Impeding Sustainability?

The Ecological Footprint of Higher Education

Higher education institutions must strive to reduce the impact of their own ecological footprints.

by William E. Rees

Framing the Problem

There is little question that the world is on an unsustainable development path. There is even a consensus among scientists in various fields that excess energy and material consumption is at the heart of the problem. Critical resource systems are being overtaxed and global waste sinks filled to overflowing.

According to some analysts, the sustainability conundrum marks a unique watershed in human development. Caldwell (1990, p. 191) argues that "the world is passing through a historical discontinuity" requiring a reorientation of previous goals and values and a radical reconfiguration of the way people relate to the Earth. Ecological economist Herman Daly (1991) characterizes this fundamental turning point as one in which biophysical constraints are forcing a paradigm shift from "empty-world" to "full-world" economic thinking.

It may actually have to be more-than-full-world thinking. Ecological footprint analysis suggests that the world is in a state of overshoot. Human demand already exceeds the long-term carrying capacity of the planet by 20 percent or more (Rees 1996, 2002; Wackernagel et al. 1999; World Wide Fund for Nature 2002). Other studies suggest that we may have to reduce our aggregate "load" on ecosystems by as much as 50 percent. This increases to over 80 percent in the high-income countries to create the "ecological space" needed for necessary growth in the developing world (Carley and Spapens 1998; Ekins and Jacobs 1994).

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No less an organization than the World Business Council for Sustainable Development has observed that "industrial world reductions in material throughput, energy use, and environmental degradation of over 90 percent will be required by 2040 to meet the needs of a growing world population fairly within the planet's ecological means" (World Business Council for Sustainable Development 1993, p. 10).

Technical adjustment or fundamental change? Even this strictly material-technical conceptualization of the problem poses an unprecedented challenge to industrial society. Far from thinking about ways to increase social equity while reducing resource consumption, virtually all official international agencies and national governments have recently come to share a comprehensive vision of sustainable development and poverty alleviation centered on unlimited economic expansion fueled by open competitive markets and more liberalized trade.

This neoliberal vision is both socially and environmentally fatally flawed. At its core resides *Homo oeconomicus*, the economists' stinted representation of humans as self-interested utility maximizers with fixed preferences and insatiable material demands. Expansionism, therefore, reflects the patently hollow belief that human welfare can be all but equated with ever-increasing income growth. (See Lane [2000] and Wilkinson [1996] for refutations of this belief.) Perhaps more critical in the present context, the growth paradigm is backed by simple, reversible, mechanistic, economic models that are simply incapable of representing the complex, discontinuously irreversible behaviors of real-world social, ecological, and even economic systems. Those who would govern an exquisitely complex world using overly simplistic models would seem to be in the thrall of a dangerous form of the "fallacy of misplaced concreteness" (see Daly and Cobb [1989] for numerous other examples).

Despite such criticisms, the expansionist myth abides no alternatives. "[Like] other social value programs, the doctrine of 'the global free market' itself does not recognize its ideology as ideology, but rather conceives of its prescriptions as *'post-ideological'* recognition of law-like truth…" (McMurtry 1998, p. 43; McMurtry's emphasis). Adherents to expansionism minimize attendant social and ecological problems, exaggerate the costs of prevention (witness the debate over climate change), and emphasize the potential of technology to overcome all obstacles. From this perspective, nothing short of certain catastrophe can stand in the way of continuous economic growth.

Indeed, expansionists perceive unsustainability as strictly a technical and economic problem. They expect advances in economic and material efficiency to produce the enormous gains in resource productivity required to accommodate both rising material expectations and a population increase of 3 billion in the next half century—all while reducing total material throughput. The world may be ecologically full, but achieving sustainability in these circumstances depends on little more than engineering a new "efficiency revolution" (Young and Sachs 1994) that will enable us to stay our present course.

Is human society unsustainable by nature? This article rejects the conventional scenario. For all our technological hubris, industrial society is on a collision course with biophysical reality. This prognosis may seem extreme but merely portends a modern variation of an ancient human trait. According to Joseph Tainter, the most intriguing aspect of the evolution of resource-rich human societies "is the regularity with which the pattern of increasing complexity is interrupted by collapse" (Tainter 1995, p. 399; see also Tainter 1988).

