all social activities into commodities to be valorized in markets and exchanged for cash. Labor, leisure, sexuality, emotion and, above all, the human experience of time were stripped of their intimacy and personality, and reconstituted as anonymous units of objective economic value. The reduction of nature and the human being to a supplier of resources and a repository of wastes was an instrumental component of the commodification process; but exploitation (of humanity and nature) was the driving force of the period.

Technological Authoritarianism

A series of pollution spectaculars beginning in the late 1960s disrupted the quantitative existence of industrialism. One of the most significant for the U.S. occurred in January 1969 when an oil well off the shores of Santa Barbara, California, drilling to a depth of nearly 3,500 feet suffered a "blowout, an uncontrolled eruption" of oil (Easton 1972: 8). The eruption lasted 12 days, creating an oil slick of one to three million gallons of oil and covered an area of 800 square miles (roughly two-thirds the size of the state of Rhode Island). Fifty five miles of coastline were washed with a "black tide" of approximately 1.3 million gallons of oil. The greatest danger occurred along a seven mile stretch of Santa Barbara waterfront where 390,000 gallons of crude came ashore. The toll on wildlife was substantial: 6,000 to 15,000 birds died as a result of the blowout, as well as 74 elephant seals and five whales (Easton, 1972: 257-261). The well was eventually capped with a 3,400 foot column of cement but significant seepage from rock and sand fissures caused by the blowout continued for several years. Seepage is still occurring 21 years later.

While politically important for the U.S., the Santa Barbara "spill" ranks a mere 46th in the calvacade of modern oil spill spectaculars. A second environmental warning on March 23, 1989 suggests how greatly the scale of damage has escalated. The Exxon Valdez oil tanker ran on that date into a reef in the Alaskan Prince William Sound and spilled 37,415 tons of crude. The oil spread to five National Wildlife Refuges and three National Park areas; the slick covered 900 square miles - roughly three-fourths the size of Rhode Island. Hundreds of miles of shoreline were washed with a black tide, in some places up to 6 inched deep. The estimate of birdkills was 100,000, including 150 bald eagles. Approximately 1,000 sea otters were also killed. Debris from the oil spill was in excess of 100 million pounds; a repository for this magnitude of waste must still be found.

The Santa Barbara and Prince William Sound devastations point to an important transition in energy- environment-development relations. No longer is the fuel source, its emissions or its wastes the principal agent of environmental violation; while oil gushed from the Santa Barbara well and emptied from the Valdez, it was the technological system and its normal accidents (Perrow, 1984) that was the cause of each disaster. In this regard, society presently degrades nature not because of its commitment to a carbon economy, but because of its commitment to technological progress. We risk environmental disaster because we are a technological society.

Oil spills are only one category of pollution spectacular experienced as part of the normal operations of contemporary industrial political economy. In addition, there has been a ubiquitous tolerance for the rapid destruction of forests and lakes. Also threatened are the interior waterways of the industrialized territories into which are dumped the liquid and solid effluvia of civilization. This source is undeniably obnoxious, but dated in its sophistication. Like coal slag, the dumping of industrial wastes in streams, rivers and lakes is a product of old-fashioned technology. The manufacture of "acid rain," on the other hand, is a more modern and insidious technique for fouling waters. The important elements of acid deposition, sulfur dioxide and, to a lesser degree, nitrogen oxides, are transformed chemically in the atmosphere and fall to earth as acidic rain, snow, fog or dry particles. Damage to aquatic resources, estuaries and costal waters, timber and recreational resources, buildings, monuments and statues, and public health are the result.

The geographic scale of acidic damage being experienced and the particular chemistry of the acids involved are distinctive to our technological civilization. Only advanced political economies can manufacture this pollution order. While not a product of spectacular technological failures - continental and transcontinental acid pollution is, rather, a systemic emission of mature industrialism - this pollutant nevertheless derives from technological progress and is remediable only by sophisticated technological means. In this respect, our social and natural futures are increasingly contingent upon even more intensive social commitments to technological progress.

A third example of technological pollution is nuclear power. In this technology, societies create both the conditions for pollution spectaculars and long-term, transcontinental-scale threats to all forms of life and habitat. With the knowledge of nuclear fission, the human race acquired the permanent capacity to destroy the basis of life on earth (Schell, 1982). This capacity renders obsolete nature as we have traditionally known it. No society can escape the threat of nuclear annihilation, but must depend upon the mutual decisions of the community of nations to forego use of certain applications of atomic knowledge. A parallel condition of dependency upon social decisions/actions exists for the natural order as well.

It is not simply nuclear weapons that thrust society into the forefront. As was learned in the Chernobyl accident, civilian applications pose a sizable threat as well. While the catastrophic dimension of the accident cannot be overlooked, an even more serious question is raised in its aftermath. Traces of iodine 131 and cesium 137 in milk throughout Europe underscore the enormously hazardous risks associated with the use of nuclear reactions to produce electricity. The gases, and their components, released in the accident are the same as those to be found in a safely operating reactor. The rubble at the Chernobyl site is dangerous to human health for tens of thousands of years; but so are the interior surfaces of the containment vessels of nuclear plants retired after decades of successful, accident-free operation. Indeed, the rubble is no different in the risk it poses to life than the waste products generated from the normal operation of a nuclear plant.

In this respect, nuclear technology and the accidents that can accompany its use are catastrophe-prone. Nuclear energy requires, as an inherent condition of its use, that protective social institutions be constructed outside the mainstream of society which are dominated by technical experts and the military. Further, these institutions must last longer than any in the human record. Indeed, management of the nuclear waste stream requires 1,000 year nuclear security zones and 100,000 year surveillance mechanisms (Weinberg, 1979:94-95; Anderson et al, 1980: 30).

