

Sustainable Technologies for Sustainable Lifestyles

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This is a preprint version of the following article:

Brey, P. (2017). Sustainable Technologies for Sustainable Lifestyles. In Kaplan, D. (ed). *Philosophy, Technology and the Environment*, MIT Press.

1. Introduction

An adequate approach to technology is unquestionably a key component of any strategy towards sustainable development. The widespread production and use of modern technology is a defining feature of industrial society. Without modern technology, there probably would not be a problem of sustainability to begin with. Many sources of pollution and environmental degradation are the result of the large-scale development and use of modern technology, including the extraction, processing and consumption of fossil fuels, the large-scale dissemination of chemical pollutants, the production of non-biodegradable waste like plastics, glass and pesticides, and soil degradation through modern mechanized agriculture. At the same time, technology is also a key factor in any solution to environmental problem. Any such solution will have to consider how technologies can be made more ecological and sustainable, and how new technologies can be developed to mitigate environmental pollution and degradation. This essay aims to investigate the importance of sustainable technology as part of a strategy towards sustainable development, and to analyze what sustainable technology would look like.

There is now broad agreement between the nations of the world that economic development should be environmentally sustainable. It is also recognized that industrial societies are the main contributors to environmental degradation. Since the 1980s, the explicit, shared goal of many countries around the world for environmental policy has been the goal of *sustainable development*. Sustainable development has been guiding most international agreements on the environment and climate change, such as the Kyoto protocol and the Copenhagen accord, and is guiding national strategies as well as the approaches of industry and environmental organizations.

Sustainable development has been defined, in the influential 1987 report of the World Commission on Environment and Development (the Brundtland report), as “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs.” (WCED, 1987, p. 43). This definition can be read as expressing basic values that should underlie economic development policies. 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, it is generally agreed, implies a serious reduction in the generation of substances and gases that threaten ecosystemic life cycles, in the immediate destruction or consumption of elements of nature, and serious efforts to protect ecosystems and natural resources.

While there is agreement on sustainable development as a goal, there is less agreement on the right strategy for attaining sustainable development. Should the emission of pollutants be regulated through a cap-and-trade scheme or should alternative reduction solutions be sought? Should renewable energy be heavily subsidized or should its development be left to the market? Should we start phasing out the production and use of coal and oil now, or should we continue to use them? Yet, as I have argued before (Brey, 1997), between all this disagreement there are many shared assumptions as well. Most Western nations agree on a base strategy that has been

called *ecological modernization*. Ecological modernization is an environmental control strategy that aims at greening production processes and the global economy in a way that leaves existing institutions and practices intact as much as possible. It centrally involves a transformation of technology: industrial production processes and produced artifacts are to become environmentally efficient or environmentally friendly, and the production and consumption of technological artifacts should use up fewer nonrenewable resources, emit fewer greenhouse gases and produce less harmful waste, both in production and consumption cycles.

In this paper, I will present the strategy of ecological modernization, and I will subject it to a critique, arguing that its reform of technology, the economy system, and production and consumption are likely to be insufficient for sustainable development. The main problem with the strategy, I will argue, is that it only aims at modest reforms in the institutions of modern industrial society, without any fundamental reform. The fundamental reform that is needed is in our values regarding the quality of life and how to achieve it. We have adopted modern, Western lifestyles based on ideals of consumption that are unsustainable unless they are thoroughly reformed. I will therefore present an alternative second strategy for sustainable development, and correspondingly, for sustainable technology, that focuses on the cultural-environmental reform of consumption and of the lifestyles and conceptions of the quality of life presupposed by it. I will discuss how this strategy relates to ecological modernization and to existing attempts to reform consumption and lifestyles, including the voluntary simplicity and degrowth movements. I will also discuss how this approach may transform the development and use of technology.

2. Ecological Modernization as a Path towards Sustainability

Many nations now have national strategies for sustainable development that typically center around reduction in greenhouse gas emissions through conservation, efficiency, and a shift towards renewable energies, efficient use of raw materials, waste reduction and the proliferation of biodegradable waste materials, better use of land and protection of biodiversity. There have also been efforts to develop such strategies at an international level, for example in the Kyoto treaty and Copenhagen accord. What these strategies have in common is that they aim to reform production and consumption processes so as to achieve sustainability while also holding on to the basic institutions of modern society, including industrialism (the economic organization of society based on large-scale industries), and a market-based, capitalist economic model that include the ideals of economic growth, limited government intervention, free trade, and a consumer society.

