

## The Sustainability Movement in Higher Education: An Overview<sup>i</sup>

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December, 2008

### A Brief Tour of Global Challenges

In 2007, the Fourth Assessment Report of the Intergovernmental Panel on Climate Change made it abundantly clear that the climate is warming and “most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas” (pg 37). [2008 Millennium Development Goals Report]

Some 2.5 billion people, almost half the developing world’s population, live without improved sanitation (pg 4). [2008 Millennium Development Goals Report]

Every day, nearly 7,500 people become infected with HIV and 5,500 die from AIDS. [2008 Millennium Development Goals Report]

World grain production has fallen short of consumption in seven of the last eight years, dropping world grain stocks to their lowest level in 34 years. Corn prices nearly doubled and wheat prices tripled between late 2005 and late 2007 (pp.19). [Chicago Board of Trade, “Market Commentaries,” for wheat and corn at [www.cbot.com](http://www.cbot.com)]

The US is planning to double the share of its grain harvest going for fuel ethanol—from 16% of the 2006 crop to 30% of the 2008 crop...this effort to reduce oil insecurity has helped drive world grain prices to all-time highs, creating unprecedented world food insecurity (pp.20). [Interagency Agricultural Projections Committee, *Agricultural Projections to 2016* (Washington, DC: USDA Feb 2007)]

Water use has grown at more than twice the rate of the population for the past century. Although there is not yet a global water shortage, about 2.8 billion people, representing more than 40 per cent of the world’s population, live in river basins with some form of water scarcity. More than 1.2 billion of them live under conditions of physical water scarcity, which occurs when more than 75% of the river flows are withdrawn (pg 40). [2008 Millennium Development Goals Report]

Globally, plant and animal species are now disappearing at 1,000 times the rate at which new species evolve (pp. 86). [Species Survival Commission, *2000 IUCN Red List of Threatened Species* (Gland, Switzerland and Cambridge, U.K.: World Conservation Union-IUCN, 2000), p. 1.]

Nearly 90% of fish residing in the ocean rely on coastal wetlands, mangrove swamps, or rivers for spawning habitat. More than half of the mangrove forests in tropical and subtropical countries have been lost (pp. 100). [Lauretta Burke et al., *Pilot Analysis of Global Ecosystems: Coastal Ecosystems* (Washington, DC: World Resources Institute, 2001) pp. 19, 51.

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<sup>i</sup> This paper was largely drawn from “Think Systemically, Act Cooperatively: the Key to Reaching a Tipping Point for the Sustainability Movement in Higher Education” by James L. Elder, which appears in the current issue of *Sustainability: The Journal of Record*, Vol 1, #5, 2008.

## I. Introduction

In all sectors of society across the United States and the world, individuals and small networks are organizing to meet the great challenges of the 21<sup>st</sup> century by promoting more sustainable thinking and practices. The higher education sector in particular represents one of the greatest, if often overlooked, opportunities to advance a more sustainable society. To appreciate the impact of this opportunity, consider the scope of higher education:

- Total annual expenditures of the 4,300 two- and four-year institutions were \$351 billion (or 3.2% of the U.S. GDP) in 2003.<sup>1</sup>
- Total employment is currently 3.4 million, including 1.2 million faculty members.<sup>2</sup>
- Total post-secondary student enrollment is 18 million,<sup>3</sup> expected to increase 23% by 2013.
- Total annual building construction spending exceeded \$11 billion in 2002, 64% of which was spent on new buildings.<sup>4</sup>
- Total annual energy expenditures are estimated to exceed \$6 billion.<sup>5</sup>

Higher education is the nation's incubator for future leaders as well as a site for research, innovation, and demonstration for a variety of model practices. Higher education prepares most of the professionals who lead and influence society. Its institutions create significant economic, social, and environmental footprints. It also has the unique academic freedom as well as the critical mass and diversity of skills to develop new ideas and to engage in bold experimentation in sustainable living. It can conduct critical research and help develop new ideas and technologies, as well as raise the level of discourse regarding societal challenges. In short, as H. G. Wells assessed its impact from a different perspective, "Human history becomes more and more a race between education and catastrophe."<sup>6</sup>

But transforming such an important sector of society is extraordinarily difficult. At a minimum, it requires strategic thinking, many champions pulling in the same direction, and a comprehensive suite of tools, resources and supports upon which these champions can draw. In other words, it needs a strong "movement," a group of people with common beliefs who collectively attempt to achieve certain general goals, in the tradition (if not always the tactics or rhetoric) of the campus anti-war movement, the campus anti-apartheid disinvestment campaign, and others.

Such societal movements always begin through isolated efforts by individual champions, followed by connecting these individual champions with support systems and networks that establish a broader community. This latter step dramatically accelerates the movement by enabling collaboration, mutual support, and synergy.

The current sustainability movement in the academic sector is just beginning this transition. There are encouraging signs of initial progress, including ambitious activities at individual colleges and universities, in the organizations that serve them, among various existing collegiate networks, and in the development of new networks solely for advancing the sustainability movement. While the growing momentum for sustainability on many campuses often has come as a result of demands by students who understand that their future is at stake, the challenge of addressing a changing climate is increasingly engaging all dimensions of the campus. As a result, hundreds of thousands of students, faculty and administrators at hundreds of colleges and universities are increasingly committed and helping to advance sustainability.

While individual schools can and occasionally do change without the external support of a broader movement, this is an inefficient, slow, and relatively rare occurrence. *For the sustainability movement in higher education to achieve its goals, the change in direction needed on many individual campuses will only occur as a strong national support system develops to support change agents and champions on individual campuses.*

It is therefore critical to understand the sustainability movement in higher education from two very different yet interrelated perspectives: the “individual school” view (the perspective from inside a single institution that focuses on changes in that institution) and the “support system” view or view from outside a single institution (the perspective that focuses on the essential movement infrastructure, coordination, and planning). In this paper, we speak to the latter. Also, we provide several appendices that offer snapshots of major sustainability initiatives that relate to curriculum change.