Only successful technological management and innovation can prevent the natural order from utter destruction. Yet, continued spread of modern technology will only increase the frequency of accidents, and the stockpile of long-lived, toxic waste, bringing into sharp focus the hegemony of commodity values over life-affirming ones. Notwithstanding the escalation of risk and destructive potential, industrial momentum requires acceptance of environmental degradation; a necessary trade-off if progress is to be sustained. Of course, society could go without oil retrieved from beneath the sea, or oblige investment in expensive anti-spill

technology; it could reduce electricity consumption, or mandate expensive technology retrofits to remove the acidification threat; it could close all nuclear facilities and adopt a sustainable development path. But such choices would mean repudiating the very quantification ideology which undergirds modern ideals of progress. In addition, failure to take environmental risks would multiply problems in other sectors of the industrial system which depend upon existing operations of the power complex. Restrictions on new oil exploration, electricity consumption and nuclear technology would almost certainly upset the balance of the technological system. The only acceptable alternative in technological society for meeting energy needs is to resort to risky technology options like nuclear power. In this respect, modern society increasingly struggles with itself: it Is a captive of the environmental problems that it is uniquely capable in all of social history of creating; and likewise a captive of the technological solutions which, once employed, invariably breed new, more difficult social and environmental problems.

Technological requirements are paramount in the new order. Human existence has been broken into endless acts of commodity production and consumption which in turn depend for their accomplishment upon networks of technology. In an explicit sense, society is governed by technological institutions which create and manage the conditions of human experience. Nature is reduced in this phase to a technical problem. An authoritarianism of technique prevails in the social and, increasingly, natural spheres.

Big Science

Society is on the threshold of a third phase of commodification. In this new era, nature will no longer be exploited for its particular attributes but will be transformed and reshaped to meet the needs and interests of technological civilization. Whether this transformation is intentional is largely beside the point. Technological societies now, or in the near future will, possess the capacity to alter the very structure of nature regardless of intent. Global warming is both the threat and promise of this phase. As Nicholas Shackleton, a climatologist at Cambridge University, has suggested, "we are going outside what nature has experienced in the recent past 500,000 years" (New York Times, January 16, 1990: C1).

The principal "greenhouse" gases - CO_2, N_2O, 0_3, CH_4 and CFCs - have continuously increased as concentrations in the atmosphere since the pre-industrial period. The primary source of these gases is fossil-fuel combustion, which accounts for nearly one-half of the CO_2 increase and is an important source of higher N_2O. If we sum across social activities, nearly 60 percent of worldwide greenhouse emissions are associated with energy production and use. Greenhouse theory hypothesizes that an atmosphere composed of high concentrations of these gases will result in higher surface temperatures. Certainly, data on global mean temperatures over the past 100 years of worldwide industrialization confirm that the planet is warming. Although the precise magnitude and physical dynamics of the greenhouse effect remain the subject of much debate, a scientific consensus appears to have formed on its existence (Flavin, 1989:15-16).

Indisputably structural in character, the greenhouse effect includes not only the prospect of higher temperatures, but changes in sea level and the distribution and location of dry and wet land areas, as well as the alteration of a host of other biological and climatological processes. The implications for human and natural existence of such changes are serious enough in their own right. But perhaps even more disturbing is the prospect that social capacities exist to instigate such radical alterations of the natural order. The most vivid means of illustrating this concern is to first consider the process by which global temperature change is effected in an exclusively natural structure. Climatic history, heretofore, was determined by the confluence of three astronomical cycles which regulate the earth's orbital ellipse, axial tilt and wobble. The orbit cycle which fixes the earth's travel within the solar system takes approximately 100,000 years to complete the series of elliptical modifications involved; the tilt cycle lasts about 41,000 years to accomplish a series of axial corrections; and the elapse of the wobble cycle is nearly 23,000 years. Together, these cycles control the timing of global warming and cooling by altering the angles and distance from which solar energy reaches the earth.

To appreciate the magnitude of social interference, these very long-lived cycles must be placed alongside the 300 years of industrialization (with the last 100 years representing, by far, the most carbon-intensive), which are cumulatively believed to have begun a social process of temperature change. The time disjuncture in these terms of reference points to the immense capacity assembling in the world political economy to threaten nature. Even skeptics of the present status of the greenhouse effect should be awed by the potential for social engineering to change the natural structure, which, if not available presently, almost certainly will soon be.

The carbon buildup that has accompanied industrialization is a testament to the systematic imposition of commodity values on the society-nature relation. It is the environmental expression of energy-economic quantification. The depth to which commodified nature is presumed by the existing social order can be exemplified by considering how the carbon dependence of modern development might be slowed or reversed. In a remarkable series of scenario analyses for a U.S. Environmental Protection Agency (EPA) report[2] on *Policy Options for Stabilizing Global Climate* (Lashof and Tirpak, 1989), some indication of the carbon dependency of the world political economy is given. Using a 110-year planning horizon, the EPA study first sought to identify a series of global carbon-reduction strategies which might stabilize atmospheric greenhouse gases at a concentration which assumes a 1.5 - 2.0 C increase in global average temperature. That is, the first scenario *assumed* that global warming is inevitable, but that we can hope to place a ceiling on the magnitude of warming. Introducing policy options iteratively into the climate change model used for the project, the researchers discovered that single, or even limited numbers of, policy steps could not achieve chemical stability. Rather, *eleven* major initiatives would be needed which ranged from a phaseout of CFC use by the year 2003; a major reforestation effort worldwide; adoption of a series of energy-efficiency improvements including the achievement of a global fleet-average auto fuel efficiency of 50 miles per gallon (mpg); and government- sponsored speedup of the commercialization of solar technologies. Even with these substantial responses implemented, the study relied upon increased nuclear power production[3] to meet the goal of a warming commitment of 1.5-2.0 C.