This approach finds its academic expression in the theory of *ecological modernization*, which has been developed since the 1980s by sociologists Arthur Mol, Gert Spaargaren, Joseph Huber, and others (Huber, 1982; Mol, 1995; Spaargaren & Mol, 1992; Mol, Sonnenfeld & Spaargaren, 2009). Ecological modernization theory explicitly rejects the assumption that a fundamental reorganization of the core institutions of modern society is necessary for sustainable development (Mol & Spaargaren, 2000, p. 19). Instead, it holds that sustainable development can be attained through a modest reform of some of these institutions, most notably by incorporation of ecological principles into industry and the economic system. The key to this reform is the development and introduction of new ecological technologies for industrial production.

Ecological modernization (EM) aims to ecologically transform industry through a series of source-oriented measures, which are 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 or consumption themselves), *volume control* (legal and organizational measures that reduce the quantity 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.

Structure-oriented measures, in particular, are identified as the key approach to sustainable development. Structural source-oriented measures tend to come in three kinds. The first is *integrated chain management*. This is a “cradle to grave” approach to production that aims to minimize the environmental load of product chains, from extraction to production, use and waste, by looking at ways of limiting environmental load of phases in the chain without increasing it for other phases. Another is *energy expansion*: the more efficient use of energy in production processes and in products and the use of renewable energy sources. A third is *quality improvement*: the production of more durable goods that can moreover be recycled. More and more, such measures are conditioned by economic measures that stimulate environmental solutions and penalize unsustainable practices.

The explicit embrace by EM of the institutions of modern society is a response to environmental critiques in the 1970s, which argued for a more radical reform of these institutions. Such critiques tended to be highly critical of industrialism, capitalism and modernity and their ideals of progress and growth, and often advocated a partial or complete dismantling of industrial society and a return to small-scale technologies (Schumacher, 1973; Illich, 1973). Proponents of EM held that approaches that embraced modernity and industrialism rather than rejecting them were more likely to lead to changes in industrial society that would yield sustainability.

By accepting and upholding the institutions of modern society, EM can be seen as accepting the project of modernization that finds its starting point at the industrial revolution. This process of modernization is characterized by an ideal of progress that is exercised through increases in productivity and technological complexity, rationalization of production, the employment of scientific principle and method, and professionalization within the economic context of free-market capitalism.

The philosophical background of the project of modernization is found in the principles of modernity. The central principle of modernity is 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 thus be understood as a 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, nanotechnology 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.

3. Limitations of Ecological Modernization

Critiques of EM come in two kinds: critiques of EM as a successful strategy for sustainability on its own terms, and critiques that are really not targeted at EM itself, but at the institutions of modernity that it sets out to preserve. In this section, my focus will not be on the latter type of critique, but only on likely success of EM as a strategy for sustainable development. Since the success of EM is ultimately an empirical issue, one may point to the success, or lack thereof, of EM in curbing emissions and environmental degradation as evidence for or against it. However, the success of EM is currently difficult to assess on empirical grounds. Proponents may point to the fact that many countries have succeeded in curbing certain forms of environmental degradation or certain emissions, in increasing energy efficiency or making early steps in transitioning from fossil fuels to renewable energy. However, opponents may point to studies that show that global emissions and environmental degradation are up, and that almost four decades of efforts according to the approach of EM have not brought society close to sustainable development.

Rather than exploring controversial empirical arguments for and against the success of EM, I will here consider two theoretical arguments against EM. These are arguments that challenge fundamental assumptions that are inherent in EM and in the underlying beliefs of modernity. They are: (1) the *argument against technological neutrality*; (2) the *argument against unlimited economic growth*.

The argument against technological neutrality points to a flaw in the project of ecological modernization, which 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 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 argument against unlimited growth points to a second flaw in the project of ecological modernization, which is 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.

Proponents of ecological modernization may argue, however, that while the reform of industry may not give us sustainable development, the ecologization or “greening” of the economy will. By subsidizing and supporting economic activity that is environmentally friendly and by taxing and penalizing such activity that is environmentally harmful, it may be argued, the economy, and thereby society, will eventually conform to the principles of sustainable development. The greening of the economy does not only help the greening of production and distribution, but also the greening of consumption. Through economic incentives, consumers will eventually purchase environmentally friendly products because they are less expensive than environmentally harmful ones and they will be stimulated to conserve energy and recycle. In this way they will, through economic incentives, be stimulated to reduce their ecological footprint and adopt sustainable patterns of consumption.