This paper is also focused primarily on the campus sustainability movement rather than the campus environmental movement<sup>ii</sup>. The latter has since achieved significant success since its launch on Earth Day of 1971. These programs have often provided a critical platform for the sustainability movement, have addressed a critical aspect of sustainability, and, some would argue, are increasingly incorporated within the campus sustainability movement. *Sustainability, however, includes not only environmental concerns but also social and economic considerations, with a focus on how to improve the quality of life for all including future generations.* As such, it is broader, more comprehensive and more strategic than efforts addressing the environment alone, and its success will engender further success for the campus environmental movement.

## **II. Status of the Sustainability Movement in Higher Education**

Many indicators point to a growing sustainability movement in higher education that has been emerging over the past five years or more. The greatest gains to date have occurred in campus operations, particularly in energy conservation and renewable energy, sustainable building design, water conservation, purchasing, transportation, and chemicals and waste management. The exploding number of schools making aggressive carbon reduction commitments is driving many of these changes.

Here are three lists of indicators—on sustainability broadly conceived, on climate change and energy, and on education and research—that provide information on the breadth of sustainability activity within the higher education landscape. Unless otherwise notes, these lists are culled from the Association for the Advancement of Sustainability in Higher Education’s Annual Digest.<sup>7</sup>

### *A. Broad Sustainability Indicators:*

1. The recently passed Higher Education Opportunity Act of 2008 authorized a “University Sustainability Program” at the Department of Education to offer competitive grants to

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<sup>ii</sup> While the campus environmental movement historically aimed to engage students and the wider campus community in learning about and taking action on individual environmental issues or policy initiatives, the campus sustainability movement is much more comprehensive and solutions-oriented. It aims to make the campus and all its associated activities (curriculum and teaching, residence life, student activities, operations, research, and assets investment) a model living laboratory and leader for sustainable practices.

institutions and associations of higher education to develop, implement and evaluate sustainability curricula, practices, and academic programs. The next step is for interested stakeholders to urge Congress to provide annual funding for this new program.

2. The Energy Independence and Security Act of 2007 authorized \$250 million annually in grants and \$500 million in loans for renewable energy and energy efficiency projects at higher education institutions, public schools, and local governments. The next step is for stakeholders to urge Congress to provide annual funding for this new program.
3. Several national nonprofit organizations and programs such as Second Nature, the national Wildlife Federation's Campus Ecology program, the Campaign for Environmental Literacy and other projects described later in this paper have been established solely to help make sustainability a foundation of learning and/or practice in higher education.
4. Over a dozen mainstream higher education associations now include advancement of sustainability as a part of their agenda and core programs, such as the American Association of Community Colleges (AACC), American Association of State Colleges & Universities (AASCU), American Council on Education (ACE), College Student Educators International (CSEI), Association of Physical Plant Administrators (APPA), Association of College & University Housing Officers-International (ACUHO-I), Association of Governing Boards of Universities & Colleges (AGB), National Association of Independent Colleges & Universities (NAICU), National Association of College and University Business Officers (NACUBO), National Association of Educational Procurement (NAEP), National Intramural-Recreational Sports Association NIRSA), and Society of College and University Planners (SCUP). See [www.aashe/heasc](http://www.aashe/heasc), the network for coordination of these efforts.
5. 700 participants attended the 2006 conference and over 1800 participants attended the 2008 conference of the Association for the Advancement of Sustainability in Higher Education; and several regional/state sustainability conferences are equally well attended.
6. Over 300 campuses have conducted campus sustainability assessments (most within the past 5 years), and hundreds more are planning to conduct them.
7. At least 250 campuses now have sustainability coordinators/directors or offices of sustainability; more than 25% (1,000) of all higher educations are expected to have such positions by the end of the decade.
8. Over 500 campuses have institution-wide sustainability or environmental committees.
9. According to the Sustainable Endowments Institute's 2008 College Sustainability Report Card,<sup>8</sup> of the 200 colleges and universities with the largest endowments surveyed,
  - 70% buy food from local farms
  - 61% have high performance green building projects and green building policies
  - 45% have made a commitment to carbon reduction
  - 42% are using hybrid or electric vehicles in transportation fleets
  - One third purchase renewable energy or renewable energy credits
  - One third actually generate their own renewable energy to some extent

10. A 2006 *University Business* survey<sup>9</sup> found "a distinct trend among colleges and universities toward environmental sensitivity," and therefore "implementing [sustainability] initiatives will likely become a requirement for institutions desiring to be in the mainstream of higher education."
11. Over the past two years, articles about campus sustainability were featured in *Time*, *Newsweek*, *New York Times*, *Washington Post*, *USA Today*, *Business Week*, *ABC News online*, and *Christian Science Monitor*, and sustainability was frequently covered in *The Chronicle of Higher Education*, *Inside Higher Ed*, *University Business*, and *Business Officer*.
12. In 2008, *Grist Magazine* named "15 Green Colleges and Universities," *Sierra Magazine* highlighted "10 That Get It," *Kiwi Magazine* issued a Green College Report, *Newsweek's Current Magazine* designated "16 Schools That Care," and Princeton Review issued a green campus ranking.
13. Within the past three or so years, several dozen larger universities have attracted multi-million dollar contributions for their sustainability efforts, with several receiving gifts exceeding \$20 million to establish sustainability centers or institutes.
14. In a review of 239 broadly-defined "applied sustainability centers" at universities across the globe,<sup>10</sup> The Aspen Institute concluded that the number and size of centers is increasing quickly, they are attracting significant resources, and their leadership in sustainability provides an increasing edge in attracting top students, faculty, and companies.

