Sustainable Technology and The Limits of Ecological Modernization

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This essay addresses the question of how sustainable development is possible, giving special reference to the role of technology. It argues that the dominant strategy for sustainable development that is now operative, ecological modernization, is insufficient, and that the reform of technology and of systems of production alone will not yield sustainable development. After a brief discussion of the notion of sustainable development, the current strategy for sustainability, ecological modernization, is outlined (§ 1). This strategy is then subjected to a critique, because of its one-sided emphasis on the reform of production systems, its belief in a 'technological fix' and its retention of an unsustainable ideal of economic growth (§ 2). Finally (§ 3), it is argued that sustainable development requires a reform of lifestyles and systems of consumption, next to the ecological reform of systems of production. Reform of technology can actually contribute to the reform of lifestyles and consumption patterns, but only as part of a comprehensive reform strategy.

1. Ecological Modernization: The Current Strategy for Sustainable Development

Since its initial formulation in the early 1980s, the notion of sustainable development has gained widespread currency. In many environmental policies, declarations and treaties, sustainable development is now a central principle. There is moreover little opposition to the idea of sustainable development. No one wants to claim that development need not be sustainable. As has often been pointed out, however, lack of opposition to sustainable development may be due to the vagueness of this notion. There is no universally accepted definition of sustainable development, and instead there is a proliferation of definitions (cf. Pezzey, 1992). Moreover, definitions that are given often remain vague. The value of the notion clearly does not lie in its representation of specific policy guidelines for development. Its value may instead be found in the way it stimulates a global change in perspective, emphasizing

the idea that environmental policy should go beyond limiting environmental impact, and should contain a vision of the future: the future of the planet and the needs of future generations should become an explicit policy issue.

The by far most influential definition of the notion of sustainable development is found in the report *Our Common Future* of the World Commission on Environment and Development (WCED, 1987), also known as the Brundtland commission. Here, sustainable development is defined as 'development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.' (p. 43). This definition can be read as expressing basic values that should underlie development policies. It is not stated in this definition what the resulting development looks like, or even what the needs of present and future generations are, and under what general conditions development would compromise the ability of future generations to meet their needs. Different interpretations of these matters will again lead to different conceptions of sustainable development.

The one major criticism of this definition comes from radical environmentalists who criticize its anthropocentrism. After all, this definition only makes the needs of humans a matter of concern. The needs of animals and the intrinsic value of nature are not mentioned, and hence this definition does not honor biocentric or ecocentric values. It is not my intention to sort out here whether biocentric or ecocentric values should be preferred over anthropocentric values. Instead, I want to argue that a consistent anthropocentric conception of sustainable development that takes the needs of future generations very seriously (as entailing quality of life beyond mere survival) entails measures that are almost as drastic as would be required for biocentric or ecocentric conceptions of sustainable development. Many species and many abiotic components of the environment are irreplaceable and of great economic value either as a resource for human use or because of their pivotal role in ecosystems on which humans depend (cf. Owen, 1980). Moreover, nature that does not have a direct economic benefit may still be important in meeting human needs. The aesthetic value of nature, in particular, may be mentioned here. The possibility to appreciate a rich and varied nature seems to be a reasonable requirement for any conception of the good life. Anthropocentric conceptions of sustainable development may therefore well require sweeping conservation strategies are that are not radically different from those required by ecocentric conceptions.

I am assuming, in any case, that sustainable development, whether defined anthropocentrically, biocentrically, or ecocentrically, requires drastic change from present conditions. Taking seriously the needs of future generations, if not the integrity of nature as a whole, requires at least that 'the environment should be protected in such

a condition and to such a degree that environmental capacities (the ability of the environment to perform its various functions) are maintained over time' (Jacobs, 1991: 79). This requirement implies the protection of ecosystems, the preservation of biodiversity, and extreme caution in the use of nonrenewable natural resources. It will also imply a serious reduction in the generation of substances and gases that threaten ecosystemic life cycles, as well as the immediate destruction or consumption of elements of nature.[1]

