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A New Systems Approach to Sustainability: University Responsibility for Teaching Sustainability in Contexts

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Abstract

A systems theory approach to sustainability in five contexts—social/cultural, economic, environmental, technical, and individual—is a realistic and useful approach to researching and teaching sustainability in the university. As a springboard for social change, the university needs to develop values-based sustainability content for classes across disciplines, and especially address the careful assessment and evaluation of both human and technical factors for solving sustainability problems.

Keywords: Sustainability, Social Sustainability, University Sustainability

We have come to understand that the greatest and most immediate *sustainability problems* humans face are related to our relationship with the natural world and the diverse populations occupying the planet. Declining environmental, economic, and social conditions world-wide require a response from the academic community. Higher education needs to address problems related to our ability to continue to occupy the planet in such a manner as to not deplete our natural resources; harm our air, water, and soil; and undermine the social, cultural, and economic sustainability of our local and global communities. These facts place a great deal of responsibility on higher education to move beyond its current sphere of academic influence and assume responsibility for becoming a spring board for individual, community, and social change.

Because defining sustainability beyond environmental terms is a difficult task – depending primarily upon one's perspective, beliefs, and economic investment—we offer the following description of a sustainable society:

> *A sustainable society possesses the ability to survive and prosper, not just with respect to environmental resources, but also with respect to quality of life as it pertains to social, economic, technical, and individual contexts, and especially the values and conditions that promote continued human prosperity and growth (e.g., opportunity, economy, privacy, community, the arts, education, and health). A sustainable society meets these needs simultaneously, and in the context of human respect and the ability to negotiate differences without violence.*

Determining the sustainability of a system (whether the system is a product, process, or human activity) depends upon the careful and complete assessment and evaluation of a range of technical and human factors, and their influences on each other, noted in The Engineer of 2020 as "the core analysis activities of engineering design" (2005). This approach is central to instructional efforts in sustainability, but it is a methodology about which too little has been written or practiced. Because sustainability factors comprise a complex system, a change in one factor is likely to result in an unpredictable change in the others (Capra 1982; Folke et al. 2002).

Sustainability, employed as a systems approach, is an issue of individual, as well as collective, human consciousness and values. Often, we are led to believe that our activities related to sustainability are a response to circumstances over which we have little control, that the forces of nature or industry naturally and necessarily precipitate environmental or social degradation. This is not necessarily so, since human intention and action can either create, or tend to ameliorate, sustainability crises. More specifically, the desire for power, material wealth, and social status**,** whether it be economic, political, or religious, is often the underlying issue creating sustainability problems. Particularly destructive is the belief that *the possession of material wealth or political power confers the right to consume more than one's share of the planet's natural resources, or to control the fate of others*—a mainstay of capitalism. These desires are motivated by individual and collective values, most specifically related to our historic and current lack of understanding of the terms under which we can continue to occupy the planet. Thus, undertaking any effort related to sustainability without considering the centrality of individual values misses the point and will likely be of limited effectiveness. Our survival as

a species is the principle issue, one that often seems to be underrepresented in academia, the media, and in our everyday conversations.

During the 1980's, and even before, with books like Rachel Carson's *Silent Spring,* Paul Ehrlich's *Population Bomb,* and countless works by Wendell Berry and John Muir, social and environmental activists came to understand that we were consuming limited resources too fast, that global poverty was growing at an increasing rate, and that population growth appeared uncontrollable. The publication of Meadow's landmark book, *Limits to Growth*, ultimately did little to evoke much action, especially from those in government and corporate sectors bent on economic growth (Meadows, Meadows, Randers, & Behrens 1972). The idea that we might be able to sustain life on Earth as we know it soon became a unrealistic vision, even though in the 21st Century many still believe it possible. The reality that we could not refrain from using limited material resources at a increasingly growing rate became a central issue. Running counter to what many of us have come to understand as sustainability in positive and hopeful terms, Bartlett (1997) offers an approach that appears bleak but true.

> The introduction of the word "sustainable" provided comfort and reassurance to those who may momentarily have wondered if possibly there were limits. So the word was soon applied in many areas, and with less precise meaning, so that for example, with little visible change, "development" became "sustainable development," etc. One would see political leaders using the term "sustainable" to describe their goals as they worked hard to create more jobs, to increase population, and to increase rates of consumption of energy and resources. In the manner of Alice in Wonderland, and without regard for accuracy or consistency, "sustainability" seems to have been redefined flexibly to suit a variety of wishes and conveniences. (p.2)

Bartlett's (1997) work counters commonly accepted definitions for sustainability, which many consider to mean "for an unspecified long period of time" (p.2). Considering Bartlett's (1978) prescient prediction that steady population growth, at a fixed percent per year, yields huge population growth in short periods of time (consider: a population of 10,000 people growing at 7% per year will become a population of 10,000,000 people in just 100 years), leads us to believe that "sustainable growth" implies "increasing endlessly" (p.8). Our limited material resources simply cannot support unlimited growth; it is a matter of mathematics. While reusing and recycling can help with our material shortages, many materials cannot be reused, and most are "down cycled" and cannot be used indefinitely. The simple fact that the Earth does not have unlimited natural resources, that world populations are growing unabated, and that our environment (air, water, soil) cannot withstand progressive deterioration leads to the conclusion that when applied to material things, the term "sustainable growth" is an oxymoron (Bartlett 1997). These realities create a complex problem of a magnitude the planet's populations have never faced, and our efforts so far have been inadequate.