*B. Climate Change and Energy Indicators:*

1. Over 560 college and university presidents have signed the new American College and University Presidents Climate Commitment.
2. Over 350 large campus buildings have or are "in line" for LEED certification (many additional buildings are using LEED standards but have not applied for certification).
3. California and Washington have mandated LEED silver for all new public university campus construction; several other states provide incentives and assistance for building sustainably-designed campus buildings.
4. A 2007 *Building Design + Construction Magazine* survey<sup>11</sup> found that 85% of colleges and universities have incorporated sustainable design principles in recent building projects.
5. The combined purchases of EPA's Top 10 green power purchasers in higher education exceeds 758 million kilowatt-hours of green power annually<sup>12</sup> (equivalent to the electricity needed for 78,000 average American homes).
6. Often as a result of student demand, higher education is now the largest purchaser of wind energy in the US.

7. In November 2007, 6,000 students traveled from across the country to participate in the three-day PowerShift Conference outside Washington, D.C. to learn about global warming and lobby Congress.
8. In January, 2008, Focus the Nation (now The National Teach-in on Global Warming Solutions) organized the biggest national teach-in in history, engaging a million students at over 1,900 institutions in a day long teach-in about global warming.

*C. Education and Research Indicators:*

1. At least 27 schools launched sustainability-themed degrees, certificates, or academic programs in 2007, up from 22 in 2006 and three in 2005.
2. In 2006, at least 18 schools established new research and academic institutes or centers dedicated to studying aspects of environmental sustainability: alternative energy, environmental education, organic agriculture and transportation. A further 10 sustainability-themed research centers opened in 2007, seven of which focus on the development of renewable energy. Plans were also announced for six additional sustainability research centers and/or partnerships, all of which will focus on new energy technologies.
3. Twenty national disciplinary associations have formed the “Disciplinary Associations Network for Sustainability” (DANS) to jointly develop curricula, standards, and professional development programs. [See the snapshot on DANS attached to this paper.]

### **III. Analysis of the Movement’s Challenges**

While the movement clearly has an initial foothold, former Harvard University president Derek Bok points out the difficulties ahead:

When society recognizes a need that can be satisfied through advanced education or research *and* when sufficient funds are available to pay the cost, American universities respond in exemplary fashion. . . . On the other hand, when social needs are not clearly recognized and backed by adequate financial support, higher education has often failed to respond as effectively as it might, even to some of the most important challenges facing America. . . . After a major social problem has been recognized, universities will usually continue to respond weakly unless outside support is available and the subjects involved command prestige in academic circles.<sup>13</sup>

#### **A. Individual Schools – Broad but shallow penetration**

While sustainability-oriented changes in campus physical plant and operations are making strong initial progress on many campuses, the more important changes in teaching and learning are not. In the vast majority of schools, these changes are at best modest - and even then, almost never as comprehensive as needed.

A new survey of over 1,000 schools released by the National Wildlife Federation in August 2008 found that:

Academics still lag behind the vision of a sustainable campus ... Today's student is just as unlikely as in 2001 to graduate with exposure to basic ecological principles, much less with an understanding of how the human-designed economy can work in harmony with natural systems... Relatively small percentages of campuses offer interdisciplinary degree opportunities in environmental and sustainability studies. Moreover, considerably fewer campuses today require all students to take courses on environmental or sustainability topics.<sup>14</sup>

Equally importantly, only a handful of colleges and universities are working to comprehensively integrate sustainability into the core values and mission of the institution as well as its curriculum. As educational philosopher C. A. Bowers repeatedly argues, the unsustainable perspective that currently underlies the core values and mission of almost all schools will therefore ultimately marginalize or defeat any substantial reform efforts.<sup>15</sup>

The difficulties of making deep transformative change in curriculum and educational practices are further complicated by additional factors:

- Moving toward sustainability is more a way of thinking than a science. As a result of this as well as the fact that universities are complex systems, campus sustainability initiatives often suffer from a lack of clear pathways toward a definable end.
- Campus sustainability work to date also tends to be piecemeal and sporadic, understandably focusing on the low-hanging fruit (such as easy-to-implement energy conservation and recycling measures, and modest changes in purchasing practices). Such steps are laudable, but inevitably fail to gain full traction and critical mass absent master plans and comprehensive strategies at the institutional level.
- Initial institutional changes also often remain relatively superficial, and then are unable to survive changes in institutional leadership, the departure of key champions, or loss of external funding.
- Senior campus leadership is largely absent from the sustainability movement (with notable exceptions). Faculty and students tend to hold higher levels of interest and commitment to sustainability than senior administrators, a situation that significantly hinders greater adoption.
- As complex and often irrational systems, universities rarely have common internal pathways for change. This makes it difficult to develop blueprints for change with wide applicability to other schools. (For a thoughtful exploration of the change process on individual campuses, see "Green Campuses: The Road from Little Victories to Systemic Transformation" by Leith Sharp, Harvard University.)<sup>16</sup>
- Even as an impressive number of campuses make significant commitments to improve physical plant and operations and the number of such commitments grows, many schools now face the difficulty of executing these commitments and often struggle with a critical shortage of institutional capacity for following through.

As a result, the sustainability movement in higher education has yet to comprehensively penetrate any of the three primary higher education functions of education, research, and community outreach/service:

1. Curriculum and Teaching: A concerted effort is especially needed to make sustainability the foundation of education for *all* college graduates. The main barriers to this include the deeply embedded disciplinary structure, how that structure drives the organization of the curriculum and school day, and the faculty reward system which generally does not value interdisciplinary curriculum development and teaching. Moreover, many—too many—introductory and general-education courses focus on disciplinary fundamentals rather than real-world problems. There are few incentives or pressures to change these deeply embedded barriers, yet they are precisely the targets at which transformative change must aim. There are several sustainability-related faculty and curriculum development initiatives in the country (featured in the appendices to this document) but at present, all are in early stages of development.

2. Research: Most sustainability-related research on campus, which is modest at best, has been narrowly focused on the environmental and energy-related practices – in other words, on the science of sustainability. The equally important social and economic fields need to be engaged to the same degree.