The notion of sustainable development has, usually in the formulation of the Brundtland commission, come to play a major role in environmental policy. Since the Brundlandt report, it now plays a guiding role in most international environmental treaties and agreements, as well as in many national and subnational environmental policies. The question is, however, what specific environmental strategies the notion of sustainable development has inspired. Is there any pattern to be discerned in policies for sustainable development that point to a uniform global response to the challenge of sustainable development? Negatively, it must be observed that many nations and other institutions that claim to underwrite the idea of sustainable development do not have environmental policies that come anywhere near to a comprehensive strategy for sustainable development, but are instead limited to the statement of vague goals or more specific targets of which it is not clear how they realize sustainable development. On the positive side, there are some nations and institutions that do employ comprehensive strategies for sustainable development.

A good example of such a strategy is the Dutch National Plan for Environmental Policy (Nationaal MilieubeleidsPlan or NMP, 1989; a second edition was published in 1993). The Netherlands is one of a handful of nations that have developed a comprehensive national environmental strategy, which outlines as of today one of the most serious and ambitious projects for sustainable development. The NMP explicitly takes sustainable development, as defined by the Brundtland commission, as the guiding principle for environmental policy. It prescribes a shift from effect-oriented measures, measures that attempt to control negative effects on the environment, to *source-oriented* measures, measures that control the source of environmental problems. This may imply controlling *emission* (adding technologies that reduce emissions and waste streams without changing responsible processes of production of consumption themselves), *volume* control (legal and organizational measures that reduce the quantity

[1] My discussion of sustainable development is aimed principally at sustainable development in Western, industrialized nations. The notions of 'ecological modernization' and the 'device paradigm' that will be used in subsequent sections do not apply to developing nations. However, I propose that the sustainable lifestyles and social and economic systems proposed in the last section constitute appropriate ideals for developing nations as they do for industrialized nations.

of base materials and products without limiting the processes of production and consumption) and *structure-oriented* measures, that imply structural changes, usually of a technological nature, that modify the processes of production and consumption.

The report next prioritizes emission control and structure-oriented measures over volume control, because of the negative consequences of volume control. Volume control is, indeed, hardly taken up as a serious measure, the most that is said being that the implementation of volume control measures cannot be excluded as an option for the coming decades, and then only in some areas. Overall, however, volume control is claimed to be dependent on 'better alternatives'. Structure-oriented measures, in contrast, are identified as the key approach to sustainable development. Emission control is identified as the dominant strategy to follow for the short term only, whereas structure-oriented measures must become the dominant strategy for the medium term.[2] Structural source-oriented measures ought to be directed at three aspects: integral chain management, energy expansion (the more efficient use of energy in production processes and in products and the use of renewable energy sources), and quality improvement (the production of more durable goods that can moreover be recycled). Such measures must result in the realization of a number of environmental targets necessary for sustainable development, such as a reduction of substance emissions of 80 to 90 % and of waste streams of 70 to 80 %, and the conservation of nature areas.

Environmental policies such as the NMP represent a marked shift from policies that are sometimes called end-of-pipe: policies that opt for a separate and sectorial treatment of environmental problems and that focus on effect-oriented measures and emission control. Although end-of-pipe measures still dominate internationally and the global efforts to implement structural source-oriented measures are still limited, it is clear that the only currently existing serious strategy to meet the demands of sustainable development is found in an overall project of this nature. Given that this strategy, centered around the idea of structure-oriented measures, is currently the only serious strategy for sustainable development, a closer analysis of this strategy and its possible limitations is highly desirable.

This overall strategy is sometimes called *ecological modernization*, a concept that was first introduced by the German sociologist Joseph Huber (1982). According to the theory of ecological modernization (Huber, 1982, 1985; Mol, 1995; Mol & Spaargaren, 1993; Spaargaren & Mol, 1992; Simonis, 1989), current efforts to meet the challenges of global environmental problems through structure-oriented measures should be understood as a project within the context of the general project of modernization.