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With this pattern in mind, modern industrial society is following a well-worn historical path of steady growth and increasing sophistication that ultimately leads to ignominious collapse. Indeed, unsustainability seems to be an inevitable "emergent property" of a structurally incompatible relationship between techno-industrial society as presently conceived and the far-from-equilibrium thermodynamic behavior of the ecosphere (Rees 2000, 2002). In simple terms, human institutions are typically characterized by mechanically linear thinking and the assumption of smoothly reversible change. By contrast, the ecosphere and related biophysical processes are characterized by markedly nonlinear and frequently irreversible behavior. Indeed, when overstressed, natural systems behave in chaotically unpredictable ways. Little wonder that systemic lags, thresholds, and similar discontinuities are already confounding traditional resource management models and threaten to overwhelm us altogether in such domains as global climate change.

Mere tinkering at the edges of our growth-based development myth cannot address such structural problems. Achieving ecological sustainability with social justice will require a fundamental shift in prevailing cultural—and scientific—values, beliefs, and assumptions. If this argument has merit, then we in education have to confront an uncomfortable corollary: To the extent that contemporary higher education nurtures and propagates our prevailing growth-bound myth, universities and colleges are presently *at cause* of the sustainability crisis.

Ecological Footprints: Tracking Unsustainability

We can assess humanity's current sustainability status using ecological footprint analysis (EFA). EFA provides an easy-to-understand index of the demands imposed on nature by any specified population, industry, or institution for comparison to available supply or to other populations (Rees 1996; Wackernagel and Rees 1996). Eco-footprinting poses a single, simple question: How much productive land and water (i.e., ecosystem area) is required to support the study population at a specified material standard of living? As noted below, the answer leads to numerous other inferences about sustainability. The method is gaining wide acceptance in sustainability assessments by government agencies and nongovernmental organizations all over the world.

Basic EF calculations. EF analysis is modeled on trophic ecology (ecosystemic feeding relationships) in that it identifies and traces to source the flows of energy and material required to support a specified human population or organization. However, unlike the food webs of other consumer organisms, the human food web must include not only the energy and material needed for our biological metabolism but also the much larger flows required to maintain our industrial metabolism.

Eco-footprinting is further based on the fact that many of these material and energy flows can be converted into corresponding land and water areas. Thus, we formally define the ecological footprint of a specified population as the area of land and water ecosystems required, on a continuous basis, to produce the resources that the population consumes and to assimilate the wastes that the population produces, wherever on Earth the relevant land or water is located. A complete eco-footprint analysis would therefore incorporate the total ecosystem area—the croplands, grazing lands, forested lands, built-over areas, and productive (fish producing) ocean areas—that the population effectively appropriates to supply its needs through all forms of economic activity (including trade), plus the area it needs to provide its share of certain land- and water-based life-support services of nature, such as the carbon sink function.

The first step in calculating the ecological footprint of a study population is to compile annualized consumption data for each significant commodity or consumer good used by that population. We obtain such data from national production and trade statistics and other sources such as the United Nation's Food and Agricultural Organization statistical publications and the World Resources Institute's biannual publication, *World Resources*. For accuracy, consumption data should be trade corrected. Thus, the population's consumption (C_{pulses}) of pulses or leguminous crops can be represented as follows:

$$C_{pulses} = production_{pulses} + imports_{pulses} - exports_{pulses}$$

The second step is to convert consumption of each item 'i' into the land area (a_i) required to produce that item by dividing total consumption (C_i) in kilograms by world average productivity or yield (y_i, in kilogram per hectare) in that specific category. This gives us the population ecological footprint for each individual item:

$$a_i = C_i / y_i$$

Next, we determine the aggregate ecological footprint (F) of the population by summing the eco-footprints for the 'n' individual items:

$$F = \sum_{i=1}^{n} a_i$$

Finally, we obtain the *per capita* ecological footprint (f) by dividing the total population footprint by the population, 'N':

$$f = F/N$$

For certain wastes that can be processed or sequestered by ecosystems (e.g., carbon dioxide emissions), we estimate the land or aquatic ecosystem area required for sustainable assimilation and recycling. In these cases, the assimilation rate per hectare and year is substituted for "yield" above. Figure 1 shows a sample calculation—the eco-footprint of pulse (peas, beans, and other legumes) consumption in Canada.

