SUSTAINABLE DEVELOPMENT: A CO-EVOLUTIONARY VIEW

Richard B. Norgaard

The challenges of sustainable development can be organized around three themes. First, modernization has been unsustainable because it has been supported by the use of hydrocarbon fuels and chemicals which are limited in availability and damaging to the atmosphere and terrestrial and aquatic systems. Sustainable development will require that the use of energy and chemicals be subservient to ecosystem maintenance. Second, political consensus and bureaucratic mobilization will be more difficult because we no longer believe that development is almost inevitable through the application of Western science. On the other hand, we may be less prone to make mistakes. The decline in belief in progress has also increased the opportunities for non-Western cultures to define development for themselves. Third, we are shifting from a mechanical to a co-evolutionary understanding of systems which helps explain why development has been unsustainable and what we must do to attain sustainability.

Pollution control, population planning and energy conservation have been incorporated into national policies during the latter 20th century. Pesticide use is regulated, industrial pollution is inveighed against, and family planning is encouraged throughout the world. Obviously most nations are not putting sufficient emphasis on these long-term problems, but none outwardly disagrees with their importance. Resource exploitation, environmental degradation and commodity output have been constrained, albeit only moderately, by limiting where production can occur, by investing resources to curb pollution and by rejecting some technologies outright. Agencies for land use planning, pollution control and technology regulation have added fresh layers to the bureaucratic onions of both the developed and developing nations.

The call for sustainability in the latter 1980s appears pretty vague compared to these earlier calls for specific controls. Previous environmental movements carefully aimed their limited political power at particular problems. The politics

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of sustainable development is taking a different course. Environmentalists want environmental systems sustained. Consumers want consumption sustained. Workers want jobs sustained. Capitalists and socialists have their 'isms' while aristocrats, autocrats, bureaucrats and technocrats have their 'cracies'. All are threatened. Thus sustainability calls to and is being called by many, from tribal peoples to the most erudite academics, from Levi-clad eco-activists to pinstripe-suited bankers. With the term meaning something different to everyone, the quest for sustainable development is off to a cacophonous start.

Thus we need to nail down the concept of sustainable development. I propose five increasingly comprehensive definitions. First, we can start at the local level and simply ask whether a region's agricultural and industrial practices can continue indefinitely. Will they destroy the local resource base and environment or, just as bad, the local people and their cultural system? Or will the resource base, environment, technologies and culture evolve over time in a mutually reinforcing manner? This first definition ignores whether there might be subsidies to the region—whether material and energy inputs or social inputs such as the provision of new knowledge, technologies and institutional services are being supplied from outside the region.

Second, we can ask whether the region is dependent upon non-renewable inputs, both energy and materials, from beyond its boundaries. Or is the region dependent on renewable resources beyond its boundaries which are not being managed in a sustainable manner? Third, we can become yet more sophisticated and ponder whether the region is in some sense culturally sustainable, whether it is contributing as much to the knowledge and institutional bases of other regions as it is culturally dependent upon others. Fourth, we can also question the extent to which the region is contributing to global climate change, forcing other regions to change their behaviour, as well as whether it has options available to adapt to the climate change and surprises imposed upon it by others. From a global perspective, this fourth definition of sustainable development addresses the difficulties of going from hydrocarbon energy stocks to renewable energy sources while adapting to the complications of global climate change induced by the transitional net oxidation of hydrocarbons. Fifth, and last, we can inquire of the cultural stability of all the regions in combination, are they evolving along mutually compatible paths, or will they destroy each other through war?

These definitions become increasingly encompassing. All, however, address the sustainability of *changing* interactions between people and their environment over time. All except the first definition also refer to the sustainability of the interactions between regions and cultural systems. While change is an essential element of each definition, none alludes to inevitable increases in material well-being and happiness or to moral progress.

Sustainability, as defined above, incorporates, yet goes beyond, the 'limits to growth' literature of the 1970s. While rejecting the myth of cornucopia is probably realistic, many have seen the rejection of progress as a negative view of the future. Many in the 'sustainability movement' have acquired a positive understanding of the role of culture and of the value of cultural diversity. Many see a positive role for non-Western realms of knowledge. Many see positive opportunities in working with natural systems. It is these positive interpretations which excite people and make the idea of sustainable development viable in diverse cultures.

This article proceeds from here with a general description of foreseeable environmental, technical and social difficulties of achieving sustainable development, concentrating on the simpler, lower-level definitions. Three arguments follow. Firstly, I argue that these new concerns with the future are coming to the surface because we no longer believe in progress. If this argument is correct, the transition in beliefs will be as important to the course of history as the transition in beliefs associated with the Renaissance. Secondly, I identify a fundamental flaw in the dominant Western worldview that has contributed to the unsustainability of past development. Thirdly, I present a co-evolutionary worldview that is compatible with sustainable development. A summary concludes the article.