It is important to note that, most often, sustainability is considered synonymous with *environmentalism* (or environmental sustainability). This limited scope neglects that sustainability must be considered a system of interdependent factors, and that a change in one factor is likely to result in an unpredictable change in other factors. The recent British Petroleum

oil spill provides an excellent example of how five sustainability contexts may be explored. Certainly, the spill created an *environmental* disaster. *Economically*, the shrimping and fishing industry has been forever changed and may no longer be a strong economic engine for Gulf Coast communities. *Socially and culturally*, human communities have been affected, for example, a) as families move out of state and b) as the shrimping lifestyle, a cultural mainstay for generations, has been decimated. *Technically*, the failure of oil drilling technology and repair methods was the cause of the disaster. *Individually*, the increasing rates of depression and family problems due to the spill are well-documented. Studying sustainability simply in environmental terms will no longer suit the complexity of our world, nor will it solve the many problems created by our environmental neglect. Solving the complex problems resulting from this disaster will require the perspectives and skills of individuals across disciplines, and as importantly, encourage an examination of the questionable individual and corporate values that were likely the fundamental cause of the spill.

This is the first task higher education must undertake—to educate students in the appropriate definition of sustainability and in the use of a systems theory approach to thinking about sustainability problems. This is especially true for engineering, as it is the central discipline addressing issues in sustainability. This is an appropriate role due to the very nature of engineering design, manufacturing processes, and products.

Unfortunately, few universities teach much more than environmental sustainability. Environmental sustainability is an excellent starting place for studying sustainability, but it presents the topic from a perspective that is of limited use to understanding the nature, causes, and effects of a *complex system* that include understanding the *reciprocal influences* of a variety of sustainability contexts.

This paper offers a systems approach to defining and teaching sustainability in interdependent contexts—social/cultural, economic, environmental, technical, and individual—in a discipline-appropriate manner across the university curriculum.

Literature Review

History of a Contextual Approach to Sustainability

Traditionally, sustainability has its roots in two engineering sub-disciplines: green engineering and environmental engineering. In general, green engineering has focused on design that is in greater long-term harmony with the environment while environmental engineering has addressed the deleterious effects engineering design (or, sadly, lack of design) has had on the environment (Pappas & Kander 2008). An early definition of sustainability was presented in *The Brundtland Report of the United Nations World Commission on Environment and Development* which first expressed concern over sustainability at its 96th plenary meeting (December 11, 1987). The Commission defined sustainability as "development… meeting the needs of the present without compromising the ability of future generations to meet their own needs" and further noted a concern "about the accelerating deterioration of the human environment and natural resources, and the consequences of that deterioration for economic and social development…" (United Nations General Assembly Report of the World Commission on Environment and Development 1987, p.3). What is, perhaps, most notable about the Report is a

definition of sustainability that includes more than environmental sustainability as well as the opinion that the environment, the economy, and society compose a *complex system*, and that a change in one factor in sustainability will likely cause unpredictable changes in the others.

Other definitions of sustainability often mirror the Commission's Report. McDonough and Braungart (2002) view sustainability from the point of view of balancing environmental, social, and cultural concerns through a "triple bottom line" based on balancing the "tripod" of ecology, economy, and equity. Charles L. Redman, director of Arizona State University's School of Sustainability defines sustainability as "…an awareness of the connectivity of the world and the implications of our actions" (2008, p.1). The University of California Los Angeles Anderson School of Management offers a multidisciplinary approach to sustainability from an economic point of view: "Sustainability (loosely defined as the simultaneous consideration of economic, environmental, and social factors) has become a key element in decision making in many areas of business and public policy, and by definition, sustainability requires a multi-disciplinary perspective" (2007, p.13). Roseland focuses on a variety of issues related to sustainable community development, such as integrating environmental, economic, and social objectives, and concepts of "natural capital and social capital, whether (and if so, how) they are linked, and explores their implications for sustainable development at the community level" (2000, p.82).

Bras-Klapwijk (2003) suggests that the environmental and social factors related to sustainability have significant influences on each other. Interactions among contexts in environmental and social sustainability can be evaluated, according to Chapin (2001), through a series of feedback systems. Expanding the notion of "reciprocal influences" among sustainability contexts, Thom takes a "holistic approach with a clear vision of systems functioning" (1998, p.95).

Several remarkable efforts have emerged from sustainability studies. The volunteer community sustainability project initiated in the early 1990's, *Sustainable Seattle*, remains today the standard for understanding and practicing sustainability that integrates a wide variety of community "indicators of sustainability" (1994, p.69). Another project, *Taiwan Sustainability*, employs a similar strategy in Mingshan Community in Taipei, Taiwan (2005). The Vancouver City Council (2002) approved the following definition of social sustainability and endorsed the approach as a guiding principle for future development:

> A sustainable Vancouver is a community that meets the needs of the present without compromising the ability of future generations to meet their own needs. It is a place where people live, work, and prosper in a vibrant community of communities. In such a community, sustainability is achieved through community participation and the reconciliation of short and long term economic, social and ecological well-being. (p.5)

Other disciplines address sustainability in multiple contexts, most specifically, the social sciences. In the psychological sciences, especially social psychology, the most obvious example is the positive psychology movement which has its roots in the works of Abraham Maslow (1968) and Carl Rogers (1980), among others. Currently, works by such authors as Martin

Seligman (Seligman & Csikszentmihalyi 2001) and Mihaly Csikszentmihalyi (1993) are the most prominent examples of works related to individual sustainability. These authors suggest that individual emotional, intellectual, and social awareness and change are the core skills necessary for promoting well-being and consciousness, and the resulting positive societal change.