We avoid double-counting whenever possible. For example, if in the analysis of a particular population's ecological footprint, one wishes to account for food-related nutrient assimilation but finds that the population composts and spreads its domestic wastes on domestic agricultural or commercial forestland, then only the agricultural and forest products footprints should be compiled in the total footprint

Figure 1 **Sample Calculation**
The Ecological Footprint of Pulse Consumption by Canadians in 1993

Total population (N): 28,817,000

Average yield of pulses (y): .852 tonnes x ha^{-1} (852 kg x ha^{-1})
Domestic production (p): 1,536,000 tonnes (t)
Imports (i): 28,284 t
Exports (e): 460,714 t
Domestic consumption (c = p + i - e): 1,103,570 t
Eco-footprint of pulse consumption by Canadians ($F = c \times y^{-1}$): 1,293,751 ha cropland
Per capita eco-footprint attributable to pulse consumption ($f = F \times N^{-1}$): .045 ha cropland

analysis. In general, we err on the side of caution in making eco-footprint estimates. Most published ecological footprint calculations are therefore likely to be under- rather than overestimates of the actual land requirements of study populations.[1] Most eco-footprint calculations are executed using standard spreadsheet software. Examples and various eco-footprinting tools and shortcuts can be downloaded from the Redefining Progress Web site (www.rprogress.org), courtesy of Mathis Wackernagel.

Methodological variations. As noted, to calculate basic population ecological footprints (e.g., for whole regions or countries), we use world-average productivities or yields in each consumption category. By assuming uniform yield, we facilitate gross comparison of the eco-footprints of different countries. However, for more detailed and balanced analyses, one can adjust basic eco-footprint calculations to reflect such things as differences in productivity among land categories (equivalence adjustment). For example, average cropland is twice as productive as average forestland and about nine times as productive as average grazing land. Thus, a given area of cropland translates into twice as many "area units" as the same area of forest, and nine times as many area units as the same area of pasture. Similarly, to estimate national "ecological deficits" (the difference between a country's ecological footprint and its domestic productive land base [Rees 1996]), we must take domestic yields into account (yield adjustment). For example, if a particular country's cropland is twice as productive as world-average cropland, then a hectare of domestic cropland is the equivalent of two hectares of world-average cropland. This country's cropland deficit would be its crop-related eco-footprint (based on world-average yields) minus twice its area of domestic cropland. (Ecological deficits can also be calculated using equivalence-adjusted data.) For more details on such adjustments, see Rees 2001; Wackernagel et al. 1999; World Wide Fund for Nature 2002.

The inherent strengths of EFA. Eco-footprinting has several unique strengths as a consciousness-raising device. The method incorporates several defining qualities of ecological economics and resonates with the ideas of various other scientists and analysts concerned with human-carrying capacity. However, its major advantage is probably conceptual simplicity and intuitive appeal. Better than other methods, eco-footprinting successfully communicates critical dimensions of human ecology to ordinary people. It recognizes that humans are biological beings and that the economy is a fully contained, growing, dependent subsystem of the nongrowing ecosphere. Eco-footprinting also personalizes the human ecological crisis by making the connection to (over)consumption—we are all consumers—and consolidating the data on the associated energy and material flows into a single familiar concrete variable, land/water area. Everyone can relate to land, and EF analysis underscores graphically that, modern technology notwithstanding, industrial society remains intimately bound to the land.

Eco-footprinting a city or university campus. Because of its considerable heuristic power, many cities, towns, and regions in countries around the world are using EF analysis in planning exercises designed to involve ordinary citizens in the development of local sustainability initiatives. Similarly, numerous student groups associated with planning, landscape architecture, or engineering studio/laboratory courses have estimated the ecological footprints of their university campuses—including groups at Rensselaer Polytechnic Institute and The University of New

Hampshire—both as a teaching/learning exercise and to assist in identifying potential energy and material savings for their institutions. Eco-footprinting can also be used for smaller scale analyses, such as comparing the biophysical impacts of different buildings or construction materials.