Foreseeable difficulties of attaining sustainable development

The following is presented with considerable hesitation. If I were an environmental determinist I could confidently describe the problems that must be overcome to attain sustainable development. Though I am not, several things seem clear. If sustainable development is to be achieved, we will have to devise institutions, at all levels of government, to reallocate the use of stock resources towards the future, curb the pace and disruption of global climatic changes, reverse the accumulation of toxins in the environment and slow the loss of biological diversity. These are the key resource and environmental issues that must be addressed.

Nobody is in favour of gorging quickly on the remaining coal, gas and oil and then struggling forever without these resources in the less favourable climate and denatured environment their use is inducing. Our engagement in this calamity stems directly from a net oxidation of hydrocarbons. Our atmosphere is being transformed by the coal and petroleum that fuel our residential, industrial and transport systems. Fossil hydrocarbons are also the primary sources of agrichemicals that simplify ecosystems and degrade water resources. Sustainable development implies switching from the use of stock to flow resources, especially from the use of energy from fossil hydrocarbons to current energy from the sun.

Flow resources—solar energy, the hydrologic cycle, the productive services of plants and animals—mostly flow from the sun. Tidal energy is an exception and some geothermal resources can be used for a very long time. Concrete and brick deteriorate very slowly. The useful life of metal goods can be greatly extended, and metals can be recycled to the extent that renewable, non-polluting energy is available. So to a large extent the call for sustainable development is a call to tap into the sun for energy through constructive management of organisms, ecosystems and environmental systems.

The management of flow, or renewable, resources for sustainable development must extend from the vitality of the smallest microbes in farmers' fields to the functioning of the atmospheric system that surrounds us all. Furthermore, these extremes are closely linked. The services of soil microbes affect the atmosphere through nitrogen fixation, the decomposition of organic material to carbon dioxide (CO_2) and the facilitation of nutrient uptake for the vegetation cover that affects both the stock of organic hydrocarbons and the Earth's albedo. The atmospheric system, in turn, affects the climatic conditions upon which

vegetation and soil microbes depend. Flow resource systems must be understood and managed, both locally and globally, as mutually determined systems. Our current piecewise efforts at environmental management are unlikely to bring us to sustainable development.

The differences between agro-ecosystems have steadily declined. Regionally unique ecological processes have been increasingly overridden by the use of fertilizers and pesticides. Under sustainable development these regionally unique processes will have to be restored and managed to capture solar energy and conserve nutrients. New agricultural technologies and institutions will be more specifically tailored to the features of the region and goods being produced than have been agrochemical technologies and institutions. We will have to pay more attention to the details of technical and institutional possibilities and limitations for specific regions. Ecosystem-specific technologies will probably be management-intensive rather than capital-intensive. Poorer regions needing assistance will need more than simply the financial means to acquire capital equipment and technologies and to adopt institutions from other regions. Appropriate knowledge, inputs and forms of organization will have to be developed for each area.

Facilitating the adoption of technologies and institutions which support the management of the global system of renewable resources will be a major challenge. Our economies and social structures have evolved over the past century to take advantage of the medium-term opportunities provided by fossil fuels. New legislation, regulations, agencies and incentives to private action to capture the gains of ecosystem management will constitute significant economic and social changes. While institutions will have to be locally tailored to support ecosystem-specific technologies, local institutions, nonetheless, will still have to mesh with regional and global institutions designed to capture the gains of ecosystem management on a larger scale and to prevent untoward broader consequences of local decisions.

Products will probably be less homogeneous once production processes differ between regions. It is not clear whether there will be more trade or less overall. The global economy, however, will be much less dominated by Western technology and capital because technology and capital will be more locally specific and because management and labour will be relatively more important than capital. The US economy itself will also probably not have such identifiable centres of industrial or agricultural concentration.

While institutions will locally both differentiate and gain in power to support this heterogeneity, new global institutions will also be necessary, especially during the transition, to restrain global hydrocarbon use and maintain global biological diversity. Though difficult to imagine, it seems inevitable that the role of nations will diminish in relative importance while local institutions and global accords will become relatively more important. Eventually the idea of importance itself will become obsolescent as our understanding of interdependence matures.

Perhaps I have it all wrong. Certainly the details will be different. The important thing is to foresee a future with major changes in our resource base, with continued environmental surprises and with the necessity for adaptive response. These resource and environmental changes will require technical and institutional responses. The really interesting phenomenon is that a key Western belief is already changing to facilitate the transition.