Sociologists have long studied communities of people and the strategies they use to maintain and improve community life. Roseland and Connelly's (1992) pioneering book, *Toward Sustainable Communities: Resources for Citizens and Their Governments*, addresses all contexts in sustainability and beyond, discussing community motivation to change, and public participation in the process of sustainable development**.** Even Plato (2003) and Socrates (2009) envisioned the ideal community to include intentional citizen participation, moral action, and quality of relationships among citizens as a means for improving and sustaining community culture. Certainly Aristotle and Homer would agree.

Recently, Thorsen offered a vision of individual sustainability that includes five basic skills related to fostering individual responsibility: "communication skills, decision making skills, problem solving skills, creativity, and change management" (2004, p.6). She suggests that teaching students to become responsible citizens through individual awareness and action is the first step in propagating community and global sustainability.

Teaching Sustainability in Contexts

Teaching environmental sustainability has become common in higher education, especially in the engineering disciplines. The approach outlined in the paper, however, is likely new for engineering faculty, many of whom have a more traditional educational or industrial background. An education to prepare students to deal with the complex problems of sustainability must be interdisciplinary and focus on all contexts of sustainability (Moore 2005; Pappas & Pierrakos 2010; Pappas & Kander 2008; Kagawa 2007; McKeown 2002). The Barcelona Declaration summarizes such an individual as "… one who has a long-term, systemic approach to decision-making, one who is guided by ethics, justice, equality and solidarity, and has a holistic understanding that goes beyond his or her own field of specialization" (2004, p.1).

Unfortunately, as discovered in a survey of students at the University of Plymouth, this holistic approach is often not how students perceive sustainability; survey responses indicated that students "associate the concepts uni-dimensionally with the environment rather than embracing a holistic (multi-dimensional) interpretation" (Kagawa 2007, p.328). To achieve more holistic goals, Huntzinger, Hutchins, Gierke, and Sutherland (2007) argue that this educational approach must change, and that sustainability and problem-based learning must be integrated into the curriculum, not just be "bolt-on" additions. Similarly, Shriberg (2002) notes that "sustainability education needs to be incorporated into core curricula and courses in many disciplines" (p.267). While some programs have struggled to achieve this goal, programs such as Smith College's Picker Engineering Program (2010), Arizona State University's School of Sustainability (2010), and James Madison University's School of Engineering (Pappas & Kander 2008) have been successful developing integrated programs.

Some universities have made strides to extend sustainability education. For example, at Cambridge University, the Department of Engineering incorporated education in sustainable development across the department by focusing on interdisciplinary and systems thinking (Fenner, Ainger, Cruickshank, & Guthrie 2005). Other universities have taken a more traditional approach, implementing "add-on" additions to the curriculum (Huntzinger, et al. 2007) by developing educational resources such as new courses and course projects (Riley, Grommes, & Thatcher 2007; Welsh, & Murray 2003; Walker & Seymour 2008), multidisciplinary case studies (Perdan, Azapagic, & Clift 2000), educational modules (Hayles & Holdsworth 2008; Tomkinson, Tomkinson, Dobson, & Engel 2008; Tesone, 2004; Roome 2005), and role play simulations (Maier, Baron, & McLaughlan 2007).

While full integration of sustainability principles into curricula has been difficult, it has been interdisciplinary. For example, at the University of Bristol, educators have developed an interdisciplinary, team-taught sustainable development course open to all majors with the purpose of demonstrating sustainable development ideas across a wide range of contexts (Hoare, Cornell, Bertram, Gallagher, Heslop, & Lieven 2008) and similarly, an interdisciplinary project course at the University of Cincinnati pools business students, industrial design students, and environmental studies students to apply sustainable development principles to projects for real-world clients (Welsh & Murray 2003).

Beyond knowledge retention, outcomes assessment should also focus on the values, attitudes, and behaviors of students (Shepherd 2008). Education in sustainability must engender values and behaviors in students that allow them to make educated and informed sustainability decisions. To do this, instruction in ethics and values must be a key part of any course in sustainability (Parkin, Johnston, Buckland, Brookes, & White 2004). Mulder (2010) suggests that a university education sharpens students' minds so they are able to make balanced appraisals of issues, and the norms and values to use in this appraisal. Similarly, Barth, Godemann, Rieckmann, & Stoltenberg (2007) stress the importance of instilling ownership of learning so that students can not only generate and acquire new knowledge, but also reflect on their own behavior and values. To engender sustainability based individual values and behaviors, a hands-on learning module is being developed at RMIT University in Melbourne that allows students "to foster values and behaviors, deepening their understanding of the issues, and help them recognize the importance and complexity of the decisions they will be asked to make in their professional lives" (Hayles & Holdsworth 2008, p.25). Arbuthnott (2009) warns, however, that changed values and behaviors do not always result in an intentional individual change, he stresses the importance of providing an environment that fosters such intentional self-development, and that programs should "plan education aimed at helping people translate their intentions into action" (p.159).

Sustainability in Five Contexts

Sustainability, as noted above, focuses on far more than our treatment of environmental resources and the inevitable waste resulting from the production of goods and services. We address sustainability in the following five contexts: social/cultural, economic, environmental, technical, and individual.