Although we can take shortcuts in estimating the eco-footprint of a city (such as simply multiplying the local population by the national per capita eco-footprint value), it may sometimes be necessary to achieve greater accuracy and develop a local database. In these circumstances, certain methodological complications arise. For example, when we compile information for countrywide assessments, certain demand data associated with consumption item 'x' are largely already included in the data compiled for consumption item 'y'. Thus, in calculating a national eco-footprint, we need include only the forest (tree-growing) land for the eco-footprint component associated with lumber. The fossil fuel required to harvest, transport, and mill the timber and lumber is already accounted for in the estimate of the national fossil fuel eco-footprint. The footprint of sawmills and urban infrastructure are incorporated in estimates of built-over land.

Things are not this simple in estimating the eco-footprint of a city or college campus. Here, if we include only the ecosystem area used directly by a producer of some consumed good, our analysis would be only one production layer deep unless we take additional steps to include land/water areas appropriated by suppliers to that producer. For example, once we have compiled the data on annual wood-fiber demand (wood products and paper) by a university (as needed to estimate the productive forest land component of its eco-footprint), we must separately estimate the quantity of fossil fuel and other inputs used by upstream suppliers in the harvesting, processing, manufacturing, and transportation of the wood products. These forms of indirect energy/material consumption contribute significantly to the university's total eco-footprint.

Various researchers have overcome the problem by wedding eco-footprint analysis to classic input-output analysis, an economic tool that enables users to trace the forward and backward flows of energy and materials through the economy. If properly designed and accurately compiled, input-output tables integrated with EF analysis can ensure comprehensive coverage of indirect but tightly linked land demands by as many upstream production layers as necessary to achieve the desired degree of accuracy.

The results of regional- or city-level studies often come as a shock to the participants. Consider the following examples:

- Based on an estimated per capita ecological footprint of 7.6 hectares (ha), Onisto, Krause, and Wackernagel (1998) showed that the 2,385,000 residents of the City of Toronto proper have an aggregate eco-footprint of 18,126,000 ha, an area 288 times larger than the city's political area (63,000 ha).
- Research commissioned for the International Institute for Environment and Development in London estimated that city's ecological footprint for food, forest products, and carbon assimilation alone to be 120 times larger than the city's geographic area or about nine-tenths the area of the entire country. In the absence of trade and natural material cycles, and assuming the interconvertability of farm- and forestland, this study showed that the entire ecologically productive land base of the United Kingdom would be required to sustain the population of London alone (International Institute for Environment and Development 1995).
- In a more comprehensive study, researchers led by Carl Folke of Stockholm University estimated that the 29 largest cities of Baltic Europe appropriate for their resource consumption and major categories of waste assimilation, an area of forest, agricultural, marine, and wetland ecosystems 565–1,130 times larger than the area of the cities themselves (Folke et al. 1997).

People used to thinking that humanity is leaving the land behind are sobered to learn the degree to which their cities remain dependent on distant ecosystem-based life-support services that they appropriate from the global hinterland.[2]

Although I am not aware of comparable published data on a university or college, there is little doubt that the eco-footprint of a typical campus will be one to two orders of magnitude larger than its physical footprint. Certainly most students and faculty will be impressed by the magnitude of the ecological load that constructing and operating a typical college or university imposes on the earth. Buildings and associated infrastructure (including the physical plant of college campuses) are notoriously energy and material intensive, accounting for 40 percent of the materials and about one-third of the energy consumed by the world economy. Much of this load can be traced to the gross inefficiency induced by historically low energy and material costs. The good news here is that urban- and campus-based eco-footprint studies can therefore identify numerous opportunities for substantial savings of energy, material, and financial resources.

The eco-footprints of nations: A measure of global discontent. Of course, the heuristic value of eco-footprint analysis goes beyond assessing local impacts. Figure 2 shows the equivalence-adjusted per capita ecological footprints for a selection of countries around the world. Note that the eco-footprints of citizens of wealthy industrialized countries such as the United States and Canada range from about 5 to almost 10 hectares compared with scarcely a half hectare for the people of the most materially impoverished countries. Indeed, the average citizens of high-income countries require up to 20 times as much productive land and water to support their consumer lifestyles as do their counterparts in the world's poorest countries. Note, too, that the world-average ecological footprint is about 2.3 hectares while there are only 1.9 hectares of productive land and water ecosystem per capita on Earth (data from World Wide Fund for Nature 2002).