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[2] As the report explains, emission technologies have the disadvantage that they do not close cycles, use up extra resources and energy, do not add to quality improvement, and cannot yield sustainable development.

Modernization is the characteristic form that development takes in modern times. It is the process of development that finds its starting point at the industrial revolution, and is characterized by increasing productivity and technological complexity, centralization, rationalization of production, the employment of scientific principle and method, and professionalization.

The philosophical background of the project of modernization is found in the principles of modernity. As the central principle of modernity, one may identify the principle of autonomy: the idea that individuals and societies can attain self-determination or self-rule, and can define their own laws of operation independently from their environment. Reason, and its most successful manifestation, science, were to guarantee this autonomy through the laws and principles they bring forth, and their application in the service of the ideal of autonomy. The ideal of progress, as another key principle of modernity, is the belief that the employment of reason and its special forms can lead to continuous increases in autonomy and improvements in the human condition. The project of modernization can be understood as a modernist project aimed at increasing the autonomy of its beneficiaries, by granting them, through technology, increased control over their own destiny, by giving them extended powers to realize their goals and satisfy their desires, as well as giving them increased protection and insurance against harm and adversity.

Ecological modernization is the logical answer from within the modernization project to the ecological crisis. It is a control strategy that is coming to replace the more conservative control strategy of end-of-pipe measures, which has turned out to be insufficiently effective in the light of mounting global environmental problems. The new strategy aims at an ecological transformation of the modernization process, that is, a transformation based on ecological principles as developed within the science of ecology. The prime targets of ecological modernization are the institutions of technology and the economy. The technological and economic system is to be made part of the ecological system, and hence to incorporate ecological principles in its own operations. Integral chain management is an example of such a process: industries are to imitate life cycle processes as found in nature so as to be ecologically sound.

The ecologization of technology is, as said, to be attained by a structural reform of (agro-)industrial production processes. New technologies, like micro-electronics, genetic engineering technologies and new materials, are thought to be able to play a central role in this reform process, because they limit resource inputs, resource use and emissions (Simonis, 1989). The ecologization of the economy (correlating with an 'economization of ecology') is thought to involve the reform of economic theory and economic policies. Most importantly, a value must be placed on nature, as a force of

production, to allow its conservation and protection to be an integral part of economic development strategies. But it may also involve 'more incidental eco-taxes, the introduction of environmental liability, the redirection of insurance condition towards environmental care, the increasing demand for ecologically sound products on the market, the introduction of the environment as a factor in economic competition and of environmental audits as a precondition for commercial loans and economic investments.' (Mol, 1995: 40).

Ecological modernization should be understood as a control strategy defined *within* the general project of modernization, because it assumes that the environmental conflict is not inherent to the project of modernization, but can be controlled from within it. It leaves the basic tenets of the project of modernization intact, together with the basic institutions and ideals of modernity. This is evident in several ways. Most principally, ecological modernization is targeted at a reform of only two institutions of modernity, being technology (or industry) and the economy. Moreover, in spite of the drastic reform of these two institutions implied by ecological modernization, their core principles remain intact. In the ecological reform of economics, the ideal of growth, as an index of progress, is preserved, as is, in most cases, the adherence to free-market capitalism. In the reform of the institution of technology, the aim is not a reduction of the role and influence of technology, or deindustrialization, but rather an increase in the environmental efficiency of technology. The modernist idea that technology is to play a central role in solving major problems is moreover retained: the control strategy of ecological modernization grants a central role to new technologies in solving environmental problems.

In fact, the project of ecological modernization can largely be understood as a technological control strategy. This can be seen in the fact that a central part of the strategy lies in the technological reform of production systems. But even concomitant changes in the organization of industry and in economic theory and policy can be understood as technological changes, when the notion of technology is taken in a broad sense, as the implementation of formalized procedures for the realization of practical ends. Economic theories and models, for one, are 'technologies' in this sense, in that they aim to calculate and predict outputs based on inputs, aiming to realize the most efficient and effective input-output function. The ecologization of economic theory implies that the notions of efficiency and effectiveness are modified by introducing new variables that refer to natural capital.