The fall of 'progress'

The idea of progress through technical mastery of nature has been central to Western culture for several centuries. Belief in technical progress also provides the enticement for the transfer of values, knowledge and modern forms of social organization to other cultures. Widespread belief in technical progress has been key to the public consensus behind change in the developed and developing world. But technical progress is increasingly in doubt. People now recognize that every new technology, even those designed to correct the problems of earlier technologies, brings unforeseen consequences. As we push our technologies to exploit more and more resources, we now recognize that both the direct devastation and the unforeseen consequences are becoming increasingly global in nature. Independent of the side-effects, people are increasingly recognizing that the products of new technologies do not necessarily increase happiness.

Our belief in progress 'sugar coated' political conflicts and 'greased' the policy process. Progress—even when it encompassed individual morality and the quality of social relations as well as material comforts—always entailed more of some good things without any reduction in other good things. Policy formulation typically stumbles on the what and for whom more than the how, but the debate over this *v* that and one group *v* another has been ameliorated by our belief in progress, by our faith that shortly all can have both. More generally, so long as we believed we were always getting more of some good things without giving up other good things, we did not question even the relative proportions of things, the mix that determines the direction of progress.

At least since Henry David Thoreau, we have recognized that real trade-offs were being made. Economists talked 'no free lunch', but also espoused the wonders of growth. Nostalgia for simpler times is conveyed through high-tech video communication systems. These inconsistencies, however, do not deny the dominance of one belief over the other. Only in the last decade has it become clear to many, through the accumulation of evidence that could be personally observed, that progress is a contradictory bundle of myths. Sustainability will have to accumulate its own myths to survive, but, unlike progress, the basic idea of sustainability directly leads to confrontations over what, for whom and when.

Belief in progress also entailed the idea that we were progressing towards pure, universal values and one right way of knowing. While this image was no more explicit than the Christian image of Heaven, it was thought that greed and hate would fade away. Harmony would be further assured through rationality and respect for fellow human beings. Given this belief, non-Western, non-Judeo-Chritian cultures were obviously seen as irrational, not on the path of progress, and hence their demise could be rightfully hastened.

Well into the 19th century Westerners thought it was acceptable to exterminate cultures in the way of progress. While many non-Western cultures have been destroyed through direct violence and the introduction of disease, most met their demise through the loss of a positive image of their future. From the turn of the century Westerners assumed a custodial role towards traditional peoples, but policy wavered between benign neglect, forced acculturation and cultural protection. Admittedly, our policies still waver, but something new is taking place in the latter 1980s. Pope John Paul II speaks to the beauty of cultural diversity, goes out of his way to visit indigenous peoples, and commends many

for their religious beliefs, especially their respect for the Earth. Nine US Protestant denominations and the United Church of Canada have apologized to indigenous peoples for the past conduct of their missionaries. And Amazon tribal leaders have met with Barber Conable, President of the World Bank, to discuss their futures.

Cultural survival is also being enhanced not only as the Western idea of progress wanes, but also through new interest in the knowledge of other peoples. Western scientists, for example, are beginning to look at traditional agricultural systems in order to understand how agro-ecosystems, management techniques and cultures can co-evolve sustainably. Thus non-Western cultures are beginning to be given respect.

Increasingly we believe that traditional peoples not only have a right to maintain their cultures but a right to influence how their cultures might evolve. Minority and alternative cultures within the USA and in Europe are also maintaining their identity much more openly than before. Sustainable development, broadly conceived, addresses the sustainability of cultural systems as well as of environmental systems.

The epistemological roots of unsustainable development

The Renaissance sketched the broad outline of development as a flowering of Western thought and artistic expression unknown for a millennium. The great explorations of the world and the establishment of colonial empires added an expanding geopolitical and economic dimension to the image. The demise of feudal society and the rise of capitalism added socio-economic transformation to the picture. Material progress coloured the image by the latter part of the 18th century. While the image became ever more elaborate, each embellishment was tied to knowledge—to its absolute increase, spread among the populace, and application in the development of better technologies for exploiting nature, improved products for easier living and new institutions for organizing people.

In its most simple version, progress was thought of as being linear, much as portrayed by the causal chain running down the centre of Figure 1 (overleaf). The image was also decidedly European and then American. It was all that Third World peoples saw as they embarked on development after independence. This simple image is still widely held and is still invoked in arguments, even by those who are well aware of its simplicity.

This linear image of development became more complicated during the 19th century. First, the advance of science required an ever more educated populace to work with the new technologies. The extra time in school took able-bodied young adults out of economic production. Second, the advance of science and technology could no longer simply be left to the few great minds who pursued knowledge for its own sake. Governments began systematically to invest in and establish permanent institutions for science and technology. Third, the increase in material goods production facilitated by new technologies resulted in the depletion of natural resources. Thus science had to be directed to the development of new technologies and social organization to exploit new resources, problems for which earlier science and technology were partially responsible. These three phenomena are illustrated as feedback loops in the otherwise linear image of Figure 1.