1) Social and Cultural Sustainability

Social sustainability refers to the ongoing human and institutional balance and prosperity that characterize a healthy social unit, and includes justice, equity, fairness, the role of individuals, relationships among social groups, the family, collective behavior, social class, race and ethnicity, medicine, education, and the role of institutions in society. Cultural factors include the shared values, attitudes, beliefs, behaviors, and social practices that characterize human knowledge and action (e.g., fine arts, humanities, the social sciences, the transmission and communication of knowledge, shared everyday way of life).

How the design and marketing of products, processes, and services tend to change how we live often requires changes in design to assess and evaluate their effect on human factors and to predict the results. An awareness of these factors may drive the decision as whether or not to develop or market a product, implement a business process, or provide a service. Again, this requires a greater understanding of the tension, reciprocal influences, and ethics among profit, power, and human well-being.

2) Economic Sustainability

Beyond the necessary profit-making policies and strategies related to the design and development of a process, product, or service, *economic sustainability addresses factors in design that influence the economic health and profile of communities including the standard of living, the business climate, employment, and the productive role of the corporation in the life of a community*. Sustainable economic and business practices most certainly have an influence on the sustainability of products and industrial processes produced but, as importantly, on the internal employee practices that promote and protect individual well-being, opportunity, and productivity. In short, corporations need to develop a community and global consciousness, and the awareness to determine how internal economic policies and practices can promote sustainable local, regional, and global communities. Considering themselves a part of a larger economic system, rather than competing with each other, might ensure the survival of corporations by contributing to a healthy economic system. It is imperative that corporations function as "corporate citizens" who have a civic stake in the community, embrace the accompanying ethical responsibility that goes beyond competition and their own financial or political interests, and relinquish *caveat emptor* as an excuse for economic abuse.

3) Environmental Sustainability

Environmental sustainability is an approach to the engineering of processes, products, and structures which has, indefinitely, a less negative or neutral, or a benign effect on all environmental systems. Sustainable design tends to produce products in which nature is not subject to continual increased use of natural resources, increases in substances produced by society, and increases in waste products and the effects of their degradation.

Often, decisions related to promoting environmental sustainability have traditionally required trade-offs among market forces, resource availability, and technology, but largely ignore the integrity of the Natural World. They may include the consideration of some human factors—but often ignore or deemphasize quality of life issues related to the economic, social, and cultural well-being of a population.

Determining the sustainability of a product, process, or human community depends upon the careful and complete assessment and evaluation of a range of technical and human factors that may (or may not) be influenced by a particular design. For example, the oft-used life-cycle analysis approach must include societal factors, not simply those related to the environment or useful life of a product or process.

Too often, profit is considered before the value and health of environmental conditions related to a project. One cannot be too frank on this topic; it is quite clear that our values as a people are far too often related to financial gain than to the health and welfare of our peoples and those who will follow us. Our global conversations more often focus on economic development and not often enough on human prosperity and survival. We have certainly reached a point in our treatment of global biological systems that we can no longer rely on prospective future advances in technology to solve our current problems, nor can we trust those whose values do not promote human well-being. Few of our political, corporate, or religious leaders are truly exempt from this characterization.

4) Technical Sustainability

Technical sustainability addresses a wide variety of mechanical and technical factors that constitute the design and manufacture of products, especially the 1) scientific research and appropriate technology (compared to alternatives) supporting product design, function, and development; 2) ease and efficiency of durable construction and use; 3) maintenance and functioning capabilities that meet the objectives for which a product is designed; 4) material selection; and 5) reduction, recovery, reuse, or disposal of parts and unused materials. Technical sustainability promotes manufacturing processes and industrial practices that are less invasive or destructive to environmental, social, or economic contexts and yield, ideally, a neutral or positive effect on these contexts.

Although technical design is not considered a "human factor" in design, one's approach to learning and applying technical design skills must reflect an understanding of and sensitivity to the manufacturing and production contexts in which these skills will be employed (including user interface), and products and processes that result.

5) Individual Sustainability

An important context missing from most discussions of sustainability, especially within academia (or society in general), is individual sustainability. Living *a sustainable lifestyle includes creating harmony, interconnection, and relatively high levels of awareness in one's values, thoughts, and behaviors, as well as maintaining an increasing control over one's physical, emotional, social, philosophical, environmental, and intellectual life.* The general dispositions that support individual sustainability are awareness, motivation, and the ability to engage in intentional self-development. As well, individual sustainability includes possessing a well-developed and demonstrated value system that acknowledges the interconnectedness of all global biological systems and our appropriate place in the Natural World.

Individual sustainability is likely the most important factor influencing the success of activities in the other four contexts. If one understands the complexities and interconnectedness of one's own individual sustainability contexts, then he or she might well transfer this systems

knowledge to understanding community and global sustainability. For this reason, learning about sustainability should start with understanding individual sustainability in the contexts noted just above.