Environmental efficiency is indeed the new goal for technology, including the technologies of economics and management science. This efficiency is to be achieved while preserving as much as possible the cherished values of modernity. The overall

system of which the institutions of technology and economy are a part, as well as most of the basic principles of these two institutions, are to remain intact. The increased environmental efficiency and ecological soundness of products produced by a more ecological industry, under conditions of a more ecological economic system, is then to guarantee sustainable patterns of consumption. Serious reform of current systems of consumption and correlated social institutions need not be pursued then. It is not surprising, then, that volume control and the reform of current lifestyles and consumption patterns are not pursued as serious options within the project of ecological modernization. The promise of ecological modernization is that serious reform in these areas will not be necessary, a promise that makes a happy fit with the modernist ideal of economic growth and the ideals of autonomy, freedom and quality of life that have become embodied in the consumer lifestyle.

A potential embarrassment for the project of ecological modernization may be thought to be found in its insistence that the ideal of unlimited economic growth is compatible with sustainable development. The modernist ideal of economic growth, as an icon of progress, seems to conflict with ecological principles that appear to support the idea of limits to growth (Meadows et al., 1972, 1991; Daly & Cobb, 1990). The apparent conflict lies in the fact that economic growth appears to imply an increase in the consumption of natural resources. In response to this problem, some economic theorists have attempted to delineate a conception of economic growth that does not imply growth in natural resource consumption. For example, Goodland & Ledec (1993) argue that economic growth (as measured by Gross National Product or a related index) is in principle unrelated to growth in natural resource consumption, and may therefore be free of any natural limits. Goodland & Ledec recognize limits to growth in natural resource consumption, but argue that 'growth in economic output may not be similarly constrained, since innovation may continue to find ways to squeeze more 'value added' from a natural resource bundle.' They conclude that 'governments concerned with long-term sustainability need not seek to limit growth in economic output, so long as they seek to stabilize aggregate natural resource consumption.' (p. 252).

This view explains how it is possible that historically, the idea of sustainable development has been tied to economic growth. It explains, for example how in the Brundtland report, the very report responsible for popularizing the idea of sustainable development, it can be claimed that an economic growth percentage of 3 to 4 percent per annum for industrialized nations and 5 to 6 percent for developing nations is desirable (p. 50), and need not lead to a further loss of natural resources (p. 52). Often, it is even claimed that economic growth benefits the environment (and economic stagnation hurts it), because poverty and environmental problems are intrinsically

related, and because economic growth is necessary to finance the costs of ecological modernization.

2. A Critique of Ecological Modernization

Does ecological modernization entail sustainable development? Perhaps the main reason why ecological modernization may not succeed is that a serious implementation of the measures required by ecological modernization may never get off the ground. I only want to be brief about this possibility, because I am not concerned here whether the ecological modernization project will ever be seriously implemented at a global scale, but rather on its implications for sustainable development if it does get implemented.

Yet, there are serious reasons to believe that ecological modernization may, at least in the short run, go not get very far beyond a cosmetic operation. Most principally, these include foot-dragging by governments and industry because of the short-term economic costs of ecological modernization. Many examples of such foot-dragging already exist, as witnessed by the unwillingness to commit oneself to serious environmental targets, as well as the endless stream of environmental targets set by governments and industry that are not met. The global economic race makes such investments particularly unattractive. Recently, for instance, the Dutch government has concluded that one of its prime targets of the Dutch NMP, a reduction of greenhouse gases after the year 2000, cannot be met because it would make the Netherlands fall behind in the international economic competition.[3] Other factors that may hamper efforts at ecological modernization are likely to include North-South conflicts over the just distribution of the economic burdens of sustainable development, opposition by vested interests such as the oil industry and car manufacturers, and opposition evoked because of the further regulation and disciplining of industry and the economy by the state.