3. Outreach and Service: Despite the huge opportunity for mutual benefit, colleges and their surrounding communities are not yet working together to create integrated approaches to sustainability. If students and staff connected their studies with work in local communities to help develop real life solutions to our sustainability challenges, they would simultaneously develop critical implementation skills and knowledge while offering a tremendous community service. (However, college students themselves, if not their institutions, are engaged in a good deal of outreach through the various student climate change advocacy projects.)

To penetrate these three primary functions, the time has come for champions to begin to think more systemically and to act more cooperatively and collaboratively, both in terms of effecting change within individual schools and within the higher education system itself. Only by taking such a leveraged approach will there be a chance to secure the vital change needed within the very short remaining time that many believe is left to us.

## B. The Support System – Emerging but lacking strength

A national movement needs a support system to provide it with essential “infrastructure”: i.e., adequate intellectual and financial capital, a moral framework, visibility and societal attention, and tools to assist champions inside institutions to surmount internal barriers to change. Such a support system has two primary functions: 1) to provide key support to individual schools and campus champions, and 2) to encourage and support change within higher education’s *own* infrastructure (the higher education associations, disciplinary societies, accrediting and regulating agencies, funders, etc).

Some of the support and resources needed by individual campus champions to take next steps includes:

- Tools: shared protocols, best practices/models, metrics/analytics, training opportunities

- Capacity: the human resources on campus to execute plans and commitments, specifically:
  - Adequate personnel assigned to address sustainability issues, with the power to implement solutions
  - Adequate expertise: for example, becoming ‘carbon neutral’ is a highly technical task, requiring very specific and skilled engineering, architectural, and transportation planning expertise, which rarely exists on campus
- External support and pressure:
  - Alumni, prospective students, government, funders, employers, and society/media all can and have influenced a campus to move forward
  - A coordinated system-wide movement from which to draw external support, reinforcement, and information (the lack of which leads to “reinventing the wheel” when programs, practices and answers exist elsewhere)
- Seed funds, to address the difficulty often encountered by champions in securing internal funds to get started. (The 1,000+ schools included in the National Wildlife Federation survey reported that funding is now their biggest obstacle to expanding sustainability programming, versus “other (higher) priorities” cited as the biggest obstacle in an earlier 2001 survey.)<sup>17</sup>

#### **IV. Conclusion**

Over the past few years in American higher education, the sustainability movement has emerged and grown dramatically. Today, it is within our reach to make sustainability foundational to the education for *all* college graduates, thus preparing them for a world experiencing all its systems in flux. Yet deep barriers to accomplishing this remain, such as our rigid disciplinary structures and faculty systems that only minimally reward scholarship, teaching, and activism related to sustainability. Few institutional incentives or national initiatives exist to overcome these barriers, yet this is precisely the place where transformative changes must occur. Only by thinking more strategically and systemically while operating more collectively can we enable sustainability education—both its tenets and its practices—to become an accepted core feature of our institutions of higher education.

#### **APPENDICES**

Appended to this briefing paper are short overviews of the major sustainability-related initiatives that focus on faculty and curriculum development. With the exception of SENCER (founded in the year 2000), all of these projects are quite new, created within the past 3-4 years.

- A. AAAS Involvement in Sustainability Science
- B. Disciplinary Associations Network for Sustainability
- C. The Association for the Advancement of Sustainability in Higher Education’s (AASHE) Leadership for Curriculum Change Workshops
- D. The Educated Citizen and Public Health: Recent Public Health Initiatives in Undergraduate Education
- E. The SENCER Initiative: Science Education for New Civic Engagements and Responsibilities

## F. The Center for Sustainable Engineering

### End Notes

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<sup>1</sup> Table 29. Total expenditures of educational institutions related to the gross domestic product, by level of institution: Selected years, 1929-30 to 2003-04. 2004 Tables and Figures. U.S. Department of Education, National Center for Education Statistics, Institute of Education Sciences. Digest of Educational Statistics. 2005.

<sup>2</sup> U.S. Department of Education, National Center for Education Statistics, 1987 through 2005 Integrated Postsecondary Education Data System (IPEDS), "Fall Staff Survey" (IPEDS-S:87-99), and Winter 2001-02 through Winter 2005-06. 2007.

<sup>3</sup> U.S. Department of Education, National Center for Education Statistics, 2005-06 and fall 2005 Integrated Postsecondary Education Data System (IPEDS), Spring 2006, Winter 2005-06, and Fall 2006. U.S. Department of Education Institute of Education Sciences. 2007

<sup>4</sup> Kats, Greg et al. The Costs and Financial Benefits of Green Buildings, A Report to California's Sustainable Building Task Force, California Sustainable Building Task Force. 2003. available at [www.cap-e.com](http://www.cap-e.com).

<sup>5</sup> Putman, Andrea and Michael Philips. *The Business Case for Renewable Energy: A Guide for Colleges and Universities*, p. 52, published by APPA, NACUBO and SCUP. 2006.

<sup>6</sup> Wells, H.G. *Outline of History*, Garden City Publishing Co, Inc, Garden City, New York..1920.

<sup>7</sup> AASHE 2006 and 2007 Digests. Association for the Advancement of Sustainability in Higher Education. [www.aashe.org/publications/digest.php](http://www.aashe.org/publications/digest.php). (last visited: 8.20.08)

<sup>8</sup> The College Sustainability Report Card. Sustainable Endowments Institute, Cambridge, MA, 2008. Pages 4-6. [www.endowmentinstitute.org/sustainability/CollegeSustainabilityReportCard.pdf](http://www.endowmentinstitute.org/sustainability/CollegeSustainabilityReportCard.pdf). (last visited: 8.20.08)

<sup>9</sup> Institutions of Higher Education: A Study of Facilities and Environmental Considerations, Martin Akel & Associates, Chester, NJ, 2006.