Successful attempts at maintaining meaningful individual sustainability are dependent upon one's ability to change intentionally. Such growth may be difficult for some, and the challenges to individual development may be hindered by personal, career, family, and psychological issues, as well as a dysfunctional relationship with time or technology (Pappas & Pappas 2011). Some psychologists, like Maslow (1968) and Rogers (1980), as well as engineers Adams (1986) and Petroski (1992), suggest that barriers to growth are related to a variety of personal limitations or insecurities. Bigda-Peyton (2004) suggests that "humans have inherent [psychological] tendencies to destroy and use up" and that "harmful overconsumption occurs when psychic structures dominated by destructive instincts succeed in overpowering life-sustaining impulses" (p.264). How ironic that academia often deemphasizes such personal topics— what Dewey (1916, 2004) refers to as "an undesirable split" (p. 9) between human experience and academic instruction—when it is quite clear that little meaningful and lasting societal change will take place until individuals understand and address the nature of sustainability on this deeply personal level. We can hardly understand sustainability on a global level if we do not understand it within ourselves. It is sad that *lifestyle diseases* like stress, the overuse of prescription and over-the-counter drugs, food overconsumption, lack of exercise, and the inability to manage time and technology are the primary sources of our emotional discomfort, unhappiness, and increasingly poor levels of health.

Sustainability Interactions and Reciprocal Influences

As noted earlier, it would appear that determining the sustainability of a product, process, or human activity depends upon the careful and complete *assessment and evaluation* of a range of technical *and* human factors, noted in *The Engineer of 2020* as "the core analysis activities of engineering design" (2005). This approach is central to sustainability efforts, but it is a methodology about which too little has been written or practiced. As noted earlier, because sustainability factors comprise a *complex system*, a change in one sustainability factor is likely to result in an unpredictable change in the others. Too little work has been done to understand and assess the reciprocal influences this complex system creates.

One of the major challenges to this systems approach is that the five sustainability contexts influence each other in complex ways, and understanding these contexts requires an awareness that goes beyond corporate goals and the lure of technological advancement. It is quite possible that an economically and environmentally sustainable design or practice will be quite in conflict with social, cultural, or ethical forces. Understanding the far-reaching influence sustainability has on the individual as well as on groups of people (local and regional communities, professional communities, geographic regions, cultures) is critical to sustainability in these contexts. Ignoring or deemphasizing this interdependence, especially the common practice of considering profit or economic growth the primary factor driving design and production, may contribute to design that meets technical and economic needs but not a variety of other needs related to environmental balance, human prosperity, and community well-being.

University instruction employing a systems methodology is relatively unexplored territory and will require significant institutional speculation, research, and experimentation. We cannot deny, however, that the sustainability of our economic institutions, social structure, and culture is a necessary component of creating and preserving sustainable societies. Given our declining environmental, economic, and social conditions world-wide, a multi-faceted response that integrates thinking from across these five sustainability contexts is needed. Because of domain-specific expertise, the ability to create interdisciplinary teams, and operational autonomy, the university is uniquely positioned to pioneer instruction in societal and individual change in order to meet the challenge of promoting human survival and prosperity. Indeed, given its educational mission, it can be argued that the university has the responsibility to lead sustainable efforts.

Sustainability and the University

Considering how we shape the lives of students and contribute research to industry and government, institutions of higher learning possess the unique ability, and perhaps responsibility, to promote sustainability and create more sustainable communities in the future. In addition, since sustainable solutions require interdisciplinarity, the university is a unique global resource of research and instruction in multiple disciplines representing a rich diversity of people, ideas, experience, and backgrounds.

These facts place a great deal of responsibility on an institution that has a documented history of initiating and supporting social change. Historically, the radical changes occurring in higher education from 1890-1920 demonstrate how the university promoted social and intellectual change necessary to integrate waves of immigrants coming to our shores, each representing a different culture. Following William James'(1890) early work, *The Principles of Psychology*, establishing psychology as a legitimate social science, universities implemented courses in psychology. In the 1930's, Dewey's (2009) suggestion that universities ought to be more relevant and teach material related to economic and social institutions met with little resistance. More recent examples include the curricular and instructional support of equal rights for women and minorities (and diversity in general), even to the point of most universities initiating programs of study to support these social changes. As well, the relatively recent inclusion of environmental studies programs in most universities establishes higher education as a major player in social change efforts.

Teaching methodologies followed suit. Near the turn of the century, Harvard's A. Lawrence Lowell, adopting principles as old as St. Thomas Aquinas' *De magistro*, suggested that true education was the "education of the self" and was dependent upon the student, not the professor, to achieve (Brubacher & Rudy 1976, p.268). Even Woodrow Wilson, then president of Princeton, suggested that higher education ought to be based upon an informal association between student and professor, with the student taking the lead on determining instructional content (Brubacher & Rudy 1976). At the same time, Dewey (2009) was promoting education focusing on contemporary issues leading to a useful philosophy of life. Later, the counterculture of the 1960s and 1970s pushed educational institutions to embrace social change issues (non-violence, civil rights, the women's movement) heretofore largely ignored by higher education. The common elements of these changes led to making higher education highly relevant and

personal. What resulted was the establishment of the university as an agent of social change, poised to engage in the controversies of the day. Unfortunately, the Reagan era tended to reestablish the university as somewhat adjunct to society and more aligned with the economic needs of industry and government.

As we have no doubt learned, and as is reflected increasingly in academia and industry, the answers to many human problems are not to be found in specific and discrete disciplines. We need to further our understanding of each discipline's contribution to defining and teaching sustainability as well as the influence each context has on the others. As a test bed for sustainability solutions, the university bears a great responsibility for pioneering analysis and evaluation, and the development of materials, processes, and methodologies that will preserve and improve a global standard of living. Unfortunately, the motivation to make large-scale and expensive corporate changes (both cultural and economic) is currently insufficient to drive this movement. Academicians and professionals active in all disciplines (most especially the technical and social science disciplines) need to understand the interconnectedness and interdependence of all disciplines, especially as related to sustainability (Pappas & Kander 2008; Pappas and Pierrakos 2010).