A second simulation defined the objective as no *additional* warming beyond the year 2000. Again, policy planning was stretched over the period from the present to 2100. The analysis assumed implementation of all strategies in the atmospheric chemical stabilization scenario, and eight additional policy responses. High carbon emission fees are imposed on the production of fossil fuels in proportion to CO_2 emissions potential; and an excise tax on fossil fuel use is enacted for the industrialized countries. Separate auto fuel efficiency standards are imposed on the U.S. which require SO mpg fleet averages by 2000 and 65 mpg by 2025. And, deforestation is halted worldwide by 2000, and reforestation efforts are doubled over the stability scenario.

These analyses demonstrate the results of 300 years of commodification of society and nature. Just to moderate the process (the stability scenario) requires extraordinary global cooperation. To begin to undo the commodification of the atmosphere (the rapid reduction scenario), global cooperation is not enough - steps toward the restructuring of industrial societies is needed. Bluntly, the removal of the prospect of transforming nature depends upon radical structural action in the social sphere. Nature and society are now structurally joined.

The manufacture of acid rain and holes in the upper ozone, the extinction of plant and animal species (and the engineering of new ones), the reduction of the planet's capacity to breathe (due to deforestation, among other things), the manufacture of highly toxic, long-lived poisons which are so dangerous that they require 1000 year security zones, and the creation and satisfaction of consumptive appetites which in their aggregate portend a change in global climate - all have become rational and efficient. A recent article in the *New York Times*

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[2]The report, published in draft in February 1989, has yet to be released in final form.

[3]Although, to rationalize the technology's promotion, it was necessary to assume annual 0.5% *decreases* in construction costs, something the world has yet to experience in 40 years of operation of the industry.

(November 19, 1989) concerning the debate over global warming and the possible need to restrict world carbon dioxide emissions is illustrative of the advanced industrial mind. In the article, Harvard economist Thomas Schelling pointed out that, "both the will and technological ability to adapt to radically different weather [has changed rapidly]. In 1860 two percent of Americans lived outside temperate or subtropical zones. By 1980 the percentage had increased to 22 percent." Schelling further argues that "the appealing idea of bequeathing the biosphere intact seems arbitrary. The quality of life in 100 years... will depend as much or more on the endowment of technology and capital as on the percentage of carbon dioxide in the air. And if money to contain carbon emissions comes out of other investments, future civilizations could be the losers." Citing a study by the U.S. Environmental Protection Agency which estimates the cost of protecting American coastal cities from a three-foot sea rise at $73 to $111 billion, the article notes that this is "a lot of money but not so much compared with the likely cost of prevention." The article concluded that an analytical consensus is emerging: "it may be cheapest to deal with the effects of global warming rather than the causes."

Thus, in the third phase of commodification we are committed to a form of world political economy in which global warming is the necessary risk of progress. Whereas the initial stages of carboniferous capitalism tested the statics of nature, namely, the absorption capacities of land, water and air, the advanced industrial order of global capital and markets challenges the dynamics of nature, in particular, the seasons, the tides, the breathing of the planet, and even the reproductive cycle of the atmosphere. While the emblems of advanced industrialism, like carboniferous capitalism, remain waste and pollution, there has been a fundamental breach of the nature-society relation. Advanced industrial life transpires not simply outside the constraints of nature, but relegates nature to commodity status, to be purchased and sold in the world political economy along with other products and services. The contemporary world political economy presumes that sustainability is a technological and economic matter. Although this presumption is typically manifested in economic terms and thus continues to be most concretely presented in discussions of trade-offs between environmental protection and material progress, its deeper implication is the demise of any idea of the inviolability of nature. There is *nothing* in advanced industrial logic beyond technological manipulation; not the climate, not the atmosphere, not species diversity. Nature is stripped altogether of autonomous status. Society as the master of nature fulfills the Western dream of science. Reason can replace randomness in the governance of life and empower humanity to author its future without constraint. Global warming signals the arrogation by society of the master role; science replaces nature as the basis of life.

CONCLUSION

The scientific revolution and the rise of capitalism initiated the reconceptualization of the relation between society and nature. A new mechanical world view emerged which emphasized rationality, order and power as the underlying principles of human and natural development. This world view demystified the physical and biological worlds so that nature is now "construed as ordered systems of mechanical parts subject to predictability through deductive reasoning" (Merchant, 1980: 214). Scientific knowledge about the environment has been achieved through the conceptual "death of nature" and the use of analytic methods predicated on the deconstruction of nature into its constituent parts (Merchant, 1980). In this view, nature is made up of "modular components or discreet parts... the parts of matter, like the parts of machines being dead, passive,and inert" (Merchant, 1980: 229). The emergence of the machine view led directly to the legitimation of the commodification process and the repudiation of earlier organic visions of the unity of social and physical reality. In contrast to the normative structures of organicism which regarded the exploitation of nature as a violation of life, the machine order treats nature and its exploitation as objective reality; there can be no normative content in nature when "matter is made up of atoms, colors occur by the reflection of light waves of differing lengths, bodies obey the law of inertia, and the sun is the center of the solar system" (Merchant, 1980: 193).

Because technological civilization operates without normative constraint, the only limits on society's interaction with nature are instrumental: economy, efficiency and scientific validity identify the boundaries of action. It is in this context that recent proposals by members of the policy and scientific communities to address global change need to be understood. Initiatives ranging from the imposition of a global carbon tax and emissions trading systems, to worldwide programs of reforestation, recycling, energy efficiency, the development of renewable energy options and the establishment of technology transfer between rich and poor nations offer practical means to retard or halt industrial destruction of the environment. The urgency for action which gave rise to these proposals is not disputed, but such steps leave unexamined the underlying social relations of energy, environment and development that have produced and will continue to reproduce structural threats to nature. As the principal sources of global environmental and technological threat, the existing world political economy and its corresponding development regime of commodified nature cannot be assumed as the structural context for designing rational, efficient or feasible solutions. Burden sharing, emissions trading and abatement-adaptation tradeoff schemes (Schelling, 1990) address only the effects of 300 years of commodification. They leave intact the exploitive regime and reinforce the momentum of technological authoritarianism. Moreover, these schemes can all too easily become forms of industrial escape from problems caused by the prevailing regime, thereby destining the poor to remain poor and nature under threat. Unless the causes and conditions of global inequality are removed, moreover, the poor will be forced to adopt development choices which largely imitate the energy-intensive economies of the industrialized group. After all, the borrowed capital, transferred technology and traded commodity which dominate transactions between rich and poor will continue to be the product of energy-intensive, environmentally destructive economies. But the spiral of commodified nature deepens with each addition of imitators. This is why, as Durning has observed, the environmental crisis and the crisis of unequal development must be solved together. They are, structurally, the same problem (Durning, 1989).