<sup>10</sup> A Closer Look at Applied Sustainability Centers. The Aspen Institute Center for Business Education, Aspen, CO, 2008. [www.aspenbe.org/teaching/sustainability.html](http://www.aspenbe.org/teaching/sustainability.html). (last visited: 8.20.08)

<sup>11</sup> Green Building Research White Paper, *Building Design + Construction*, October 2007

<sup>12</sup> EPA Top 10 List for Higher Education. <http://epa.gov/greenpower/toplists/top10ed.htm> (last visited: 8.20.08)

<sup>13</sup> Bok, D. *Universities and the Future of America*, Duke University Press, Durham, NC, 1990. Pages 104-05.

<sup>14</sup> Campus Environment 2008: A National Report Card on Sustainability in Higher Education - Trends and New Developments in Leadership, Academics and Operations, 2nd edition. National Wildlife Federation, Reston, VA, 2008. <http://www.nwf.org/campusEcology/campusreportcard.cfm>. (last visited: 8.20.08)

<sup>15</sup> Bowers, C. *University Reform in an Era of Global Warming*, 2008. [www.cabowers.net/pdf/Final-7chureform%20\(1\).pdf](http://www.cabowers.net/pdf/Final-7chureform%20(1).pdf). (last visited: 8.20.08)

<sup>16</sup> [http://www.greencampus.harvard.edu/about/documents/green\\_universities.pdf](http://www.greencampus.harvard.edu/about/documents/green_universities.pdf). (last visited: 8.20.08)

<sup>17</sup> Campus Environment 2008: A National Report Card on Sustainability in Higher Education - Trends and New Developments in Leadership, Academics and Operations, 2nd edition. National Wildlife Federation, Reston, VA, 2008.

# Appendix to “The Sustainability Movement in Higher Education: An Overview”

## Appendix A. AAAS Involvement in Sustainability Science contributed by Sarah Banas

As a society dedicated to collaboration across scientific disciplines, AAAS has a legacy of engaging its members in issues surrounding sustainability. Starting with its coverage of the World Commission on Environment and Development (Brundtland Commission) in 1983, the AAAS flagship journal *Science* has published hundreds of news items, editorials, and reports on sustainability. Several AAAS presidents have also identified sustainability as a key component of their presidency. Most recently, John Holdren (Harvard Kennedy School) chose “Science and Technology for Sustainable Well-being” as the theme for the 2007 AAAS Annual Meeting.

Sustainability is also a common theme throughout AAAS’ program activities. In addition to the Roger Revelle Fellow in Global Stewardship, as many as a quarter of the AAAS Science and Technology Policy Fellows are involved in an *ad hoc* sustainability group. The Center for Science, Technology, and Congress regularly tracks climate change policy and has held briefings on such topics as biofuels, adaptation, and mitigation. Sustainability has also been incorporated in the Education Directorate, including the creation of a new K-12 curriculum guide on teaching climate change.

More recently, AAAS has created a Center for Science, Technology, and Sustainability to bring together scientists and engineers from developed and developing countries to address fundamental science and technology issues at the nexus of social and environmental development. A key activity of the Center is the Forum on Science and Innovation for Sustainable Development (<http://sustainabilityscience.org>), an online network highlighting important programs, resources, and events, and linking scholars, managers, and decision makers interested in conducting and applying science and technology to support a sustainability transition. Traffic to the website has tripled over the past year, attracting on average over 400 visitors a day. Over 40% of these visitors are international.

Another ongoing project for the Center is a review of university-based science and technology for sustainability (“sustainability science”) programs aimed at stimulating dialogue on how such programs might develop and interact, not only in the U.S., but globally. In late 2006, AAAS invited program directors to submit information about their program’s structures, goals, and their respective challenges and successes. The 49 responses received by mid-January 2007 formed the basis for a Roundtable discussion at the AAAS 2007 Annual Meeting in February, which covered approaches to tackling common challenges that confront sustainability science programs. These challenges included working across academic units to integrate natural and social science research; obtaining funding to support faculty research and studentships; designing curriculum; and maintaining academic rigor. A complete list can be found in the summary of the survey results, available for download at: <http://sustainabilityscience.org/content.html?contentid=1484>. A discussion at the 2008 Annual Meeting focused on additional strategies for collaboration between these universities, including linking Fellows and exchanging research methodologies. As an outcome of this discussion, a special section on fellowship opportunities was added to the Sustainability Science forum (see:

<http://sustainabilityscience.org/opportunity.html?Type=JU>), and a handful of universities have begun discussions about establishing a summer seminar to link their fellows. This discussion will continue at the 2009 AAAS Annual Meeting in Chicago in February 2009.

The Center also coordinates activities with AAAS affiliates and friends. Center staff serve as a co-convenor for the Disciplinary Associations Network for Sustainability (DANS, featured in another of these appendices), sit on the National Academies' Roundtable on Science and Technology for Sustainability, and serve on the Advisory Council for the Association for the Advancement of Sustainability in Higher Education (AASHE). This year, the Center also joined as a member of the Engineers Forum on Sustainability, a group comprised of the major engineering association that has been meeting regularly for the past 10 years to share information as a means to promote the principles and practice of sustainability within their membership.

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## Appendix B.

# Disciplinary Associations Network for Sustainability

[www.aashe.org/dans](http://www.aashe.org/dans) contributed by Debra Rowe

The Disciplinary Associations Network for Sustainability (DANS) is an informal network of professional and disciplinary associations collaborating to advance sustainability education. The mission of DANS includes “helping higher education exert strong leadership in making education, research, and practice for a sustainable society a reality.” More specifically, DANS participants have included in its mission the following statements.