The sustainability challenge is of a greater magnitude and difficulty than those social issues noted above. Academic programs, following some serious restructuring, can address this dilemma, one which involves revising curricula in established programs as well as developing new programs that focus on educating students using a systems approach to sustainability. Because academic disciplines are no longer discrete, new programs should focus on the future configuration of disciplines rather than on the still rather staid conditions that characterize much traditional academic work. Some universities have introduced limited instruction in sustainability into curricula, but this is not enough. *The immediacy of global sustainability problems requires significant curricular and philosophical change, even to go as far as re-envisioning the role of the university in society*. Perhaps this task is left to universities since there appears to be no other institution capable of creating massive educational change in a relatively short period of time. Traditional programs, and this likely includes those in the majority of universities in the United States, still struggle to revise curricula in the face of faculty who do not sufficiently understand or accept, or simply resist the unique changes current conditions require.

Sustainability across Academic Disciplines

Flexible new programs offer the most efficient and innovative response to sustainability problems, most especially those in engineering. While traditional programs will still fill a critical need, innovative instruction in new and progressive programs (implementing instruction in sustainability, values, and systems) will likely be the source of developing effective responses to global sustainability challenges, as well as helping U.S. higher education maintain its productivity in sustainability research, practice, and implementation.

Sustainability is not a discipline in itself, rather it is a context in which all disciplines can be taught, just as innovation, design, and globalization are contexts in which disciplinary content is taught. It is entirely possible to integrate sustainability into most any university course, each

addressing one or more specific sustainability context. Because the study of sustainability is relevant to most human intent and action, so our methods of inquiry and instruction need to address a broad spectrum of topics. Following are a few brief examples of how sustainability might be integrated into research and instruction in a variety of university disciplines:

Engineering—addressing issues in sustainability (especially environmental) is an appropriate role for the discipline due to the very nature of engineering design, manufacturing processes, and countless products. For example, the impact of specific designs on social/cultural and individual sustainability could be incorporated into coursework and projects.

English and the Arts— In writing courses, non-fiction readings and assignments in science and technology can address sustainability. Countless examples in fiction address the topic from a variety of points of view (especially individual and social sustainability). Because the historical role of the arts is to provide a vision of ourselves *to* ourselves (as noted by Emerson in "The Poet"), art can serve as an important reflection of who we are, and in this case, in ways related to sustainability.

Sciences and Technology Studies—the predominant disciplines addressing sustainability. The natural and applied sciences have natural links to the understanding, composition, and preservation of the Natural World. Technology can be considered both the cause and as well as the remediation of some sustainability problems.

Health Sciences—address the link between individual sustainability—how one acts to bring one's body and mind in harmony with the Natural World—and health issues that inherently address topics related to sustainability (food consumption, stress, prescription drugs, health care trends in society, disease, and unhappiness). How one cares for one's body and mind is a sustainability issue at its most intrinsic level, and likely needs to be addressed before one becomes an influential advocate for community or global change.

Social Sciences—In psychology and sociology, individual human intent as well as collective human action are, perhaps, at the root of the sustainability problem. What is it that prevents individuals and groups from working towards sustainability? What factors promote sustainable thought and action? History and political science provide a rich opportunity to discover the causes of current problems, and the political processes and legislation that influence sustainability across contexts.

Communications and Education—These disciplines are central to the study, understanding, and dissemination of sustainability information. Because these disciplines naturally and readily integrate into all other disciplines, they have an especially important role to play in sustainability studies. Teaching students methods of learning about and communicating sustainability topics is a valuable instructional skill.

Business Disciplines—Economic policies, business processes, marketing strategies, and management practices all address social or economic sustainability factors that influence the production and distribution of products and services. The role of business in promoting sustainability is potentially endless because our financial institutions and corporations control

production, and hence the consumption, of natural, human, and financial resources. The business disciplines occupy the unattractive position of having the most control over sustainability, and are continually subject to the tensions related to profit vs. human and environmental well-being. Even more fundamentally, the corporate sector suffers the greatest need for institutional and ethical change.

It is not necessary (or appropriate) for any one discipline to cover all the characteristics and workings of sustainability. This approach suggests curricular integration of sustainability throughout the university curriculum in order to offer students a comprehensive and useful understanding of sustainability, as well as the discipline-specific tools necessary to learn to live sustainably and take appropriate community responsibility.

Instructional methodologies need to reflect the complexities and nature of problems that have refused to yield to traditional instruction. The unique characteristics of highly complex problems require employing thinking and problems solving strategies with which we are not yet adept. Examining problems using such methodologies as complex systems and systems theory, and a wide variety of cognitive processing and behavioral change methodologies could expand students' understanding of the problems we face and allow them to develop a variety of complementary solutions to address these unique problems. This is the topic for another article.

Conclusion

The resolution of most sustainability problems are especially dependent upon an individual's values, and his or her ability to live according to these values. Perhaps the central issue is behavioral change motivated by some simple facts, noted by Leary (1982):

1) There is an increasing number of increasingly dissatisfied people crowding this planet.
2) There is a decreasing amount of land, energy, raw materials, hope, and precise future planning. (p.xii)

These same problems were addressed more than 50 years ago by many other writers, environmentalists, and philosophers including Wendell Berry, Paul Erlich, and Rachel Carson. Even Henry David Thoreau (1965) noted over 150 years ago the serious consequences of ignoring the environmental and social implications of living without addressing the values related to our actions.