Human existence outside earth's atmosphere is technologically plausible and, under present institutional circumstances, perhaps economically rational. This technological fact hardly justifies the destruction of the basis of life on earth as we have known it.

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In Proceedings of the Sixth Annual Meeting of the National Association of Science, Technology and Society, pp. 67-76 (1991)

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Nature is reacting to the activities of modern society in unique and largely unexpected ways. These reactions are in some ways surprising since human society has traditionally been ascribed a minor role in determining the course of natural processes. Though society has long discarded its wastes in nature, the "predominant view in the natural sciences was that life on Earth is primarily passive, responding to nonliving forces like volcanic eruptions, severe storms, droughts, and even drifting continents" (Schneider, 1989:6). While this conception of passivity is under increasing challenge, the "critical importance of human involvement seems to have been lost" in many of the recent physical and biological debates of global change (Price, 1989: 42). In those rare instances where attention is given to interactive relationships, discussion of the social and political character of human organization and activities is strangely absent. Thus, the few cases in which global warming has been portrayed in terms of nature-society interactions rely almost exclusively on units of carbon (or other chemicals) emitted per person or per unit of economic activity to characterize and measure the relationship. But the energy-environment-development nexus cannot be captured by studying the chemical content of energy-based industrial emissions alone. Indeed, the social content - the political economy - of this nexus is likely to be key to unravelling the sources and responses to global change. Perhaps the most difficult challenge is to consider whether nature is undergoing a process of social capture which eventually may make it in effect a social sub-system subject to political attitudes and ideologies, and a functioning part of the world political economy. Although the present energy- environment-development regime is only about 300 years old (dating to the spread of a coal economy, steam technology and wage labor), it has reached a level of sophistication which may render its operations a threat to several million years of climate, biological and social evolution.

SOCIAL STRUCTURE AND NATURE

Three hundred years of industrialization have rendered social and ecological relations[1] largely commodity-based. Human existence transpires within a reality of production and consumption of commodities which together release into the air and water and deposit on plants and the soil pollutants more numerous than we probably know and, certainly, more complex in their effects than we understand. This reality is structured and motivated by the logics of technology and capital; environmental consequences are, at best, a residual concern. We depend for our lives and our experience of life upon a collective capacity to produce goods and services and upon individual capacities to obtain and consume goods and services, as though nature was incidental to the human drama. As Mumford argued, society has become a "megamachine" with its members existing as so many machine parts. In the technological milieu, natural experience has all but evaporated except as an "emotional good."

There have been concerted efforts to develop social analyses which can both characterize the commodification process and challenge its hegemony over social and ecological relations. But even the most comprehensive social frameworks conceive only the possibility of social activities which degrade the environment. Structural transformation of the environment is presumed to be beyond the reach of social influence. Theories of Western political economy,

[1]Social relations refers here to individual and collective relations among human beings; while ecological relations refers to the interaction of humanity with all other forms of life and with the natural order as a whole.

for example, are regarded by many as among the most extensive in social analysis in their critical examination of social power and exploitation. But even in this comprehensive social framework, the rules or laws of nature are understood to operate literally outside the laws of social motion (as Marx termed them).

The analytic boundary between society and nature assumed in theories of political economy does not preclude conception of relations between the two. But efforts in this direction need to observe the difference between nature-society relations and putatively social ones (especially, political and economic relations). For example, it is possible to develop a structural analysis of social activities producing pollution: social behaviors can be conceived as structurally organized to continuously disrupt or degrade "environmental quality"; and changes in social structure can be shown as necessary to remedy the pattern of polluting behavior. Such an analysis, though, leaves intact the distinction between society and nature as phenomenal structures.

Natural inquiry in its most general form likewise observes an analytic boundary between the two spheres. The influence of human beings on natural operations and vice versa, is recognized in the paradigms of biology, chemistry and physics. But again, the architectures of social and natural order are understood as maintained by relations and rules which are distinct to each sphere. In this respect, natural inquiry, like its social counterpart, operates on a premise of dual realities - one social and one natural. Implicit in the dual-realities premise, from a social point of the view, is the assumption of the permanence of nature, particularly as a reservoir for social activities. It is presumed that virtually anything can be socially practiced and repeated with the principal environmental consequences being a natural disturbance or degradation of environmental quality. To speak about environmental "spillover effects," "externalities" and "social costs," it is essential to the very logic of the language in which these ideas are conceived that one can reliably believe in the natural reservoir as, in effect, bottomless; and that the problems of environmental disruption or degradation, eventually, can be internalized within the social structure. This does not preclude social catastrophe - the starvation of large populations, the spread of epidemics, annihilation of societies or even the human species - but, ultimately, such disasters are confined to their social sphere. The permanence of nature is not obviated or negated by human disasters.

The natural point of view is similarly predicated on nature's analytic permanence. Only with this characteristic can nature provide the grounds, literally, for validation/falsification of the supposed rules and laws of natural order, the epistemological centerpiece of this mode of inquiry. We cannot think about natural order within the reigning paradigms without, at the very least, assuming a distinct order for nature. Indeed, for most practitioners of natural inquiry, a hierarchy of orders is implied between the natural and the social, with the former setting, broadly, the conditions and constraints for actions in the latter, a so-called ecology of order.