“We commit to facilitating the following actions in support of education for sustainable development:

1. *Support sustainability within the disciplines* – e.g., creating venues (e.g., conferences, journal issues, grants, etc.) for sustainability-oriented research; and providing curricular and pedagogical resources for faculty to incorporate sustainability into their teaching;
2. *Support sustainability across the disciplines* – e.g., fostering relationships and collaborating with other disciplines and specialties to create meaningful opportunities for cross-fertilization of ideas and problem-solving around sustainability;
3. *Support sustainability beyond the academy* – e.g., engaging with policy-makers, non-academic NGOs, and the public in an effort to foster sustainability literacy; and supporting members who choose to take a public role in promoting the transition to a sustainable society;
4. *Practice institutional responsibility* – e.g., taking action to produce positive environmental, social, and economic impacts of our organizational activities;
5. *Adopt sustainability as a value* – e.g., communicating our support for sustainability in the academic disciplines to our members; creating a discourse within our organizations about the significance of sustainability to our discipline (and vice-versa).”

The DANS Network was formed in May of 2006 by the U.S. Partnership for Education for Sustainable Development ([www.uspartnership.org](http://www.uspartnership.org)). DANS now has 37 member associations, listed on the 3<sup>rd</sup> page. It functions as an informal network of about fifty individuals, all of whom are staff members at these associations. Through member publications, electronic communications, professional development opportunities for member, their association websites and the DANS website, and information sent to higher education and general media outlets, the participating associations are informing their constituents about available sustainability resources and how to become involved. College and university faculty and staff are invited to include sustainability in their teaching, curricula, academic assignments, campus activities, and civic and community partnerships.

The DANS network and its facilitators are using diffusion of innovation theory to encourage and support positive change. Diffusion of innovation theory acknowledges that, in any large change effort, there are innovators, early adopters, secondary adopters, and laggards, and that the norms of behavior shift once a substantial portion of the secondary adopters adopt the innovation.

This encouragement of sustainability education has led to sustainability resolutions passed by disciplinary associations (e.g. American Psychological Association, American Academy of Religion), articles by higher education leaders calling upon their association’s membership to do more with sustainability education (e.g. American Association for the Advancement of Science), multiple articles in the higher education press and the general media (e.g. *Chronicle of Higher Education*, *Inside Higher Education*, *Newsweek*, *NBC Nightly News*), keynote speakers at national conferences on the need for sustainability education (e.g. American Studies Association, National Association of Biology Teachers), a resolution passed by DANS participants to include sustainability content and concepts in the next revision

of textbooks, and the posting of resources on sustainability education on the DANS and participant associations' websites.

Within the DANS network, we are engaging professional associations in initiating sustainability taskforces to create more professional development opportunities and conference themes for sustainability, and making informational resources on sustainability education easily available. A review of a collection of sustainability-related activities from our DANS participants demonstrated that over two-thirds of the disciplinary associations are taking the initiative to include sustainability-related information in one or multiple forms with their members. Within our DANS working groups, we use systems thinking to identify and set as high priority what we call "system shifting projects" that can rapidly promote positive change for a sustainable future, such as working with textbook publishers and authors to include sustainability in the next revisions of the textbooks. We have seen successful inclusion of sustainability into textbooks in business disciplines, psychology, chemistry and math. We keep DANS participants and both the general and the higher education media informed about advancements through our website and its resources pages ([www.aashe.org/dans](http://www.aashe.org/dans)) and well as through periodic updates and national conference calls. DANS has developed a Sustainability Fellows program that is designed to increase the hours available from each association to devote to sustainability-related activities and initiatives. The first round of Fellows will be selected in this coming year (<http://www.aashe.org/dans/EducationFellowsProgram.php>).

There is much more work to be done to make the teaching of sustainability part of the professional norm and standards within disciplines. Yet, some professional disciplines have already set the precedents of establishing the teaching of sustainability as part of their professional and accreditation norms, *e.g.* engineering, architecture, and interior design. Many associations are moving forward with developing materials that can be used within the discipline as well as shared across disciplines (see the resources page of DANS for examples.) We are beginning to look to other countries such as Sweden for more advanced implementation of sustainability education.

Success will be attained when:

- there is a societal norm that students and the general public as well as higher education professionals and educators are aware of our societal and global sustainability challenges and are engaged in the solutions;
- wherever appropriate, curricular materials and textbooks integrate sustainability concepts and content;
- the professional norm and promotional criteria for academic professionals reflect an understanding of and engagement in sustainability;
- standards and accreditation criteria reflect the above;
- our societal and organizational policies reflect our sustainability challenges and our ongoing commitment to simultaneously create the triple bottom line of healthier ecosystems, social systems and economies.

### **Participating organizations in DANS:**

The following organizations have identified at least one staff person to participate in quarterly conference calls, attend periodic in person meetings, take resources back to members (via publications, electronic communications, or conference activities) and share progress within the association with the other DANS participants.

American Academy of Religion  
American Anthropological Association  
American Association for the Advancement of Science  
American Association of Colleges for Teacher Education  
American Chemical Society  
American Institute of Biological Sciences  
American Marketing Association

American Philosophical Association  
American Political Science Association  
American Psychological Association  
American Society for Engineering Education  
American Society of Civil Engineers  
American Society of Mechanical Engineers  
American Sociological Association  
American Studies Association  
Aspen Institute  
**Association for the Advancement of Sustainability in Higher Education (cross-sector association)**  
Association for the Study of Literature and the Environment  
Association of American Colleges and Universities  
Association of Collegiate Schools of Architecture  
Association of University Leaders for a Sustainable Future  
Association to Advance Collegiate Schools of Business International  
Broadcast Education Association  
College Student Educators International  
Computing Research Association  
Ecological Society of America  
International Society for Ecological Economics  
Mathematical Association of America  
National Association of Biology Teachers  
National Council for Science and the Environment  
National Humanities Alliance  
National Women's Studies Association  
Society for College and University Planning  
The National Academies, Division on Earth and Life Studies  
The National Academy of Science  
U.S. Partnership for Education for Sustainable Development  
U.S. Society for Ecological Economics