However, the economic aspect of ecological modernization appears to have the same problems as its technological aspect in that it assumes that the efficiency gains of ecological modernization will outpace growth in consumption. Economic incentives may stimulate people to purchase environmentally friendly products like energy-efficient lamps and hybrid cars, but with the growth of the economy and concomitant increases in wealth and income, people will have larger houses with more lamps, and will use more automobiles, so that increases in consumption may well offset the environmental gains made in the greening of consumer products and particular consumption processes.

3. Sustainable Consumption as a Condition for Sustainability

If ecological modernization does not yield sustainability, the question is which alternative environmental strategies do. As argued, any such strategies will have to abandon the classical modernist ideal of economic growth and the belief in a largely technological solution to the environmental crisis. This is not to say that any ideal of economic growth has to be abandoned, let alone the modernist ideal of progress. What needs to be abandoned is the idea of unlimited economic growth attained by continuous growth in the quantity and economic value of goods

available in different economic sectors (mining, agriculture, forestry, fishery, automotive, electrical, energy, metallurgical, textile and clothing, consumer goods, etc.) Significant sustainable growth could still be possible compared to the current economy through intense processes of ecological modernization. However, even if so, such growth will have its limits, and it might very well be possible that these limits have already been reached by now.

Abandoning the classical ideal of economic growth also does not imply giving up on the ideal of progress. The enlightenment ideal of progress was initially not formulated as a belief in economic growth, but rather as a belief that science, technology and reason could better the human condition and improve the quality of life. Only much later did quality of life become linked to economic prosperity and economic, which happened in classical economics through the notion of utility. In recent decades, however, a measure of quality of life, or well-being, has been developed separately from economics in studies of happiness, well-being and quality of life (Kahneman, Diener and Schwartz, 1999).

The study of well-being has also affected economics, in which the correlation between economic processes and individual well-being has become a topic of study (Frey and Stutzer, 2002). In so-called happiness economics, it is considered how economic factors like income, wealth, unemployment and social security, as well as social and institutional factors like freedom, relationships and good governance, affects individual well-being. Some economists have even gone further to argue that happiness should become the new metric of economics, replacing monetary value or preferences (ordinal utility) as the values that economics aims to optimize. On this conception of economics, economic and public policies should not aim to maximize GDP but should rather aim to maximize gross national happiness, as measured through some happiness index.

In part as a result of these efforts, happiness and quality of life indices have taken on a major role in public policy over the past twenty years. These indices, such as the Economist Intelligence Unit's quality-of-life index, the UN *Human Development Index* and Gallup's global well-being survey, are used to measure happiness or quality of life within nations, cities or regions and to make comparisons between them. Some countries have even started to use happiness indices to guide national policies and are using them as a supplement or alternative to gross domestic product (GDP) as a measure of progress. Bhutan is the first country that has decided to measure its progress in terms of *gross national happiness* (GNH) rather than GDP, using sophisticated surveys to measure the population's level of well-being. Other countries that are using or considering GNH indices include Thailand, China, Australia, Canada, France and the United Kingdom.

A workable strategy for sustainability should, I claim, replace the ideal of unlimited economic growth with an ideal of limited economic growth within ecological boundaries, and should divorce the notion of progress from the notion of economic growth and refocus it to mean the advancement of well-being in human societies. The major problem for any such strategy is that in current industrial societies, the ideal of well-being is itself still strongly conditioned by the ideals of economic success and high levels of consumption of goods and services. Consumerism, the social and economic practice and ideal of consuming ever increasing quantities and services so as to enhance one's quality of life, is the major obstacle. In a workable strategy for sustainability, a reform of systems of consumption that includes a partial or complete abandonment of consumerism will be a necessity. This implies that the strong focus of EM on a reform of systems of production will be supplemented with a strong reform of systems of consumption as well.