However, a range of "environmental" issues, including the rapid decomposition of stratospheric ozone and other changes in the chemical composition of the earth's atmosphere, point to the difficulties, to say the least, of maintaining the assumption of a dual reality - one natural, and one social - at the structural level. For our purposes, the most important scenario for the breakdown of the dual reality thesis is that the commodification process has functionally spread to the architecture of nature itself. In this possibility, the potential for social activity to affect its own context is thought to be great enough to redesign nature. This potential is in part an outgrowth or legacy of social behaviors under the structural guidance of industrial capital; and in part a result of the achievements of certain scientific and technological practices. Under this scenario, the forces of technology and capital are not limited to acts of natural disturbance or degradation. Rather, the very structure of nature is subjected to the design principles of these social forces. The contrast would be between capital- and technology-guided decisions to endanger the health of workers and whole communities by pollution practices at various industrial sites (which enhance profit, market position, etc.); and the collected practices of technological societies which in toto valorize a particular atmospheric chemistry (specifically, one richer in CO_2). The difference is fundamental. In the former case, a social structure- technological society - guides behaviors which adversely impact nature at the

behavioral level: air, water and human tissue are poisons to some degree. But the natural order which produces air, water and living matter is not itself altered; the effect of the pollution is too small to restructure nature. In the latter, social structure threatens to cause a different natural order to evolve. This interpretation conceives commodification as having breached the nature - society duality and is now encroaching on the structural organization of nature itself. This prospect lies beyond the theoretically possible for social and physical analysis as presently organized. Apparently, however, it is not outside the reality of contemporary energy-environment-development relations.

THE PHASES OF COMMODIFICATION

In this section, an analysis of the commodification process and its evolution through three phases is offered. As developed here, the three phases represent a process of maturation in energy-environment- development relations. The reach and range of commodification embedded in these relations successively expands and manifests an accretive quality in its evolution. We do not intend in this analysis to suggest that different relations underlie each phase; quite the contrary, we believe that a common core of relations can be detected across the three periods of order and change.

Carboniferous Capitalism

In this century's most comprehensive examination of Western urban industrial growth, Lewis Mumford argued that modern society has simultaneously lost all semblance of balance with the natural order while reducing the focus of human life to the mere production of things (Mumford, 1961). An alliance of science, capitalism and carbon power reorganized social order on the pervasive principle of *quantification* (Mumford, 1961: 570):

> Quantitative production has become, for our mass-minded contemporaries, the only imperative goal: they value quantification without qualification . In physical energy, in industrial productivity, in invention, in knowledge, in population the same vacuous expansions and explosions prevail.

The new social order produced goods at an unparalleled rate and magnitude, but also pollution of a type and scale hitherto unknown (Mumford, 1934: 168-169):

> In this [industrial] world the realities were money, prices, capital, shares: the environment itself, like most of human existence, was treated as an abstraction. Air and sunlight, because of their deplorable lack of value in exchange, had no reality at all. . . the reek of coal was the very incense of the new industrialism. A clear sky in an industrial district was the sign of a strike or a lock-out or an industrial depression.

The nature and contents of what Mumford called the "atmospheric sewage" of modern industry changed in the 20th century, but the chain of energy combustion-to-environmental degradation was not altered. The alliance of science and technology, the power complex, and the industrial economy ushered in a social order of environmental mining and pollution as a functional part of human progress. In effect, pollution was "normalized."

Lasting well into the 20th century, the phase of *pollution normalcy* is distinguished by its rationalization of nature as alternately a resource mine and a bottomless sewer into which the afterthought of industrial production could be deposited. The industrial degradation of nature, of course, did not exempt human life from the damage. Indeed, industrial tolerance for pollution presupposed that human suffering was a necessary part of the equation. As the air was fouled with technological and economic advance, 20th century cities, like their 19th century counterparts, were afflicted with the worst pollution. Circulated through an industrially-manufactured cloud of chemical waste (mostly energy-based), urban air worldwide exacted the price of modern existence - life threatened by the involuntary, heretofore

life-giving, act of breathing. Chronic bronchial, lung, circulatory and heart problems were and are the special mark of industrial civilization.

When the industrial elites worried at all about pollution or social health, it was to assure that popular efforts to address these problems were kept strictly local and posed no threat to profit-making. In this objective they were assisted by the "new thinking" of economics which abstracted environmental social abuse from the workings of the production regime, assigning them the residual status of an "externalities." In this treatment, those who profited from pollution or threatened human health were exempted from responsibility for cleaning up; society as a whole was to bear the burdens of progress. Policy and law followed the "analytic" view of the economists, giving institutional permission for the waters, land, air and the human body to be used as dumps.

The legitimation of pollution and disease, while a defining facet of early capitalism, must be understood within the broader context of the commodification of society. The target of capitalist development in its first century was the transformation of all social activities into commodities to be valorized in markets and exchanged for cash. Labor, leisure, sexuality, emotion and, above all, the human experience of time were stripped of their intimacy and personality, and reconstituted as anonymous units of objective economic value. The reduction of nature and the human being to a supplier of resources and a repository of wastes was an instrumental component of the commodification process; but exploitation (of humanity and nature) was the driving force of the period.

Technological Authoritarianism

A series of pollution spectaculars beginning in the late 1960s disrupted the quantitative existence of industrialism. One of the most significant for the U.S. occurred in January 1969 when an oil well off the shores of Santa Barbara, California, drilling to a depth of nearly 3,500 feet suffered a "blowout, an uncontrolled eruption" of oil (Easton 1972: 8). The eruption lasted 12 days, creating an oil slick of one to three million gallons of oil and covered an area of 800 square miles (roughly two-thirds the size of the state of Rhode Island). Fifty five miles of coastline were washed with a "black tide" of approximately 1.3 million gallons of oil. The greatest danger occurred along a seven mile stretch of Santa Barbara waterfront where 390,000 gallons of crude came ashore. The toll on wildlife was substantial: 6,000 to 15,000 birds died as a result of the blowout, as well as 74 elephant seals and five whales (Easton, 1972: 257-261). The well was eventually capped with a 3,400 foot column of cement but significant seepage from rock and sand fissures caused by the blowout continued for several years. Seepage is still occurring 21 years later.