Our limited understanding of these five contexts in sustainability, especially in engineering programs, may well be due to most of our efforts being focused on only environmental issues. In the environmental context, we have only recently begun to understand sustainability and engage in activities to promote it. Three factors: 1) unabated population growth, 2) the overconsumption of limited non-renewable natural resources, and 3) continually increasing individual consumption may well doom even the most active efforts to establish sustainable communities.

All sustainability systems are nearing a breaking point, and our efforts remain sorely inadequate. Quite clearly, life on Earth will be significantly different in the next 50 years, and we can no longer continue with the illusion that we can sustain life as we know it. Some have termed our global crisis pre-apocalyptic, in some ways not unlike the 1960s nuclear scares. Perhaps we need to acknowledge the unthinkable, that we may be living the last years of human existence and that if we do manage to survive more than another century, our existence may well become unimaginably dire. Successful efforts to improve global sustainability may well *extend* our comfortable stay on the planet, but we have no precedent (even considering the remarkable build up to WWII) to support the idea of some that we are capable of the changes necessary that would result in a truly sustainable global society.

Human populations need to better understand and engage in collective behavior and thinking methodologies that more often address the needs of groups of people rather than those of the individual. As Hardin (1968) notes in "The Tragedy of the Commons," problems like this may have no technical solutions, only human ones. The answers to the problem of sustainability, as well as other problems we face as a global society, are based on human *values*—ones that translate to sustainable *behaviors*.

References

Adams, J. (1986) *Conceptual blockbusting*. Cambridge, Mass.: Perseus Books.

Anderson school of Engineering. (n.d.). Retrieved from http://www.anderson.ucla.edu/x15180.xml

Arbuthnott, K. D. (2009). Education for sustainable development beyond attitude change. *International Journal of Sustainability in Higher Education, 10(2),* 152-163.

Barth, M., Godemann, J., Rieckmann, M., & Stoltenberg, U. (2007). Developing key competencies for sustainable development in higher education. *International Journal of Sustainability in Higher Education, 8(4)*, 416-430.

Bartlett, A. (1997). Reflections on sustainability, population growth, and the environment—Revisited. *Renewable Resources Journal, 15(4*), 6-23.

Bartlett, A. (1978) Forgotten fundamentals of the energy crisis. *American Journal of Physics, 46(3)*, 876-888.

Bigda-Peyton, F. (2004). When drives are dangerous: Drive theory and resource overconsumption. *Modern Psychoanalysis, 29(1),* 251-270.

Bras-Klapwick, M., Hahn, A. & Mulder, K. (2003). Training of lecturers to integrate sustainability in engineering curricula. Delft University, Faculty of Technology, Policy & Management, De Vries Van Heystplantsoen 2, 2628 RZ Delft, The Netherlands

Brubacher, J. & Rudy, W. (1976) *Higher education in transition: A history of American colleges and universities.* New York: Harper and Row.

Capra, F. (1982). The turning point: A new vision of reality. *The Futurist*, 16(6), 19-24.

Chapin, F., Sala, O., & Huber-Sannwald, E. (2001). *Global bio-diversity in a changing environment*. New York: Springer-Verlag.

Csikszentmihalyi, M. (1993). *The evolving self*. New York: Harper Collins.

City of Vancouver, policy report social development: Definition of social sustainability. (2002). Retrieved from http://vancouver.ca/ctyclerk/cclerk/20050524/documents/p1.pdf

Declaration of Barcelona. (2004). Retrieved from http://eesd08.tugraz.at/pics/declaration_of_barcelona_english.pdf

Dewey, J. (1916, 2004). Democracy and education: An introduction to the philosophy of education. New York: WLC Books.

Educating the Engineer of 2020. (2005). The National Academies Press. Retrieved from http://www.nap.edu/catalog.php?record_id=11338

Earth Summit-Agenda 21. (2009). Retrieved from The United Nations Program of Action from Rio: http://www.un.org/esa/dsd/agenda21/

Ehrlich, P. R. (1968). *The population bomb*. New York: Ballantine Books.

Fenner, R. A., Ainger, C. M., Cruickshank, H. J., & Guthrie, P. M. (2005). Embedding sustainable development at Cambridge University Engineering Department. *International Journal of Sustainability in Higher Education, 6(3),* 229-241.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C., & Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *AMBIO*: *A Journal of Human Environment*, 31(5), 437-440

Hardin, G. (1968). The tragedy of the commons. *Science, 162,* 1243-1248.

Hayles, C. S., & Holdsworth, S. E. (2008). Curriculum change for sustainability. *Journal for Education in the Built Environment, 3(1),* 25-48.

Hoare, A., Cornell, S., Bertram, C., Gallagher, K., Heslop, S., & Lieven, N. (2008). Teaching against the grain: Multi-disciplinary teamwork effectively delivers a successful undergraduate unit in sustainable development. *Environmental Education Research, 14(4),* 469-481.

Huntzinger, D. N., Hutchins, M. J., Gierke, J. S., & Sutherland, J. W. (2007). Enabling sustainable thinking in undergraduate engineering education. *International Journal of Engineering Education, 23(2),* 218-230.

James, W. (1890). *The principles of psychology*. New York: Dover.

Kagawa, F. (2007). Dissonance in students' perceptions of sustainable development and sustainability: Implications for curriculum change. *International Journal of Sustainability in Higher Education, 8(3),* 317-338.