Although it has traditionally focused on the reform of production, EM has include the reform of consumption in its platform since the 1990s (Spaargaren & Van Vliet, 2000; Spaargaren, 2003). In spite of the criticism in the previous section, couldn't EM therefore be a plausible candidate strategy for sustainable development if it also includes a reform of

consumption? Let us therefore consider EM's position on the reform of consumption. This position is that a restructuring of consumption should not assume that consumption needs to be limited, but rather that it should be restructured along ecological lines. Such a restructuring could sometimes mean that less is consumed, but it does not involve overall downsizing or limits to consumption (Mol & Spaargaren, 2010). The challenge, as EM has it, is to try to restructure consumption patterns and lifestyles through sociotechnical innovations so as to make them more sustainable "without the need to abandon the existing high quality levels of modern consumption" (Spaargaren 2003, p. 697).

EM's approach to the greening of consumption has, however, received much less attention so far than the topic of production, so that in practice, EM's emphasis is still strongly on the reform of production processes. A more fundamental problem is that by not abandoning the overall idea of limitless consumption and, consequently, of limitless growth, and by not advocating an overall downsizing of consumption, it embraces the ideals of unlimited growth and consumerism that I just critiqued. The belief that a sustainable ecological restructuring of consumption is possible without overall limits and downsizing of consumption is not well-grounded, and therefore EM's approach to the ecological restructuring of consumption is not likely to succeed.

What is needed instead is an approach to consumption that gives it a central place in a strategy for sustainable development, and that holds that a reform of consumption implies an abandonment of consumerism and limitless growth. Such an approach will have to be different from the largely technocratic approach of EM that focuses on technological and economic reforms. It will require cultural reform and particularly a reform of values regarding the quality of life and its dependency, or lack thereof, on high levels of consumption and economic growth. As a result of such reform, people will be prepared to consume less overall and to avoid or minimize those consumptive practices that are unsustainable.

There is increasing scientific evidence that the correlation between well-being and high levels of consumption is weak at best. Since the 1970s, studies have consistently shown that people in high-income countries are not significantly happier than people in low-income countries (at least, those whose incomes are above a certain threshold), and that rises of income above this threshold did not seem to yield significant increases in happiness. This has been called the paradox of happiness (Easterlin, 1974). Studies have also shown that people whose values center on the accumulation of wealth or material possessions are at a greater risk of being unhappy, anxious, and depressed, regardless of whether they are successful in such accumulation (Kasser, 2002). Many authors have argued 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 (Seligman, 2002; Borgmann, 1984).

Yet, how realistic is it that a cultural reform of consumption will be possible in the near future? Aren't people so caught up in consumerism that a radical change in practices will be impossible? I believe there is some reason for optimism. Some studies show that in Western countries, a shift has been taking place since the 1970s from "modern" values that center on economic accumulation and social status to "postmodern" values such as freedom, self-expression and quality of life (Inglehart, 1997). Other studies show a decrease in consumerist attitudes in younger generations (Parker, Haytko and Hermans, 2010).

Studies have also shown that consumption has in recent decades changed from a means of meeting material needs to a means of creating personal identity (Hamilton, 2010). This development may make change in consumption patterns easier to achieve, since a transformation and possible decrease in the volume of consumption may be easier if it requires changes in how people construct their identities than it would be if it would imply that certain needs are no longer satisfied. A growing awareness of environmental problems amongst consumers, together

with changes in values that undo the perceived connection between quality of life and high levels of consumption, could yield new identities and lifestyles that emphasize sustainability over consumption.

Several social and intellectual movements have emerged in recent decades that aim to transform consumption to make it more sustainable. *Ethical consumerism* (Harrison, Newholm and Shaw, 2005) is perhaps the best known of these. It is a form of consumer activism with the intent to purchase products that have been ethically produced and are not harmful to the environment and society, and to avoid or boycott those that do not meet up to such standards. Environmental considerations have traditionally been central to it. However, ethical consumerism does not directly challenge consumerism itself, nor the idea of unlimited economic growth. It is therefore not necessarily a strategy that will yield the radical reform of consumption processes that is needed for them to become sustainable.

Voluntary simplicity, or *simple living* (Etzioni, 1998), is movement with American origins that is not borne out of ethical concerns, but a desire to enhance the quality of life for individuals. It is a trend towards living simpler lives that tends to include less possessions, less consumption, less worktime, increased self-sufficiency, simplified diets, and being satisfied with what one has rather than what one wants. It sometimes also includes the use of simpler technology or even a complete renunciation of technology. Voluntary simplicity can be understood as a radical form of *downshifting* (Schor, 1998), a broader social trend aimed towards finding an escape from the stress that comes from economic pursuit. Downshifting implies finding a better balance between leisure and work, accumulating fewer possessions, and focusing one's life on personal fulfillment and relationship building rather than on economic success. Both voluntary simplicity and downshifting are strategies that appear compatible with the kind of reform of consumption that is needed for sustainability.