During the 20th century we have learned that new technologies not only

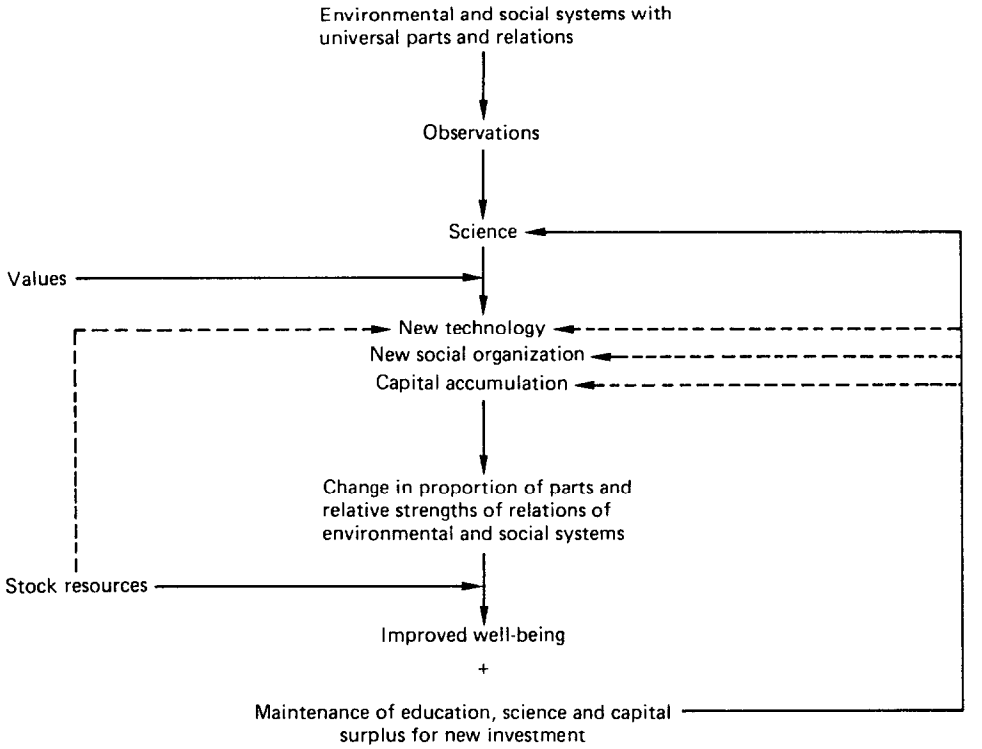

Figure 1. An early 20th century image of the development process

sequentially deplete different qualities of resources but also sequentially degrade different qualities of the environment. This has necessitated further investments in science, technology and institutions. Furthermore, we have become attuned to how our own value systems, to say nothing of those of non-Western cultures, are modified by development and of how these changes, in turn, affect our social organization and choice of technology. If we added these additional feedbacks to the picture, Figure 1 would be indistinguishable from a plate of spaghetti. This, of course, is much of the problem. Our simple image of development has become lost, and none too soon, in the complex of good, bad and potentially disastrous things that development has wrought. Without a clear image, it has become increasingly difficult to obtain a consensus on either goals or processes. This, however, is only the beginning of the difficulty.

Early Western scientists set out to understand a static world as God had created it. They envisaged the acquisition of knowledge as a process whereby individual minds investigate nature's parts and processes. The mind was thought of as an independent entity that perceives and interprets. Asking questions, thinking and acting neither influence the underlying principles which govern nature nor affect the mind itself. Like the mind, nature also just is. People and the natural world are juxtaposed in the Western worldview. The idea of objectivity in the natural sciences that has been adopted by the social sciences stems from this static juxtaposition.

The 19th century image of development was based on this Western understanding of knowledge and action. Given the assumption that both natural and