I will assume, here, that such obstacles can be overcome. The question I want to address in this section is if there are principled flaws in the project of ecological modernization. Now, it must be recognized that the success of ecological modernization in securing sustainable development is ultimately an empirical issue, not to be decided on theoretical grounds alone. Nevertheless, I believe that two

fundamental flaws in the general project of ecological modernization can already be discerned, one relating to the particular conception of technology adopted in ecological modernization, the other relating to its retention of particular ideals economic growth, progress, and the quality of life. Both flaws are inherited, I will argue, from core assumptions of modernity.

The first flaw in the project of ecological modernization is its retention of an instrumentalist, Enlightenment conception of technology. It is a core assumption of the ecological modernization project that the environmental crisis can be solved through mostly technological means, and that a technological reform enables a controlled ecological modernization of production systems that makes them ecologically sound while retaining a high output. Ecological modernization hence has all characteristics of a technological fix: the solution of a complex social problem through technological as opposed to other means. This faith in a technological fix for environmental problems can be criticized because critiques of instrumentalist conceptions of technology have taught us that technological solutions frequently have unwanted and unexpected side-effects, and a technological solution may simply not be possible for any social problem. The particular side-effects of technological reform within the project of ecological modernization are likely, I argue, to undermine this very project as a control strategy for sustainable development.

The idea that technologies are not neutral and standardly have unanticipated and undesirable side-effects is of course not new in the philosophy of technology. Important, however, are the details of how this idea applies to the project of ecological modernization and works to undermine it. The most fundamental reform strategy of ecological modernization was identified earlier as the structural technological reform of production systems, involving such strategies as integral chain management and quality improvement. Now, consider the strategy of integral chain management. In this control strategy, the aim is to modify production processes and corresponding products such that material cycles are created that are closed off as much as possible, with a minimum of emissions and waste streams. The recycling of used up products and of wastes generated in production, the use of renewable raw materials, and, when recycling is not an option, of biodegradable product materials, is a central part of this strategy.

The optimism that sustainable production processes based on the principles of integral chain management will generally be possible may, however, turn out to be unjustified. Consider, first, the implications of a move towards the use of renewable and biodegradable materials in integral chain management. Smits (1996) explains how the use of such materials may fail to yield a more sustainable production process. She

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[3] 'Stabilizatie als "Harde Dobber",' in the Dutch newspaper *Trouw*, April 2 1996, page 4.

considers a hypothetical case in which most future polymers (plastics) are produced from renewable materials like corn starch, rather than from nonrenewable resources like petroleum. As she explains, 'Considering the current heavy demand for polymers, such a development would necessitate a considerable increase in the scale and intensity of agriculture. How much farming land, pesticides, acidification and erosion of the soil, damage to landscape or expulsion of local inhabitants would be needed to fulfill the demand for polymers?' (p. 218). Massive product recycling in integral chain management may be hampered with similar 'side-effects.' As Smits explains, a recycling economy would require added transportation of wastes and waste selection and reprocessing, processes that are energy-intensive. As she sums up, 'what is the use of almost closed material cycles, if these cycles themselves turn around faster and faster? Environmental policy aimed at sustainable development by way of integral chain management could possibly choke in its own goals.' (p. 219).

The second flaw in the project of ecological modernization lies in its attempt to reconcile the ideal of sustainable development with the ideal of unlimited economic growth. As explained in the previous section, the defense for the compatibility of these two ideals rests on the assumption that increased environmental efficiency of technologies will offset expected increases in environmental degradation. New technologies, such as micro-electronics, genetic engineering technologies and new materials, as well as new environmental technologies and procedures such as integral chain management are thought to be instrumental in attaining increases in efficiency. They will enable the extraction of more and more economic activity from the same stock of natural resources, while stabilizing pollution and waste streams. The consequences of the use of these technologies are hence increasing 'dematerialization' (the use of less or lighter materials for technologies that yield the same functionality, cf. Herman et al., 1989), more durable goods, less waste streams, with waste that tends to be more biodegradable, less or less harmful emissions, and an increase in energy efficiency.