Several conclusions flow directly, or can be inferred, from these data:

- Wealthy consumers appropriate more than two to five times their equitable share of the world's ecological output. This spread reflects the gross and growing socioeconomic inequity between rich and poor, between Northern high-income countries and Southern developing countries.
- The world as a whole is already in "overshoot" by as much as 21 percent. Humans are consuming more than nature is producing and generating more waste than nature can assimilate.
- Global society is therefore living (and growing), in part, by liquidating "natural capital" and overexploiting critical life-support functions of nature. This is a sufficient explanation for many signs of human ecological dysfunction, from fisheries collapses to ozone depletion and climate change.
- The material standards of high-income countries cannot be safely extended to even the entire present human population of 6 billion using prevailing or likely technologies—this would require two or three additional Earth-like planets. Moreover, an additional 2 to 3 billion people are likely to join us at the table by the middle of this century.
- If the above conclusions are even generally correct, the expansionist vision to which most of the official world subscribes is an ecologically malignant and socially disastrous myth.

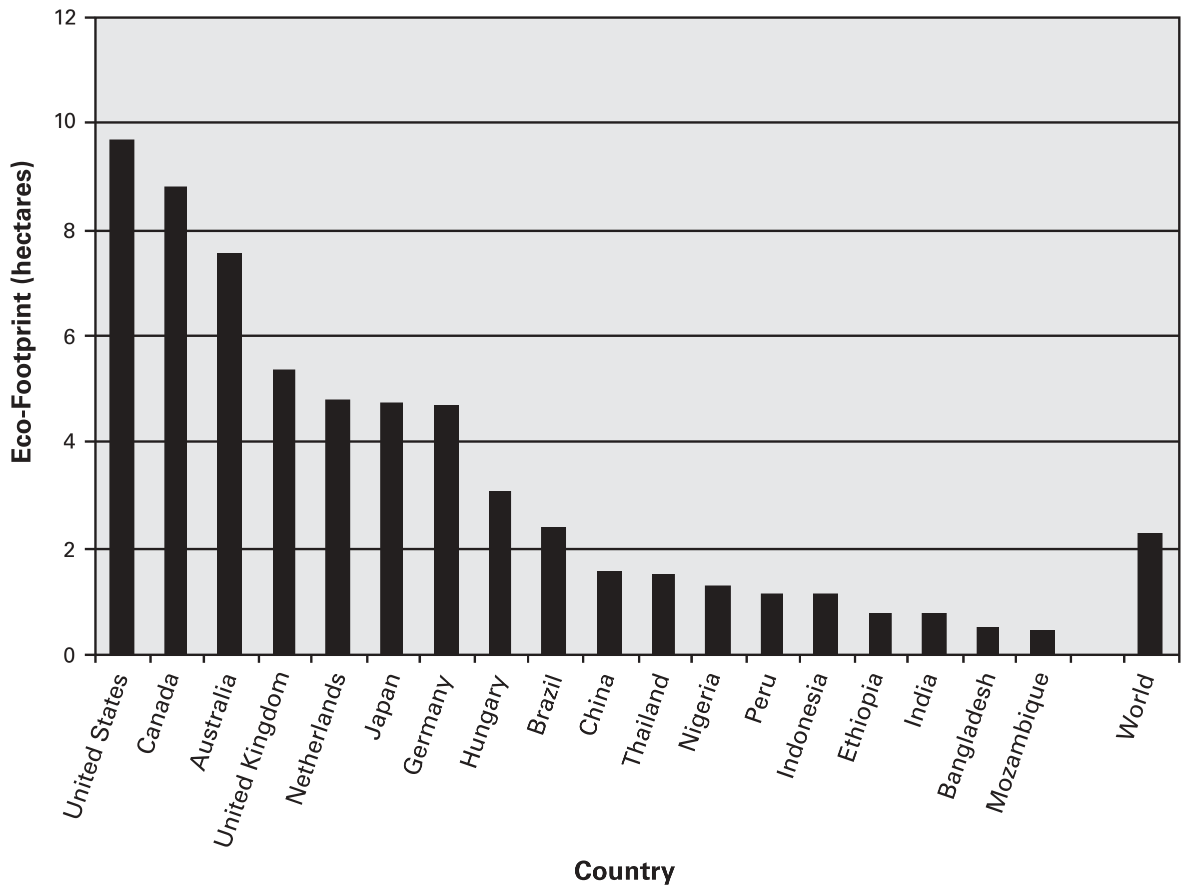
The Eco-Footprint of Higher Education

> [The depletion and pollution of the planet] is not the work of ignorant people. Rather it is largely the result of work by people with BAs, BSs, LLBs, MBAs and PhDs. (Orr 1994, p. 7)