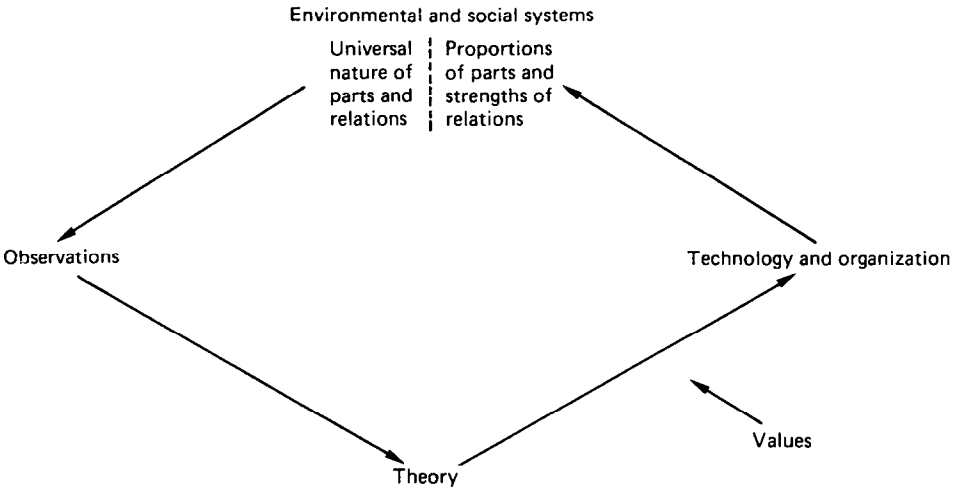

Figure 2. An atomistic–mechanistic view of knowledge and development

social systems consisted of unchanging parts and relations, development consisted of adjusting the relative numbers of the parts and the relative strengths of the relations. Action did not change the underlying nature of the systems. Since the nature of the parts and relations of systems were presumed not to change, knowledge could be presumed to be universal over time. Furthermore, differences in natural and social systems across regions could also be thought of as differences in the proportions of parts and strengths of relations. Thus the idea of underlying universal truths could be maintained across diverse environments and cultures.

This atomistic–mechanistic view of knowledge and development is illustrated in Figure 2 by looping the line of causation of Figure 1 back on itself. Note the assumed barrier between the changing proportions of the parts and strengths of the relations and the very nature of the same. The barrier, of course, does not exist. Its absence in reality accounts for why development has been unsustainable in the past. Action changes the nature of parts and relations, typically in an irreversible manner. We keep introducing totally new parts—agrichemicals into ecosystems and televisions into social systems—which create brand new relations. Basing action on science girded by false beliefs in universals and objectivity continually results in 'unforeseen' changes in social and environmental systems. Thus the unsustainability of past development has an epistemological explanation.

The rise of an alternative worldview

Even if the transition is 'merely' technically driven for decades to come, the process will be complicated by increasingly vocal constituencies calling for something more. For it appears that sustainability is becoming the clarion of a new age. The call for progress or modernization was equally vague, but it evolved into a meta-, or covering-, belief system, a great carpet under which old beliefs and new contradictions were swept for centuries. The call for sustainability may be the beginning of another covering-belief era. It has a certain irre-

versibility. No one can fail to heed it, yet as each person does, beliefs about modernization are necessarily called into question.

Broadly conceived, the call for sustainable development resonates with the rise of new understandings of environmental systems, technology, social organization, knowledge, values and their interplay. These new understandings reject the modern belief that these realms can be understood separately, that they do not interplay. Thus we will not simply be implementing new technologies but will have to grapple with a transition in beliefs as well. If the idea of sustainability is replacing the idea of progress, the potential for change is enormous.

With sustainability as a metabelief instead of simply another objective on the agenda, we enter a wholly new political realm. Old objectives will fade away as new unforeseeable ones arise, confounding the political process by making old compromises meaningless while opening up both unexpected opportunities and problems. On the other hand, the entrenched interests which would make the transition so difficult under the narrow conception will become redefined. It is unclear whether the challenges will be greater or less, but they will certainly be different as sustainability becomes a metabelief.

Transition in understanding

Just as the idea of progress is strongly tied to an understanding of knowledge and its accumulation, so the demise of the idea of progress and the rise of the idea of sustainability are linked to changes in that understanding. These changes deserve careful elaboration for they indicate how the future will be different.

First, there is the problem of complexity. The laws of physics and chemistry may be universal. But the number of ways that the parts and relations known to physicists and chemists can combine to form complex materials—to say nothing of biological organisms, let alone ecosystems or social systems—is infinite. The existence of universal principles for the parts and basic relations says nothing about the existence of universal principles for far more complex parts and relations between them. Nevertheless, the majority of scientists and the public at large still think 'real knowledge' is universal. Fortunately a growing number of people are moving beyond this myth.

Second, natural and social systems are not only complex but the parts and the relations between the parts are constantly evolving. This evolution also precludes universal principles. The rate of evolution varies from very slow for geological processes to very fast for micro-organisms. It is also very fast for social systems of intelligent species, especially so when their theory of knowledge and action denies evolutionary feedbacks.

Third, our understanding of knowledge and action has a nexus of problems associated with objectivity, consciousness, intentionality and free will. People are not apart from nature or from their social systems. Learning changes knowledge, how people act, and the dynamics of the interactions between peoples and between people and nature. Knowing, once it is in any sense used, changes what is thereafter important to know as well as the bounds of action and freedom.