While politically important for the U.S., the Santa Barbara "spill" ranks a mere 46th in the calvacade of modern oil spill spectaculars. A second environmental warning on March 23, 1989 suggests how greatly the scale of damage has escalated. The Exxon Valdez oil tanker ran on that date into a reef in the Alaskan Prince William Sound and spilled 37,415 tons of crude. The oil spread to five National Wildlife Refuges and three National Park areas; the slick covered 900 square miles - roughly three-fourths the size of Rhode Island. Hundreds of miles of shoreline were washed with a black tide, in some places up to 6 inched deep. The estimate of birdkills was 100,000, including 150 bald eagles. Approximately 1,000 sea otters were also killed. Debris from the oil spill was in excess of 100 million pounds; a repository for this magnitude of waste must still be found.

The Santa Barbara and Prince William Sound devastations point to an important transition in energy- environment-development relations. No longer is the fuel source, its emissions or its wastes the principal agent of environmental violation; while oil gushed from the Santa Barbara well and emptied from the Valdez, it was the technological system and its normal accidents (Perrow, 1984) that was the cause of each disaster. In this regard, society presently degrades nature not because of its commitment to a carbon economy, but because of its commitment to technological progress. We risk environmental disaster because we are a technological society.

Oil spills are only one category of pollution spectacular experienced as part of the normal operations of contemporary industrial political economy. In addition, there has been a ubiquitous tolerance for the rapid destruction of forests and lakes. Also threatened are the interior waterways of the industrialized territories into which are dumped the liquid and solid effluvia of civilization. This source is undeniably obnoxious, but dated in its sophistication. Like coal slag, the dumping of industrial wastes in streams, rivers and lakes is a product of old-fashioned technology. The manufacture of "acid rain," on the other hand, is a more modern and insidious technique for fouling waters. The important elements of acid deposition, sulfur dioxide and, to a lesser degree, nitrogen oxides, are transformed chemically in the atmosphere and fall to earth as acidic rain, snow, fog or dry particles. Damage to aquatic resources, estuaries and costal waters, timber and recreational resources, buildings, monuments and statues, and public health are the result.

The geographic scale of acidic damage being experienced and the particular chemistry of the acids involved are distinctive to our technological civilization. Only advanced political economies can manufacture this pollution order. While not a product of spectacular technological failures - continental and transcontinental acid pollution is, rather, a systemic emission of mature industrialism - this pollutant nevertheless derives from technological progress and is remediable only by sophisticated technological means. In this respect, our social and natural futures are increasingly contingent upon even more intensive social commitments to technological progress.

A third example of technological pollution is nuclear power. In this technology, societies create both the conditions for pollution spectaculars and long-term, transcontinental-scale threats to all forms of life and habitat. With the knowledge of nuclear fission, the human race acquired the permanent capacity to destroy the basis of life on earth (Schell, 1982). This capacity renders obsolete nature as we have traditionally known it. No society can escape the threat of nuclear annihilation, but must depend upon the mutual decisions of the community of nations to forego use of certain applications of atomic knowledge. A parallel condition of dependency upon social decisions/actions exists for the natural order as well.

It is not simply nuclear weapons that thrust society into the forefront. As was learned in the Chernobyl accident, civilian applications pose a sizable threat as well. While the catastrophic dimension of the accident cannot be overlooked, an even more serious question is raised in its aftermath. Traces of iodine 131 and cesium 137 in milk throughout Europe underscore the enormously hazardous risks associated with the use of nuclear reactions to produce electricity. The gases, and their components, released in the accident are the same as those to be found in a safely operating reactor. The rubble at the Chernobyl site is dangerous to human health for tens of thousands of years; but so are the interior surfaces of the containment vessels of nuclear plants retired after decades of successful, accident-free operation. Indeed, the rubble is no different in the risk it poses to life than the waste products generated from the normal operation of a nuclear plant.

In this respect, nuclear technology and the accidents that can accompany its use are catastrophe-prone. Nuclear energy requires, as an inherent condition of its use, that protective social institutions be constructed outside the mainstream of society which are dominated by technical experts and the military. Further, these institutions must last longer than any in the human record. Indeed, management of the nuclear waste stream requires 1,000 year nuclear security zones and 100,000 year surveillance mechanisms (Weinberg, 1979:94-95; Anderson et al, 1980: 30).

Only successful technological management and innovation can prevent the natural order from utter destruction. Yet, continued spread of modern technology will only increase the frequency of accidents, and the stockpile of long-lived, toxic waste, bringing into sharp focus the hegemony of commodity values over life-affirming ones. Notwithstanding the escalation of risk and destructive potential, industrial momentum requires acceptance of environmental degradation; a necessary trade-off if progress is to be sustained. Of course, society could go without oil retrieved from beneath the sea, or oblige investment in expensive anti-spill

technology; it could reduce electricity consumption, or mandate expensive technology retrofits to remove the acidification threat; it could close all nuclear facilities and adopt a sustainable development path. But such choices would mean repudiating the very quantification ideology which undergirds modern ideals of progress. In addition, failure to take environmental risks would multiply problems in other sectors of the industrial system which depend upon existing operations of the power complex. Restrictions on new oil exploration, electricity consumption and nuclear technology would almost certainly upset the balance of the technological system. The only acceptable alternative in technological society for meeting energy needs is to resort to risky technology options like nuclear power. In this respect, modern society increasingly struggles with itself: it Is a captive of the environmental problems that it is uniquely capable in all of social history of creating; and likewise a captive of the technological solutions which, once employed, invariably breed new, more difficult social and environmental problems.