Leary, T. (1982). *Changing my mind, among others*. Englewood Cliff, N.J.: Prentice Hall, Inc.

Lin, S. & Lee, Y. (2005). Sustainable community indicators: Case of Mingshan community, Taipei, Taiwan. *8th International Conference of the Asian Planning Schools Association*. Retrieved from http://www.irbdirekt.de/daten/iconda/CIB8251.pdf

Maier, H. R., Baron, J., & McLaughlan, R. G. (2007). Using online role play simulations for teaching sustainability principles to engineering students. *International Journal of Engineering Education, 23(6),*1162-1171.

Maslow, A. (1968). *Toward a psychology of being.* New York: Van Nostrand Co.

Meadows, D.H., Meadows, D.L., Randers, J., & Behrens, W.W. (1972). *Limits to growth: A report for the club of Rome's project on the predicament of mankind.* New York City: Universe Books.

McKeown, R. (2002). *Toolkit economy education for sustainable development.* Retrieved from http://www.esdtoolkit.org/

McDonough, W. & and Braungart, M. (2002). *Cradle to cradle*. New York: North Point Press.

Moore, J. (2005). Seven recommendations for creating sustainability education at the university level. *International Journal of Sustainability in Higher Education, 6(4),* 326-339.

Mulder, K. F. (2010). Don't preach. practice! Value laden statements in academic sustainability education. *International Journal of Sustainability in Higher Education, 11(1),* 74-85.

Nichols, M. (2009). *Socrates on friendship and community: Reflections on Plato's Symposium, Phaedrus, and Lysis*. New York: Cambridge University Press.

Pappas, E. C. & Kander, R. G. (2008). Sustainable engineering design at James Madison University. *Proceedings of 38th ASEE/IEEE Frontiers in Education Conference*. U.S.A., 38, 231-248.

Pappas, E. & Pappas, J. (2011) A dispositional behavioral approach to teaching cognitive processes that support effective thought and action. *Innovative Higher Education, 36(5),* 1-14.

Pappas, E. & Pierrakos, O. (2010). Integrating developmental instruction in sustainability contexts into an undergraduate engineering design curriculum: Level one. *Proceedings of the 40th ASEE/IEEE Frontiers in Education Conference*. U.S.A., 40, 46-56.

Parkin, S., Johnston, A., Buckland, H., Brookes, F., & White, E. (2004). Learning and skills for sustainable development: Developing a sustainability literate society. *Higher Education Partnership for Sustainability (HEPS)*. London: Forum for the Future.

Perdan, S., Azapagic, A., & Clift, R. (2000). Teaching sustainable development to engineering students. *International Journal of Sustainability in Higher Education, 1(3),* 267-279.

Petroski, H. (1992). *To engineer is human*. New York: Random House Books.

Picker engineering program. (n.d.). Retrieved from Smith College http://www.science.smith.edu/departments/Engin/

Plato. (2003) *The republic.* New York: Penguin

Riley, D. R., Grommes, A. V., & Thatcher, C. E. (2007). Teaching sustainability in building design and engineering. *Journal of Green Building, 2(1),* 175-195.

Rogers, C. (1980). *A way of being*. Boston: Houghton-Mifflin Co.

Roome, N. (2005). Teaching sustainability in a global MBA: Insights from the one MBA. *Business Strategy and the Environment, 14(3),* 160-171.

Roseland, Mark. (2000). Sustainable community development integrating environmental, economic, and social objectives. *Progress in Planning*, 54(2), 73-132.

School of Sustainability. (n.d.). Retrieved from Arizona State University: http://schoolofsustainability.asu.edu/

Seligman, M. & Csikszentmihalyi, M. (2001). Positive psychology: An introduction. *American Psychologist*, 55(1), 5-14.

Shephard, K. (2008). Higher education for sustainability: Seeking affective learning outcomes. *International Journal of Sustainability in Higher Education*, 9(1), 87-98.

Shriberg, M. (2002). Institutional assessment tools for sustainability in higher education: Strengths, weaknesses, and implications for practice and theory. *International Journal of Sustainability in Higher Education, 3(3),* 254-270.

Sustainable Seattle and indicators. (1994). Retrieved from: http://sustainableseattle.org/Programs/RegionalIndicators/

Tesone, D. V. (2004). Development of a sustainable tourism hospitality human resources management module: A template for teaching sustainability across the curriculum. *International Journal of Hospitality Management, 23(3),* 207-237.

Thom, D. (1998). Engineering education and the new industrial revolution. *International Journal of Engineering Education, 14(2),* 89-94.

Thoreau, H. (1965). *Walden.* New York: Bantam Books.

Thoresen, V. (2004). Cultivating sustainable lifestyles. *UNESCO, IEF Conference,* University of Thessaloniki, Greece.

Tomkinson, B., Tomkinson, R., Dobson, H., & Engel, C. (2008). Education for sustainable development — an inter-disciplinary pilot module for undergraduate engineers and scientists. *International Journal of Sustainable Engineering, 1(1),* 69-76.

United Nations general assembly report of the world commission on environment and development (1987). Retrieved from: http://www.un.org/documents/ga/res/42/ares42-187.htm

Walker, J. B., & Seymour, M. W. (2008). Utilizing the design charrette for teaching sustainability. *International Journal of Sustainability in Higher Education, 9(2),* 157-169.

Welsh, M. A., & Murray, D. L. (2003). The ecollaborative: Teaching sustainability through critical pedagogy. *Journal of Management Education, 27(2),* 220-223.

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