**Related national networks:**

**The Higher Education Associations Sustainability Consortium** is a parallel network of broader higher education associations. ([www.aashe.org/heasc](http://www.aashe.org/heasc))

**The American University and College Presidents' Climate Commitment:** over 500 college and have joined in a high-visibility effort to address global warming by garnering institutional commitments to neutralize greenhouse gas emissions, and to accelerate the research and educational efforts of higher education to equip society to re-stabilize the earth's climate. ([www.presidentsclimatecommitment.org](http://www.presidentsclimatecommitment.org))

*For more information contact:*

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Appendix C.  
The Association for the Advancement of Sustainability  
in Higher Education's (AASHE)  
Leadership for Curriculum Change Workshops  
contributed by Geoffrey Chase and Peggy Barlett

Since 2005 the Association for the Advancement of Sustainability in Higher Education (AASHE) has been offering workshops on Leadership for Curriculum Change. These workshops, offered by Peggy Barlett (Professor, Anthropology, Emory University) and Geoff Chase (Dean, Undergraduate Studies, San Diego State University), are aimed at helping faculty members at colleges and universities throughout the country develop the skills and abilities to lead sustainability-oriented curriculum change workshops on their own campuses. Growing out successful curriculum change projects led by Chase at Northern Arizona University (the Ponderosa Project) and Barlett at Emory University (the Piedmont Project), the Leadership for Curriculum Change project is based on the assumption that sustainability is tied to every discipline and that it needs to be integrated throughout curriculum. These workshops are also predicated on the assumption that faculty have purview over the curriculum and that, therefore, they are the best positions to determine how to change courses and programs to help students acquire the background knowledge, skills, and abilities that will enable them to contribute to a more sustainable world.

Over the last three years more than 180 faculty members have taken part in these AASHE-sponsored workshops and have gone back to their own campuses to work with their colleagues to develop projects that integrate sustainability into a wide range of courses. Coming from a wide range of public private, two-year, and four-year colleges and universities, these faculty are now working collectively with hundreds of faculty who are integrating sustainability into general education, major, and interdisciplinary programs. Feedback from workshop alumni indicate that active "sustainability-across-the-curriculum" initiatives are under way on at least 30 individual campuses. And, the Curriculum for the Bioregion initiative at The Evergreen State College involves 32 colleges and universities in the Puget Sound bioregion.

Two-day workshops are offered twice a year, once in San Diego, California, and once in Atlanta Georgia, and continue to receive more applications than can be accommodated. The workshops model intellectually exciting and inviting strategies for introducing the field of sustainability to a diverse faculty audience. They also create occasions for participants to explore how to implement similar workshops and curriculum-change-initiatives on their home campuses. While these workshops have been very successful, AASHE recognizes that there are other ways of acknowledging what is already being taught in the curriculum and that we need to consider how learning outcomes related to sustainability can help us and our students.

Consequently, at a strategic planning session in August 2008, the AASHE board and staff developed the ambitious goal that 10% of all courses taught at each college and university in the United States by 2011 will address the interaction among social, environmental, and economic issues as they relate to real world problems.

AASHE has also established a curriculum working group that will convene at its national meeting in Raleigh, North Carolina in November 2009 to establish mechanisms through which this goal can be achieved, as well as to brainstorm about other ways in which sustainability can be integrated into a broad range of courses throughout the disciplines.

## Appendix D.

### The Educated Citizen and Public Health: Recent Public Health Initiatives in Undergraduate Education

contributed by Susan Albertine, AACU

The Educated Citizen and Public Health initiative serves the broader higher education community, making the case for integrative public health study within undergraduate education. Until recently such programs of study have been relatively uncommon.

The initiative intends to foster curricular and co-curricular program development for undergraduates across all institutional types and to present this work within a comprehensive liberal education framework. It simultaneously aims to fulfill the recommendation of the Institute of Medicine (IOM) (made in 2003) that "...all undergraduates should have access to education in public health." This is a call for an educated citizenry capable of responding to the world's growing array of health challenges. The initiative is a cooperative effort of undergraduate, arts and sciences, and public health educational organizations, including the Association of American Colleges and Universities (AAC&U), the Council of Colleges of Arts and Sciences (CCAS), the Association for Prevention Teaching and Research (APTR), and the Association of Schools of Public Health (ASPH). The Centers for Disease Control and Prevention (CDC) have observed, participated, and given support for publications and a faculty development program. The American Public Health Association (APHA) has observed, participated, and urged its affiliates in the field to join the effort. APTR includes membership and leadership from all major health professions. The initiative intends to connect and inform, to bring undergraduate study of integrative public health to all baccalaureate institutions, to foster interdisciplinary and inter-professional collaboration, and to link to other initiatives that address human health and environmental sustainability.

The Educated Citizen and Public Health has been developed in alignment with the Liberal Education and America's Promise (LEAP) initiative of AAC&U, the signature campaign of the association. LEAP aims to transform undergraduate education for the 21<sup>st</sup> century and to raise the level of college student achievement to meet the demands of a volatile economy and globally interdependent world.

The Institute of Medicine call for access to public health education has influenced long- and short-term goal setting. The concept was initially developed by an inter-professional curriculum task force organized by APTR—the Healthy People Curriculum Task Force. The group decided to reach out to the arts and sciences through CCAS. The task force recognized that the roughly 100 accredited public health programs and schools could not alone bring about such change, nor could the health professional schools on their own. Hence their decision to aim for an educated citizenry, for *all* students, rather than to focus on pre-professional education.

This line of thinking emerges alongside growing interest among health professions' educators to introduce prevention of illness as a viable model for learning rather than relying heavily on models founded on treatment of disease. As evidence-based practice and emphasis on prevention have begun to reshape health professional education, outreach to undergraduate education as a whole, to baccalaureate liberal education, is a logical next step.