Obviously, these developments may help to arrive at more environmentally efficient technologies. However, two objections may be made against the idea that the promise of increased environmental efficiency of technologies allows for economic growth without increased damage to the environment. First, a historical argument can be made. Promises that new technologies would help solve the environmental crisis have already been made from the 1970s, but these promises have not been fulfilled because increases in environmental efficiency have tended to have been offset by economic growth. When nations desire to keep up an economic growth percentage of 3 or 4 % per annum, the environmental efficiency of technologies has to increase with at least that amount each year. Maybe future developments make this possible, but past

developments have not given any reasons for optimism.

A second, more principled objection is that there appear to be limits to the increases in environmental efficiency that are attainable. Dematerialization, for example, clearly has its limits, because in many artifacts, a repeated reduction of their mass would either lead to losses in functionality or to losses in durability or safety. Moreover, as was already pointed out, many new environmental technologies may have environmental side effects that ultimately make them unsustainable. As was also pointed out, in particular, the substitution of new, renewable and biodegradable technologies and the development towards a recycling economy may only lead to limited increases in environmental efficiency. It can be concluded, then, that the hypothesis that unlimited increases in environmental efficiency are possible rests again on an unjustified faith in technology to fix problems. The hypothesis that the efficiency gains of ecological modernization will outpace growth in consumption is without substantiation and therefore little more than a gamble.

3. Sustainable Consumption as a Condition for Sustainable Technology

Although I do not expect to have provided conclusive arguments against the promise that ecological modernization will yield sustainable development, I hope to have cast serious doubts on its future success. This requires one to at least take seriously alternative control strategies that abandon the modernist ideal of economic growth and the belief in a largely if not exclusively technological solution to the environmental crisis. Any alternative control strategy will require serious changes not only in systems of production, but also in systems of consumption.[4] If current systems of production and consumption cannot be made sustainable by making them more environmentally efficient, then the alternative is to eliminate them in favor of qualitatively different systems of production and consumption that are sustainable. Alternative control strategies hence require one to take seriously two types of reform that are not seriously considered within the project of ecological modernization: a reform of production systems that will entail (partial) deindustrialization, and a reform of

[4] Throughout this essay, I am retaining the idealization that systems of production and consumption can be distinguished from one another and changed independently of one another. This idealization is, however, false. Production systems also consume products (they use up resources and the individuals that work in them consume while at work), and consumption systems are frequently part of production systems (e.g., consumers who recycle contribute to a production system). Moreover, many infrastructural features exist to facilitate both production and consumption (e.g., a highway system is used both for business purposes and for private purposes.

systems of consumption, together with the social institutions and lifestyles in which these are embedded.

The idea that current systems of consumption need to be reformed is of course not new. The affluence and consumption level of industrialized nations has often been identified as a root cause of environmental problems. A preparatory report from an UNCED committee puts the matter succinctly: 'It is clear that current lifestyles and consumption patterns of the affluent middle-class of some developed countries, involving high meat intake, consumption of large amounts of frozen and 'convenience' foods, ownership of motor-vehicles, numerous electric household appliances, home and workplace air-conditioning, widespread airtravel, space-expansive urban housing, motorized commuting and shopping are not sustainable.' (cited in Rogers, 1993: 234).

A reform of systems of consumption to make them more sustainable will imply less consumption of resources. According to standard economic wisdom, less consumption of resources implies a decline in the standard of living, and therefore an overall decline in the quality of life. Many goods will become scarcer, and it will happen more frequently that human needs are left unsatisfied. Clearly, any reform strategy for sustainable development that entails less per capita consumption of resources should consider whether and how such reform lowers the quality of life. If necessary to secure sustainable development, modest decreases in the quality of life should of course be accepted. However, it has often been questioned that a decrease in consumption necessarily entails a decrease in the quality of life. Many authors have argued, instead, that quality of life does not derive from affluence, but from the experience of mental and bodily engagement and connectedness with one's surroundings that is gained through meaningful interaction with one's social and physical environment (e.g., Borgmann, 1994; Tatum, 1994; Milbrath, 1990; Strong, 1995; Simpson, 1995). Such proposals hence point to the possibility of alternative, less affluent lifestyles that entail an increase, rather than a decrease, in the quality of life.