Another observation not directly evident from figure 2 is that those countries whose citizens impose the greatest per capita ecological load on the planet are the countries that have the highest levels of public and private education. Contrast this with the commonplace assertion that ignorance and poverty are the main causes of much of the world's ecological degradation (a position supported even by the Brundtland Commission [World Commission on Environment and Development 1987]). Whether conscious or unconscious, the latter argument is sheer denial or at least avoidance of reality. The demonstrable fact is that the greatest so-called environmental problems confronting the world are the result of production and consumption processes traceable mainly to the highly urbanized, well-educated, high-income populations of developed, mainly Northern countries. In the words of Gary Snyder (1990, p. 119), it is people who "make unimaginably large sums of money, people impeccably groomed, excellently educated at the best universities—male and female alike—[who orchestrate] the investment and legislation that ruin the world." And, we might add, who enjoy and propagate a lifestyle that is literally dissipating the ecosphere.

To acknowledge our universities and colleges as an important source of unsustainable attitudes and behavior is not to assign blame. Rather, it is to open the possibility of addressing the problem. Like most other social institutions in today's scientific-materialist society, universities are peopled by individuals who, more or less unconsciously, acquire and reflect the prevailing values of the society in which they mature. Our purpose here, therefore, is to raise to consciousness the role that higher education plays in helping to make industrial civilization the most ecologically and socially destructive society known.

Figure 2 **Per Capita Ecological Footprints of Selected Countries**



Source: Worldwide Fund for Nature 2002

The first step must be to free ourselves from the perceptual blinders of the dominant cultural myth and muster the courage to look our ecological and social reality straight in the eye. This will be difficult for ordinary citizens and even for many denizens of academe who have not previously found reason to question the only mind-set they have ever known. However, if in a time of crisis "we are unable to identify reality and therefore unable to act upon what we see, then we are not simply childish but have reduced ourselves to figures of fun—ridiculous figures of our unconscious" (Saul 1995, p. 21–22).

Unfortunately, the only way an unconscious society caught up in a particular paradigm can respond to a crisis is by inward self-reference to its foundational values. Hence, to date, the industrial world has defined sustainability in terms of yet more economic growth, albeit involving greater economic and material efficiency and fewer regulatory impediments (e.g., World Commission on Environment and Development 1987). Regrettably, greasing the skids of industrial society does not address the fundamental problem. It merely makes us more efficiently unsustainable. The historical evidence shows that in the absence of effective policy countervails, efficiency actually leads to *increased* gross material throughput. (EF analysis supports this observation. The most technologically efficient countries on Earth are among those with the largest per capita eco-footprints.) More efficient consumption of the world's real wealth "can never be a recipe for long term success" (Raven 2002, p. 957).

Toward Resolution: The Roles of Higher Education in Creating a Life-Sustaining Culture

> The measure of a civilization's growth and sustainable vitality lies in its ability to transfer increasing amounts of energy and attention from the material side of life to the educational, psychological, cultural, aesthetic, and spiritual side. (Toynbee's Law of Progressive Simplification, quoted in Elgin 1993)

David Orr (1994, p. 8) suggests that the problem with higher education in the developed world is that it "emphasizes theories, not values; abstraction rather than consciousness; neat answers rather than questions; and technical efficiency over conscience." All true enough, but this does not mean that higher education—even science education—is value free. Nor can it be. The relevant question is what values *should* higher education reflect to facilitate the transition to a sustainable world?

Direct and indirect impacts of higher education. The modern curriculum, particularly in the sciences and social sciences (including economics, political science, and commerce), reflects a set of core values and beliefs that are frequently taken for granted (i.e., they go unstated) but that serve to set humanity against nature and ultimately against itself. Consider the following suspect values and orientations: scientism, anthropocentrism, humans-as-masters-of-nature (or, the feminists' extension, the dominance of older, white males over women, children, other races, and nature), atomism, reductionism, mechanism, materialism, and utilitarianism. These are the values that underpin the expansionist paradigm with its emphasis on maximizing growth through selfish individualism, competitive relationships, market mechanics, capital accumulation, efficiency, and globalization. They are the founding values and remain the dominant values of global capitalism and techno-industrial culture generally.