Technological requirements are paramount in the new order. Human existence has been broken into endless acts of commodity production and consumption which in turn depend for their accomplishment upon networks of technology. In an explicit sense, society is governed by technological institutions which create and manage the conditions of human experience. Nature is reduced in this phase to a technical problem. An authoritarianism of technique prevails in the social and, increasingly, natural spheres.

Big Science

Society is on the threshold of a third phase of commodification. In this new era, nature will no longer be exploited for its particular attributes but will be transformed and reshaped to meet the needs and interests of technological civilization. Whether this transformation is intentional is largely beside the point. Technological societies now, or in the near future will, possess the capacity to alter the very structure of nature regardless of intent. Global warming is both the threat and promise of this phase. As Nicholas Shackleton, a climatologist at Cambridge University, has suggested, "we are going outside what nature has experienced in the recent past 500,000 years" (New York Times, January 16, 1990: C1).

The principal "greenhouse" gases - CO_2, N_2O, 0_3, CH_4 and CFCs - have continuously increased as concentrations in the atmosphere since the pre-industrial period. The primary source of these gases is fossil-fuel combustion, which accounts for nearly one-half of the CO_2 increase and is an important source of higher N_2O. If we sum across social activities, nearly 60 percent of worldwide greenhouse emissions are associated with energy production and use. Greenhouse theory hypothesizes that an atmosphere composed of high concentrations of these gases will result in higher surface temperatures. Certainly, data on global mean temperatures over the past 100 years of worldwide industrialization confirm that the planet is warming. Although the precise magnitude and physical dynamics of the greenhouse effect remain the subject of much debate, a scientific consensus appears to have formed on its existence (Flavin, 1989:15-16).

Indisputably structural in character, the greenhouse effect includes not only the prospect of higher temperatures, but changes in sea level and the distribution and location of dry and wet land areas, as well as the alteration of a host of other biological and climatological processes. The implications for human and natural existence of such changes are serious enough in their own right. But perhaps even more disturbing is the prospect that social capacities exist to instigate such radical alterations of the natural order. The most vivid means of illustrating this concern is to first consider the process by which global temperature change is effected in an exclusively natural structure. Climatic history, heretofore, was determined by the confluence of three astronomical cycles which regulate the earth's orbital ellipse, axial tilt and wobble. The orbit cycle which fixes the earth's travel within the solar system takes approximately 100,000 years to complete the series of elliptical modifications involved; the tilt cycle lasts about 41,000 years to accomplish a series of axial corrections; and the elapse of the wobble cycle is nearly 23,000 years. Together, these cycles control the timing of global warming and cooling by altering the angles and distance from which solar energy reaches the earth.

To appreciate the magnitude of social interference, these very long-lived cycles must be placed alongside the 300 years of industrialization (with the last 100 years representing, by far, the most carbon-intensive), which are cumulatively believed to have begun a social process of temperature change. The time disjuncture in these terms of reference points to the immense capacity assembling in the world political economy to threaten nature. Even skeptics of the present status of the greenhouse effect should be awed by the potential for social engineering to change the natural structure, which, if not available presently, almost certainly will soon be.

The carbon buildup that has accompanied industrialization is a testament to the systematic imposition of commodity values on the society-nature relation. It is the environmental expression of energy-economic quantification. The depth to which commodified nature is presumed by the existing social order can be exemplified by considering how the carbon dependence of modern development might be slowed or reversed. In a remarkable series of scenario analyses for a U.S. Environmental Protection Agency (EPA) report[2] on *Policy Options for Stabilizing Global Climate* (Lashof and Tirpak, 1989), some indication of the carbon dependency of the world political economy is given. Using a 110-year planning horizon, the EPA study first sought to identify a series of global carbon-reduction strategies which might stabilize atmospheric greenhouse gases at a concentration which assumes a 1.5 - 2.0 C increase in global average temperature. That is, the first scenario *assumed* that global warming is inevitable, but that we can hope to place a ceiling on the magnitude of warming. Introducing policy options iteratively into the climate change model used for the project, the researchers discovered that single, or even limited numbers of, policy steps could not achieve chemical stability. Rather, *eleven* major initiatives would be needed which ranged from a phaseout of CFC use by the year 2003; a major reforestation effort worldwide; adoption of a series of energy-efficiency improvements including the achievement of a global fleet-average auto fuel efficiency of 50 miles per gallon (mpg); and government- sponsored speedup of the commercialization of solar technologies. Even with these substantial responses implemented, the study relied upon increased nuclear power production[3] to meet the goal of a warming commitment of 1.5-2.0 C.

A second simulation defined the objective as no *additional* warming beyond the year 2000. Again, policy planning was stretched over the period from the present to 2100. The analysis assumed implementation of all strategies in the atmospheric chemical stabilization scenario, and eight additional policy responses. High carbon emission fees are imposed on the production of fossil fuels in proportion to CO_2 emissions potential; and an excise tax on fossil fuel use is enacted for the industrialized countries. Separate auto fuel efficiency standards are imposed on the U.S. which require SO mpg fleet averages by 2000 and 65 mpg by 2025. And, deforestation is halted worldwide by 2000, and reforestation efforts are doubled over the stability scenario.

These analyses demonstrate the results of 300 years of commodification of society and nature. Just to moderate the process (the stability scenario) requires extraordinary global cooperation. To begin to undo the commodification of the atmosphere (the rapid reduction scenario), global cooperation is not enough - steps toward the restructuring of industrial societies is needed. Bluntly, the removal of the prospect of transforming nature depends upon radical structural action in the social sphere. Nature and society are now structurally joined.