Finally, the more recent *degrowth movement*, which has its roots in (Southern) Europe, is a social, political and economic movement that holds that to attain a sustainable society, limits must be imposed on growth, and that argues for the downscaling of both production and consumption (Demaria et al., 2013). It centrally holds that a decrease in consumption need not result in a decrease in well-being, and instead aim to maximize happiness and well-being through other means, such as art, music, family, culture and community. Most degrowthers are also anti-capitalist, holding that capitalist economies unavoidably promote unlimited growth, consumerism, and greed at the expense of solidarity and justice.

I do not want to argue that any of these movements presents the perfect path towards the ecological reform of consumption and towards a sustainable society. However, their existence is evidence of a growing interest in society to address environmental problems through a reform of consumer culture. But what will be the place of technology in such a society? And what role can technology play in making this change in consumer culture possible? This will be the topic of the next section.

5. Technologies for Sustainable Lifestyles

Most consumer goods, including cars, electronics, furniture, clothing, and computers, are the result of industrial production processes and as such qualify as technological products. The question I aim to answer in this section is how the market of consumer goods will need to be reformed so as to allow for sustainable consumption. Sustainable consumption is evidently not dependent on supply alone, but also on demand and on usage patterns. But my focus will, at least initially, be on the supply side. An ecological restructuring of the market of consumer goods will have to involve two types of reform: (1) the introduction of consumer products that are themselves sustainable and that promote sustainable behaviors and lifestyles, and (2) the reduction or elimination of consumer products that are unsustainable and support unsustainable

behaviors and lifestyles.¹

Producers, consumers, regulators and civil society organizations will all have a role in attaining these two types of reform. Producers, as developers of new products, ought to have a leading role in the first type of reform. There is a variety of ways in which their products can contribute to sustainable consumption:

- Use of sustainable materials (e.g., biodegradable plastics, recyclable metals) and sustainable, renewable energy sources (e.g., devices that run on solar energy or green batteries)
- Designing for energy efficiency in products that consume energy
- Making durable products, that are made out of durable materials, have a long lifecycle, and that have the ability to be repaired or upgraded so that no replacement product is needed
- Adoption of product life-cycle approaches in which the company's total environmental impact is accounted for with respect to a product, from raw materials to production, distribution, consumer use and disposal.
- Designing products that impede or discourages unsustainable behaviors and lifestyles and encourage conservation (e.g., showers that switch off after five minutes of use)
- Designing products that support or require sustainable behaviors and lifestyles (e.g., products that make the use of bicycles as a means of transportation more attractive)

Of these reforms, the first four are currently well-known in ecological design. The last two, however, have not yet received as much attention. They both rest on the idea that products can be designed so as to steer or influence behaviors, attitudes and lifestyles, and this idea is not universally accepted. However, in recent years, several approaches to design have been developed that do incorporate this idea.

One class of approaches goes under the name of *persuasive technology* or *persuasive design* (Fogg, 2003; Wendel, 2003). Persuasive technology is technology that is designed to change attitudes or behaviors of the users through persuasion and social influence, while refraining from coercion. Most of its applications are in the design of computing technologies, and it draws heavily from experimental psychology and human-computer interaction studies. Persuasive technologies may stimulate certain actions by making them easier or more attractive or pleasant to perform, they can send out messages to encourage people to take certain actions, they can create experiences that allow for behaviors to be explored, rehearsed or empathized with, and they can help communicate social approval or disapproval for certain behaviors. One of its applications is in environmental design, in which case the aim of design is to persuade users to engage in more environmentally sound behaviors. For example, some cars now have fuel economy meters that indicate whether one's driving behavior is economical, thereby stimulating drivers to drive at more economical speeds. There are also educational computer games that in playing them provide information about the relation between domestic behaviors and household

¹ While proponents of EM are likely to argue that both of these reforms are consistent with EM, it is fair to say that EM places its emphasis on the technological solutions that are minimally intrusive to consumerist lifestyles. The difference between EM and the position I advocate is ultimately one of degree: how radical will the reform of systems of consumption be? In the position that I advocate, there would be a greater emphasis than in EM on reducing consumption, limiting and eliminating unsustainable products and introducing products that support or require serious reorientations in behaviors and lifestyles.

energy consumption, thus stimulating more sustainable behaviors.