In this light, there can be little doubt that higher education contributes to the so-called developed world's enormous ecological footprint. The physical operations of our major teaching and research institutions, of course, make a direct contribution. However, far more important is the indirect manifestation of higher education as reflected in the values and beliefs that our colleges and universities help to propagate in the world. Currently, many universities seem to define their role not in terms of creating better, more intellectually aware global citizens, but rather as producing a "product" that will help their respective nations to hone their competitive edges and maintain dynamic growth in an increasingly global market economy. In short, to the extent that the values responsible for society's unsustainable practices and behavior are reinforced in our institutions of higher learning, higher education today actually impedes the quest for sustainability.

This is not to say that we teach unsustainability. There is no need to—it emerges inexorably from programs in virtually every scientific and practical discipline that reflect the qualities of a culture that has objectified reality and all but abstracted itself from the living world. Education today largely responds to the demands of our competitive techno-industrial society for employees that are stripped of feeling, emotionally crippled, morally adrift, all but incapable of compassion for either other peoples or other species and thoroughly alienated from the fact of their own engagement in the natural world.

Similarly, we cannot teach sustainability. We should not have to—it should emerge spontaneously, the inevitable product of a curriculum reflecting joy and wonder at humanity's privileged role as the emerging consciousness of the living world. For global sustainability on a finite planet, education should be oriented toward the life-sustaining values needed to create a society founded on mutual respect, spiritual fulfillment, a cultivated compassion for all others, and a sense of participating consciousness with nature. Instead of hard, cold, alienating enlightenment rationality, we need an enlightened rationality that both celebrates the full potential of human beings and acknowledges our full organic engagement in the natural world.

Higher education today actually impedes the quest for sustainability.

Changing beliefs and values. The bottom line is that to achieve a socially just, ecologically sustainable society will require a virtual revolution in the values and beliefs, assumptions, and behaviors that govern our relationships with each other and with nature. Fortunately, the requisite replacement values are already part of the human behavioral repertoire. Humans may be competitive and individualistic but we are equally cooperative and social; people can be selfish and acquisitive but at other times are altruistic and sharing; some individuals seem cold and heartless—even violent—in their relationships, while others are warm and compassionate in everything they do.

All of these capacities are under varying degrees of genetic and social control. The problem is that our prevailing cultural myth emphasizes the darker end of the spectrum of behavioral possibilities, playing to the calculating, self-interested utility maximizer in each of us (to the extent of sanctioning greed as a virtue with sadly predictable results). Higher education is part of the problem. Science and engineering assume a pointless mechanical world. While business ethics courses have become common, the emphasis in commerce faculties is on the duty to maximize shareholder value, with scant attention paid to the wider public interest. Economics departments often prefer the elegance of mathematical abstraction to the messy reality of human society, increasingly distancing the discipline from practical issues of economic sustainability (Galbraith 2000). The bulk of research funding goes to disciplines that create marketable intellectual property of any kind. Meanwhile, the humanities wither in relative terms. Abetted by the education system at all levels, our materialistic culture traumatizes healthy individuals, cutting them off from much of their own emotional and spiritual potential. Many people live in a state of dissociation or disconnect from other humans and the natural world. No one should be surprised that the result is the widespread erosion of community, the moral corruption of commerce, and the wholesale degradation of ecosystems, now on a global scale.

Assuming intellectual leadership. In many respects, universities and colleges have been swept along all too passively by the winds of corporate globalization, in no small part because of increasing reliance on the private sector for funding and related support. Ironically, knowledge in the "knowledge-based society" is no longer a public good. But as the world community tallies up the damage wrought by the neoliberal expansionist storm, the time is ripening for universities to seize the initiative for real change. The opportunity and challenge for higher education is once again to assume the intellectual leadership of a floundering culture whose flagship myth has lost its moral and ethical keel and is wrecking the earth.