Fourth, people do not individually perceive and know either the natural or the social world. Each of us perceives through the models we have inherited and through our social organization. We are dependent on others for our theories of

weather as well as for daily measurements of the same. Information is collected, conveyed and accumulated through social organizations—weather services, research institutes, universities, bureaucracies, corporations, news networks and political systems—each with their particular models of reality through which they observe and combine observations into knowledge. Culture in general and social organization in particular pattern and filter the perception, transmission and retention of information. Knowledge reflects the values; the ways of thinking; the technologies for perceiving, transmitting and retaining information; and the social organization of each culture. And each of these, in turn, affects the evolution of what there is to know.

Fifth, learning is mostly a process of trial, error and selection. Deductive reasoning, hypothesizing, experimenting and testing play an important role, but the only real experiments and tests are conducted in practice.

Sixth, organizations learn and acquire knowledge which adds to more than the sum of the knowledge of the individuals in the organizations. Organizations perceive through the research and knowledge of their individual members, but perceptions are then patterned and filtered by organizations as if they had their own way of thinking. Organizations make decisions. Organizations make mistakes that encourage them to change their ways. And when organizations succeed, they grow and their ways of knowing expand in importance.

In this emerging worldview, knowledge is intertwined with values, social organization, technology and resource systems. It is contextual, arising in the context of social organization, technologies and values of particular peoples, times and places. Knowledge, in this view, is a part of the 'patchwork quilt' of the cultures around the globe. Furthermore, each patch is complex. No one way of understanding it is sufficient and, even with multiple ways, we will periodically be surprised.

Much as we are experiencing a transition in our understanding of knowledge and of values, we are also experiencing a transition in our understanding of social organization. Modernization accelerated with the adoption of the idea that societies are best thought of as the sum of their individuals and that social values are the sum of individual values. People now, however, are beginning to recognize that people have little identity apart from the organizational or cultural systems which give them their values and reinforce their use. We are no longer very good at pretending that tastes are genetic, that everyone can deduce moral behaviour for themselves, that societies—particularly their economies—should be structured accordingly, and that government need only assume a remedial role to assure that individual opportunity is maintained and minimally acceptable behaviour is defined by the law. Acting on this understanding of social organization has resulted in growing numbers of mentally ill, psychologically disturbed, deliberate dropouts, involuntary job market misfits and just generally stressed, as well as a resurgence of private and public greed. The contradictory rise in the 1980s of elements of classical liberalism as well as fundamentalist Christian and Islamic beliefs is occurring in an otherwise visionary vacuum that the idea of sustainability might better structure.

Similarly, our understanding of resource systems is changing. The old idea that scientists can learn about species and processes in their undisturbed natural settings, or that such knowledge is special, is fading. Most ecosystems have been affected by human activity for millennia. Only a few terrestrial ecosystems show little sign of human perturbation. People have always been an

active agent in the evolution of ecosystems, albeit largely a destructive agent since the shift from renewable resource system management to hydrocarbons during the past century. Knowledge of environmental systems now requires an understanding of how humans have influenced them over time.

Lastly, few still think of technology as neutral with respect to values, organization, the environment or knowledge. The endless stream of choices with respect to technology made by entrepreneurs and corporate boards have affected our social organization at least as much as the cumulative passage of laws and establishment of agencies by our legislatures. Technology affects how we perceive the world around us, process observations and store information. It also affects what is important to know. Technology, by changing how we relate to each other and to nature, has made some values more important and stifled the nurturing and transfer of others. And, of course, the transformation of environments both locally and globally directly relates to technology.

These changes are no longer understood simply as new complications to a view of the world as an already complex machine. Quite the contrary, we are beginning to perceive these introductions as the stimuli of unpredictable evolutionary processes. We now also see value systems evolving over time in response to changes in social and natural systems and the technologies that transform them. And we are beginning to see that knowledge systems are contextual, that they evolve in the context of value, organizational and technological systems and that different cultures have different knowledge systems that are 'equally' functional in the contexts in which they evolved.

The intertwining of knowledge, values, social organization, technology and resource systems is more or less symmetrical; no system dominates another,