Persuasive design is different from design that requires behaviors, or that excludes certain behaviors from taking place. Examples of such designs are showers that are designed to turn off after five minutes of use, cars with built-in speed delimiters that ensure an economical use of fuel, and solar panel-equipped appliances that automatically switch to solar power if there is enough sunlight to make this possible. Such design is an alternative way of stimulating sustainable behavior that gives a better guarantee that it will take, but that may also meet with resistance because of perceived user-unfriendliness or absence of functional features.

A class of design approaches could go under the name of *design for well-being* (Brey, 2014). These are approaches to design that aim to enhance the well-being of users. As argued in Brey (2014), a large variety of approaches to design for well-being has emerged in recent years, including life-based design, emotional design, positive psychology approaches and others. Ruitenbergh and Desmet (2012), for example, have developed a positive psychology approach to design that focuses on long-term life satisfaction rather than short-term experiences or emotions in using products. Their designs are intended to support meaningful activities, which are activities that use and develop personal skills and talents of the users, that are rooted in core values of the user, that contribute to a greater good (a thing or person), and that are rewarding and enjoyable in themselves. Design includes visualising meaningful activities and then designing products that enable or inspire people to engage in these activities.

Many approaches to design for well-being take the psychological literature on well-being seriously. This implies that they have less of a focus on short-term pleasures and consumer experiences, but rather focus on supporting meaningful experiences, social relationships, engagement with one's physical and social environment, self-improvement, and long-term life satisfaction. In this way, these technologies support and foster non-consumerist behaviors, values and lifestyles, and may in this way support the transition to more sustainable lifestyles.

There is yet another way in which producers can support sustainable consumption, which does not involve design. Producers are normally also involved in marketing their products. Much of contemporary marketing is not about showing the qualities and benefits of products, but about marketing lifestyles in which the product is positioned. These can be luxurious lifestyles, healthy lifestyles, achievement-oriented lifestyles, experience-oriented lifestyles, and others. Such lifestyle marketing can also be used to promote sustainable lifestyles in which the marketed product fits. This could mean that are marketed in a direct and overt manner for their fit with a sustainable lifestyle. Since such marketing probably does not yet have appeal for large portions of the population, sustainability could also be marketed indirectly, by promoting lifestyles for personal well-being that also happen to support sustainability. In this way, marketing can help individuals construct and strengthen identities that include ecological sensibility and can stimulate the sustainable use of products.

6. Conclusion

In this essay, I have investigated the importance of sustainable technology as part of a strategy towards sustainable development, have analyzed how technology should be developed for it to become sustainable. I have described the current dominant strategy for sustainable development as ecological modernization, an environmental control strategy that aims a greening production processes, and to a lesser extent also consumption processes, in a way that leaves existing institutions and practices intact as much as possible and that focuses on the ecological transformation of technology and production. I have argued on both theoretical and empirical grounds, that this approach is not likely to result in sustainable development. A more fundamental reform of some of the systems and underlying values and beliefs of modernity will

be needed. Most centrally, I have argued, a fundamental reform is needed in patterns of consumption and modern, Western lifestyles, and the values and beliefs that underlie them.

I have argued that there is an approaching consensus in empirical studies of well-being and happiness that there is a weak correlation at best between well-being and high levels of consumption, and that consumerist lifestyles may actually make people unhappy. In addition, there appears to be an increasing receptiveness among the public to embrace new lifestyles that move beyond consumerism and materialism. I have argued that because of the needed reform of consumptive practices, the development of sustainable technology should not just focus on ecological principles in production technology and eco-efficiency, but also on supporting sustainable consumptive practices and lifestyles. I have presented ways in which such a greening of technologies for consumption may be realized.

It should not be thought, however, that the redesign of technologies to promote sustainable consumption will be sufficient in itself to engender sustainable systems of consumption. The idea that this is 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. Technological reform will certainly be of great help in the move towards sustainable patterns of consumption. However, such reform should be seen as part of a comprehensive strategy for sustainable consumption, which also includes social and economic incentives and public debates about values, lifestyles, the quality of life, and the future of the planet.

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