To call to question the destructive values of techno-industrial society is not to debunk science per se. Science and technology are essential to a sustainable future, but postmodern science will require a more elegantly life-compatible science than anything practiced in the mainstream today. To illustrate, ecologically sustainable agriculture requires a vastly more sophisticated understanding of complex systems theory and ecosystems behavior than does the prevailing corporate, high-input, "brute force" production agriculture. Similarly, sustainable energy technologies will feed on the energy flows that naturally course through the ecosphere (e.g., the solar flux, wind and tides) without augmenting or disrupting nature's material cycles as does fossil fuel. Has there ever been a greater challenge to academic science and technology than having to learn to work with nature?

Remaking academic disciplines. Indeed, every discipline from the most material of the hard sciences to the softest of the humanities must now contemplate remaking itself and reintegrating with other disciplines in conformity to "full-world" reality. Taken to its logical conclusion, sustainability means nothing less than a revolution in the research programs and curricula of universities and colleges. It is therefore heartening that the revolution seems to have begun. Student, faculty, and administrative organizations in universities across the developing world are increasingly engaged in special campus projects, developing long-range research agendas, and holding special symposia on sustainability-related curriculum development in response to this challenge. For example, The University of British Columbia has a special Sustainability Office that has saved the administration millions of dollars through energy and material conservation associated with plant operations and thus significantly reduced the campus's ecological footprint; a dedicated Sustainable Development Research Centre; a graduate School of Community and Regional Planning whose mission statement is "to advance the transition to sustainability through excellence in integrated policy and planning research, professional education and community service" (www.scarp.ubc.ca); numerous individual courses on sustainability; at least one graduate student–inspired education project in sustainability-related curriculum development; and a College of Sustainability on the drawing board.

Further Thoughts and Conclusions

Birthing a sustainable society is a daunting task, both because of the problems inherent in thinking "outside the box" and because of the inevitable resistance from those with vested interests—psychological and financial—in our prevailing mythology. On the positive side, humans are well practiced in fashioning and upgrading their cultural myths (Grant 1998). The expansionist paradigm, like all that preceded it, is itself a social construct cobbled together in bits and pieces—sometimes consciously, sometimes not—over the last three centuries. Only in the last 25 years has growth mania seemingly been fixed in place by constant exercise and strident repetition. This myth can be (and is being) deconstructed and a replacement is taking shape. In fact, universities have some catching up to do if they hope to regain the trust and confidence of the many organizations and ordinary citizens that have begun to articulate a new life-sustaining cultural myth.

Creating a socially just and ecologically sustainable global culture—living more equitably within the means of nature—will require new international institutions that can exercise a transnational veto over certain behavioral predispositions that may have been adaptive in a relatively empty world but that are potentially fatal today. (The newly established International Criminal Court is a case in point.) It also means that the world community must acknowledge the full range of human behavioral possibilities and emphasize those qualities most appropriate for mutual survival in an ecologically full world. Competitive individualism must be balanced by cooperative mutualism when it comes to protecting the global commons; growth and efficiency must give way to equity and sufficiency to establish a climate for global security. (Reducing our ecological footprints in the North to create the ecological space needed for growth in the South is a clear prerequisite to geopolitical stability.)

Sustainability poses an unprecedented challenge to human technical and social ingenuity.

Clearly, sustainability poses an unprecedented challenge to human technical and social ingenuity and the outcome is by no means certain. Success in the conscious engineering of global sustainability would mark a watershed in human evolution, the ascent of self-aware intelligence over scripted determinism. In thus confronting our own history and behavioral ecology, Homo sapiens will either "rise above mere animal instinct and become fully human, or wink out ignominiously, a guttering candle in a violent storm of our own making" (Rees 2002, p. 266). In short, we have no real option but to succeed. To fail would mean the sorry cycle of societal collapse will close once again, this time on a global scale.

Notes

1. The ecological footprint is not, in any event, intended to capture the corresponding population's entire ecological impact. For example, chlorofluorocarbons and the stratospheric ozone depletion they cause cannot be represented by eco-footprint analysis. The same is true of any other waste whose effects are not readily convertible into a corresponding land area.

2. These findings raise interesting questions for traditional land-use planning. For example, just what do we mean by "urban land" if over 99.5 percent of the land ecologically occupied by city residents lies outside the municipal boundary?

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