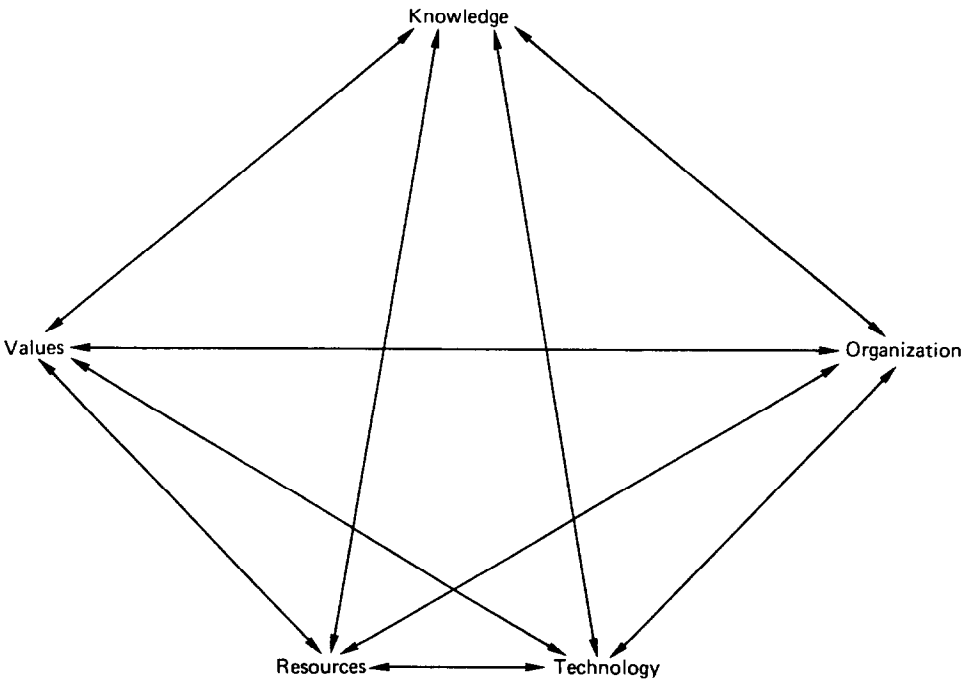

Figure 3. A co-evolutionary view of development

none provides a more obvious starting point for understanding the whole, and each can only be understood in the context of the others. The symmetry simplifies the 'spaghetti problem' of Figure 1 and eliminates the imaginary, trouble-causing barrier of Figure 2. Symmetry allows us to portray the whole system quite simply as an evolutionary process as in Figure 3.

This emerging worldview is dynamic. Not only is each subsystem related to all the others, but each is changing and affecting the evolution of the others. Deliberate innovations, chance discoveries and random changes occur in each subsystem that affect the distribution and qualities of components and relations in the subsystem. Whether these new components and relations are maintained depends on whether they prove fit with respect not only to the other components and relations within the subsystem but also to the other subsystems. With each subsystem putting selective pressure on each of the other subsystems, they co-evolve in a manner whereby each reflects the others. Thus the coupling illustrated in Figure 3 is maintained even while everything is changing, for the coupling selects the change.

This co-evolutionary interpretation of Figure 3 gives us insight into how development occurred before the use of hydrocarbons, the nature of unsustainable development, and the challenge of the return to sustainability. Until the use of hydrocarbons, development was a process of social system and ecosystem co-evolution that favoured human welfare. People initiated new interactions with their environment and social institutions—in the form of behavioural norms, myths and organization—developed to reinforce those interactions which were favourable and discourage those which were unfavourable. Through the co-evolutionary process of development social systems increasingly reflected characteristics of the human influenced ecosystems they inhabited, while ecosystems reflected characteristics of the social systems which affected how individuals interacted with the ecosystems. Obviously this co-evolutionary process did not result in sustainable development for all societies. Many suffered, some were overtaken by others, and the welfare of the survivors did not steadily increase. But at least those societies which historically met their demise did not take the global environment with them.

The era of hydrocarbons drove a wedge between the co-evolution of social and ecological systems. Capturing the energy of the sun through ecosystem management became less and less important as Western science facilitated the capture of fossil energy. Social systems evolved around the expanding means of exploiting hydrocarbons and only later adopted institutions to correct the damage this co-evolution entailed for ecosystems. Hydrocarbons freed societies from immediate environmental constraints but not from ultimate environmental constraints—the limits of the hydrocarbons themselves and of the capacity of the atmosphere and oceans to absorb CO_2. Our value system, knowledge system, social organization and technologies coevolved to fit the opportunities which the exploitation of fossil energy provided. Our social systems reflect these medium-term opportunities rather than the long-run opportunities of co-evolutionary development with the renewable resources of the global system. The policy challenge of sustainable development consists of finding a path towards a positive social and ecological co-evolution.

Sustainability does not imply that everything stays the same. It implies that the overall level of diversity and overall productivity of components and relations in systems are maintained or enhanced. It implies that existing traits are deliber-

ately maintained as options until after new ones have proven superior. Of course, it is not possible deliberately to monitor or manage every trait. The shift towards sustainable development entails adapting policies and strategies that sequentially reduce the likelihood that especially valuable traits will disappear prematurely. It also entails the fostering of diversity *per se*. This definition of sustainable development applies to belief systems, environmental systems, organizational systems and knowledge systems equally well. And necessarily so, for the sustainability of components and relations in each subsystem depend on the interactions between them.