The manufacture of acid rain and holes in the upper ozone, the extinction of plant and animal species (and the engineering of new ones), the reduction of the planet's capacity to breathe (due to deforestation, among other things), the manufacture of highly toxic, long-lived poisons which are so dangerous that they require 1000 year security zones, and the creation and satisfaction of consumptive appetites which in their aggregate portend a change in global climate - all have become rational and efficient. A recent article in the *New York Times*

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[2]The report, published in draft in February 1989, has yet to be released in final form.

[3]Although, to rationalize the technology's promotion, it was necessary to assume annual 0.5% *decreases* in construction costs, something the world has yet to experience in 40 years of operation of the industry.

(November 19, 1989) concerning the debate over global warming and the possible need to restrict world carbon dioxide emissions is illustrative of the advanced industrial mind. In the article, Harvard economist Thomas Schelling pointed out that, "both the will and technological ability to adapt to radically different weather [has changed rapidly]. In 1860 two percent of Americans lived outside temperate or subtropical zones. By 1980 the percentage had increased to 22 percent." Schelling further argues that "the appealing idea of bequeathing the biosphere intact seems arbitrary. The quality of life in 100 years... will depend as much or more on the endowment of technology and capital as on the percentage of carbon dioxide in the air. And if money to contain carbon emissions comes out of other investments, future civilizations could be the losers." Citing a study by the U.S. Environmental Protection Agency which estimates the cost of protecting American coastal cities from a three-foot sea rise at $73 to $111 billion, the article notes that this is "a lot of money but not so much compared with the likely cost of prevention." The article concluded that an analytical consensus is emerging: "it may be cheapest to deal with the effects of global warming rather than the causes."

Thus, in the third phase of commodification we are committed to a form of world political economy in which global warming is the necessary risk of progress. Whereas the initial stages of carboniferous capitalism tested the statics of nature, namely, the absorption capacities of land, water and air, the advanced industrial order of global capital and markets challenges the dynamics of nature, in particular, the seasons, the tides, the breathing of the planet, and even the reproductive cycle of the atmosphere. While the emblems of advanced industrialism, like carboniferous capitalism, remain waste and pollution, there has been a fundamental breach of the nature-society relation. Advanced industrial life transpires not simply outside the constraints of nature, but relegates nature to commodity status, to be purchased and sold in the world political economy along with other products and services. The contemporary world political economy presumes that sustainability is a technological and economic matter. Although this presumption is typically manifested in economic terms and thus continues to be most concretely presented in discussions of trade-offs between environmental protection and material progress, its deeper implication is the demise of any idea of the inviolability of nature. There is *nothing* in advanced industrial logic beyond technological manipulation; not the climate, not the atmosphere, not species diversity. Nature is stripped altogether of autonomous status. Society as the master of nature fulfills the Western dream of science. Reason can replace randomness in the governance of life and empower humanity to author its future without constraint. Global warming signals the arrogation by society of the master role; science replaces nature as the basis of life.

CONCLUSION

The scientific revolution and the rise of capitalism initiated the reconceptualization of the relation between society and nature. A new mechanical world view emerged which emphasized rationality, order and power as the underlying principles of human and natural development. This world view demystified the physical and biological worlds so that nature is now "construed as ordered systems of mechanical parts subject to predictability through deductive reasoning" (Merchant, 1980: 214). Scientific knowledge about the environment has been achieved through the conceptual "death of nature" and the use of analytic methods predicated on the deconstruction of nature into its constituent parts (Merchant, 1980). In this view, nature is made up of "modular components or discreet parts... the parts of matter, like the parts of machines being dead, passive,and inert" (Merchant, 1980: 229). The emergence of the machine view led directly to the legitimation of the commodification process and the repudiation of earlier organic visions of the unity of social and physical reality. In contrast to the normative structures of organicism which regarded the exploitation of nature as a violation of life, the machine order treats nature and its exploitation as objective reality; there can be no normative content in nature when "matter is made up of atoms, colors occur by the reflection of light waves of differing lengths, bodies obey the law of inertia, and the sun is the center of the solar system" (Merchant, 1980: 193).

Because technological civilization operates without normative constraint, the only limits on society's interaction with nature are instrumental: economy, efficiency and scientific validity identify the boundaries of action. It is in this context that recent proposals by members of the policy and scientific communities to address global change need to be understood. Initiatives ranging from the imposition of a global carbon tax and emissions trading systems, to worldwide programs of reforestation, recycling, energy efficiency, the development of renewable energy options and the establishment of technology transfer between rich and poor nations offer practical means to retard or halt industrial destruction of the environment. The urgency for action which gave rise to these proposals is not disputed, but such steps leave unexamined the underlying social relations of energy, environment and development that have produced and will continue to reproduce structural threats to nature. As the principal sources of global environmental and technological threat, the existing world political economy and its corresponding development regime of commodified nature cannot be assumed as the structural context for designing rational, efficient or feasible solutions. Burden sharing, emissions trading and abatement-adaptation tradeoff schemes (Schelling, 1990) address only the effects of 300 years of commodification. They leave intact the exploitive regime and reinforce the momentum of technological authoritarianism. Moreover, these schemes can all too easily become forms of industrial escape from problems caused by the prevailing regime, thereby destining the poor to remain poor and nature under threat. Unless the causes and conditions of global inequality are removed, moreover, the poor will be forced to adopt development choices which largely imitate the energy-intensive economies of the industrialized group. After all, the borrowed capital, transferred technology and traded commodity which dominate transactions between rich and poor will continue to be the product of energy-intensive, environmentally destructive economies. But the spiral of commodified nature deepens with each addition of imitators. This is why, as Durning has observed, the environmental crisis and the crisis of unequal development must be solved together. They are, structurally, the same problem (Durning, 1989).

Human existence outside earth's atmosphere is technologically plausible and, under present institutional circumstances, perhaps economically rational. This technological fact hardly justifies the destruction of the basis of life on earth as we have known it.

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