A society containing such lifestyles and corresponding systems of consumption need not give up on modern technology, but only bring it back to a sustainable level. Bringing technology back to a sustainable level will imply, next to the improvement of their 'environmental efficiency' as pursued in the project of ecological modernization, a decrease in the quantity of artifacts and machines that are produced and used, and the elimination of artifacts and technologies that remain seriously damaging to the environment even after optimization of their environmental efficiency and their replacement by more sustainable alternatives.

Yet another strategy in the pursuit of sustainable technology is the design of artifacts that are themselves capable of limiting spurious consumption. Artifacts may do

this by rationing their own use, or by putting conditions on their use. For example, showers may be designed to turn of after five minutes of use, cars may be designed with built-in speed delimiters that ensure an economical use of fuel, and computer networks can be designed to limit the transmission of files that do not conform to the function for which the network has been designed. In this way, artifacts function as enforcers of laws and accepted standards of behavior, and may be said to have a built-in environmental morality. Note that this type of design differs from design aimed at the environmentally efficient product design pursued in the project of ecological modernization. A design is environmentally more efficient than another design if it is less harmful to the environment while affording the same functionality. Here, however, the functionality of artifacts is rationed or conditioned by their design.[5]

A final strategy for sustainable technology is found in the design of technologies that foster sustainable ideals of the good life and attitudes of responsibility to the environment. As has been argued by Albert Borgmann (1984, Strong, 1995), artifacts differ in the level of engagement that their use requires. Some artifacts, when used, engage the user with nature, with other individuals, or with the artifact itself, whereas others fail to do so. According to Borgmann, engagement 'discloses the significance of things and the dignity of humans' and 'engenders a concern for the safety and well-being of things and persons.' (220). There are, in my analysis, two principal ways in which artifacts that foster such engagement may lead to more sustainable interaction with the environment. First, artifacts may create a connectedness with the environment by disclosing the environment to their users in new ways, that show its beauty, value, and intrinsic worth (cf. Rothenberg, 1993; Strong, 1995). These are artifacts that make visible the implications they have for, and the ties we have to, the environment. For example, as a vehicle for transportation, a bicycle discloses much more of the environment than an automobile. Second, artifacts may be designed so as to create ties to the artifact itself, so that it is less easily treated as a disposable. This may happen by making artifacts durable, by making investments in quality, and by personalizing their design. In either way, more sustainable lifestyles are promoted.

It should not be thought, however, that the redesign of technologies to promote sustainable consumption, through the design of artifacts that limit their own use or that foster more sustainable attitudes towards consumption or the environment, will be sufficient in itself to effect sustainable systems of consumption. The idea that this is

[5] Artifacts may also foster engagement and limit spurious consumption at the same time, and these processes may even enhance each other. For example, a speed delimiter in a car will slow down cars, and in this way succeed in a more efficient use of fuel, but the slower velocity attained in this way may lead to more engagement with the landscape that surrounds the motorists.

possible amounts to another belief in a technological fix, this time by the 'social engineering' of lifestyles and patterns of consumption through a reform of technology. As an isolated strategy, such reform will fail, because existing consumer preferences and market competition by other technologies will lead to a rejection of such technologies by most consumers in favor of technologies that are less sustainable but make a better fit with their ideal of the good life. I am not denying that technological reform may be of great help in the move towards sustainable patterns of consumption. However, such reform should only be seen as part of a comprehensive strategy, in which social, cultural, and economic changes are affected by multiple strategies, the strategy of technological reform being one of them.

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