From this broader perspective of sustainable development we see that development has been unsustainable, not simply because the use of hydrocarbons has been destroying the environment, but because there has been a cultural implosion. Value systems have been collapsing. Knowledge has been reduced to Western understanding. And social organization and technologies have become increasingly the same around the world. The cultural implosion and environmental transformation have been closely interconnected. The switch to hydrocarbons allowed cultures to stop co-evolving with their unique environments and adapt the values, knowledge, technologies and organization of the West. Sustainable development will entail a return to the co-evolutionary development process with the diversity that remains and the deliberate fostering of further diversity to permit adaptation to future surprises.

Summary

Without raising the issues of nuclear war and its subsequent winter or whether plants and animals should have rights, I have probably identified more issues and outlined a more drastic revamping of Western thought than even intrepid futurists can constructively contemplate. Furthermore, it is by no means clear that my perception of sustainable development, of Western cultural contradictions and of favourable signs of change will be seen and accepted by others, sufficient others, to effect the sustainable development I envision. With this last caveat, let me conclude with a summary of the argument.

Five levels of sophistication for thinking about sustainable development were identified in the introduction. Formulating a response to the questions associated with each of these levels is becoming a major challenge. The argument moved on to point out that these questions are on the agenda not only because of the environmental evidence that development has been unsustainable but also because we are losing our faith in progress. Our interactions with the environment and each other consistently produce immediate success and subsequent systemic problems, both social and environmental. I then rooted this phenomenon in Western epistemological beliefs. We have been led down the garden path of our own self-destruction by the idea that science consists of simple universal statements about parts and relations and the idea that we and our values can somehow remain outside the world we know. I then proposed a very general, malleable, co-evolutionary world view consistent with trends in current thinking. This view avoids the old problems but, of course, raises new ones.

First, though conflict will no longer be ameliorated by the myth of cornucopia, a positive sense of interdependence may develop between individuals, cultures and nations as a richer understanding of the changing interactions of people

and their environment is acquired. New alliances are likely to evolve, much as they are doing in the environmental movement today, not so much on specific issues, but on ways of approaching the future. In this context, we will spend more time comparing the pros and cons of alternative sortings of possible decisions over different decision arenas rather than designing optimum policies. The question of the appropriate political arena will become more intense with the need for both region-specific institutions to support region-specific ecosystems and technologies, and for institutions to control trans-regional and global environmental change.

Second, we will be working in a political and administrative environment that itself will be changing. Striking compromises between opposing interests is difficult enough under relatively stable institutional environments. We will have to devise means whereby the 'payoffs' of medium-term future compromises at the national level can be assured even though the compromisers may be able to foresee that the national government will be less powerful, or at least playing a significantly different role, in the future. We will have to devise means whereby the complex compromises needed for future success can be made at the local level even though local institutions are initially weak and there are uncertainties with respect to the directions in which they may evolve. We, in short, will have to learn how to construct compromises which not only incorporate institutional contingencies, but incorporate them at different levels of government over different time periods.

Third, the policy process will enter the realm of the hermeneutic where there is no prior agreement on the key questions, appropriate framework or essential facts. With an expansion of worldviews and a broader conception of knowledge, we will find little consensus on questions, methodologies and data for determining optima. Good policy makers will be those who can lead enlightening conversations between scientists with different disciplinary backgrounds and between people of different cultures and knowledges. These conversations may lead to a common understanding but will be effective whenever they simply reduce single-minded intransigence.

Fourth, better information will still smooth the process of reaching public decisions. Information generation will come through contextual/interpretive thinking. Information generation through the positive analyses currently emphasized in most public policy graduate schools will become nearly obsolete. This transition, observable now in the policy arena, will be hastened by the rise of local knowledge and values and the need to bridge the knowledge of diverse organizations, at all levels, involved in environmental and social coordination.

Even with the idea of sustainability as a metabelief that hides the contradictions left over from our earlier belief in progress, the transition will be difficult and hazardous. Belief in positivism, in universal values, in universal truths and in society as the sum of its parts offered individual freedom from the arbitrary power of church and state that evolved during the Middle Ages. At the same time, these beliefs facilitated the evolution of a social system that is neither socially nor environmentally sustainable. The epistemological basis for the hierarchies of technical experts and justifications for action of the modern social order are as arbitrary—as evidenced by the long-run destruction of cultural diversity and the global environment—and consequently just as tyrannical and destructive of freedom in the long run, as any church and state in history. Sustainability as I envision it will end this form of tyranny, but we must be wary

of the processes which allow power to become concentrated and used arbitrarily in the social order to come. Right, wrong, truth and justice will clearly be harder to define in the context of both cultural diversity across regions and global coordination. In short, the challenge will be to retain the best that Western culture promised while circumventing its systemic defects.

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This article is a synthesis, rather than a sequential discussion, of ideas explored by many before me. Though specific references at specific points proved impossible, I acknowledge that most of the material incorporated in this synthesis can be found in the following references:

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