At the highest level, then, success for the initiative would be signaled by exponential growth of undergraduate programs and activities, curricular and co-curricular, toward an educated citizenry, developed in parallel with curricular reform of graduate and professional

education. Communication and collaboration between the arts and sciences and professional schools should become more frequent through the interdisciplinarity this initiative fosters. Admissions to graduate and professional programs should eventually evolve to endorse and embrace the interdisciplinarity of undergraduate public health study. The MCAT, for example, may be influenced to change as a result (a leader of the initiative is on an MCAT review committee).

Undergraduate public health should, we intend, also appear as an item or items in the national agenda for health, organized decennially by the Department of Health and Human Services. Healthy People 2020 is now being drafted; undergraduate public health education will be included for the first time.

Outreach to public health professionals through the Centers for Disease Control and Prevention (CDC), recommended by the initiative and endorsed by APHA, would be another excellent outcome. Leaders expect to see benefits to undergraduate students for service learning in local health agencies and benefits to the agencies themselves. More, the many public health agencies and affiliated organizations may be brought into partnership with liberal arts colleges and regional universities that may have no allied health units or faculty with advanced degrees in public health.

We have approached the IOM to discuss plans for another IOM roundtable, yet another excellent outcome. The discussion was preliminary; the roundtable would require significant funding.

The Josiah Macy, Jr. Foundation has awarded AAC&U a grant to survey current efforts and activities in undergraduate public health. AAC&U and ASPH are collaborating on a needs assessment to determine the best ways to support the development and expansion of undergraduate public health curricula in colleges and universities. Much of our strategy will depend on the results of the survey and focus group responses.

Leaders have sought to create a highly engaging interdisciplinary initiative of great social value and to spread the concept and share resources as freely and widely as possible. Leadership has been nimble, responsive, and fluid, launching ideas and following up with communication and outreach. Frankly, at first the leaders had no idea how to launch any such large effort. The first organized meeting was a consensus conference, a known activity in the health professions, but not usual practice within the arts and sciences. Then we discovered we were riding a wave, as participants found common ground and made possible our first publication. In the last year we have begun to learn as a network of leadership how to move forward, intentionally, a decentralized, loosely coordinated collaboration with no full time staff. Four staff members at AAC&U include work on this initiative as part of their assignments (one of these part-time on grant funding).

We have not yet sought major funding for administration. We have used limited and targeted funding for professional development institutes and for printing and distribution of curricular materials offered free of charge. Following other successful grassroots movements, we have relied on the intrinsic interest and social currency of the ideas and vision. We would be the first to admit astonishment at our success.

## **Related and/or Supporting Organizations and Initiatives (not mentioned above)**

Association for General and Liberal Studies (AGLS); Community-Campus Partnerships for Health: <http://www.ccph.info/>; PERC: Prevention Education Resources Center: <http://www.teachprevention.org/>;

Project Kaleidoscope (affiliated with AAC&U); Bringing Theory to Practice (affiliated with AAC&U)

## Unaffiliated Projects (Potential Convergence Initiatives)

United Nations Population Fund: [www.unfpa.org](http://www.unfpa.org); SENCER; Council on Undergraduate Research (CUR)

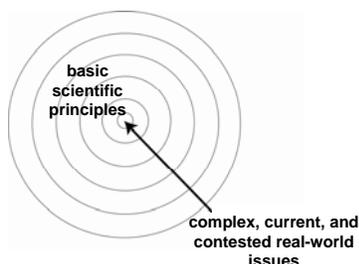
## **Selected Resources and Publications**

- The Curriculum Guide to Undergraduate Public Health Education, version 3.0 is available for feedback through APTR at [www.teachpublichealth.org](http://www.teachpublichealth.org), CCAS at [www.ccas.net](http://www.ccas.net), and AAC&U at [www.aacu.org](http://www.aacu.org). The Recommendations for Undergraduate Public Health Education are also available at <http://www.aptrweb.org/resources/pdfs/Recommendations.pdf> and at [www.aacu.org](http://www.aacu.org)
- *Morbidity and Mortality Weekly Report* CDC publication of “essential findings” of the Consensus Conference on Undergraduate Public Health Education, October 19, 2007 The full consensus conference report is available through CCAS at [www.ccas.net](http://www.ccas.net)
- CDC Podcast on undergraduate public health education with Dr. Julie Gerberding, Director of CDC, available at <http://www2a.cdc.gov/podcasts/player.asp?f=8696>
- *Inside Higher Education*: Epidemiology as an Undergraduate Mainstay <http://www.insidehighered.com/news/2007/11/07/health>
- *Liberal Education*: AAC&U “Back to the Pump Handle: Public Health and the Future of Undergraduate Education” Albertine S, Persily NA, and Riegelman.R [http://www.aacu.org/liberaleducation/le-fa07/le\\_fa07\\_perspectives1.cfm](http://www.aacu.org/liberaleducation/le-fa07/le_fa07_perspectives1.cfm)
- *American Journal of Preventive Medicine-APTR* September 2008 Theme issue on undergraduate public health education [www.ajpm-online.net](http://www.ajpm-online.net).
- *Washington Post*- For a Global Generation, Public Health Is a Hot Field front page September 18, 2008 <http://www.washingtonpost.com/wp-dyn/content/article/2008/09/18/AR2008091804145.html?hpid=topnews>

## Appendix E.

### The SENCER Initiative: Science Education for New Civic Engagements and Responsibilities contributed by Cathy Middlecamp with Danielle Kraus

Launched in 2000, SENCER (Science Education for New Civic Engagements and Responsibilities) is a national undergraduate curriculum reform initiative funded by the CCLI program of the National Science Foundation. Its mission is to “apply the science of learning to the learning of science, all to expand civic capacity.” Through faculty development workshops, model curricular examples, and small grants to campuses, SENCER aims to: (1) get more students interested and engaged in learning in science, technology, engineering and mathematics (STEM) courses, (2) help students connect STEM learning to their other studies, and (3) strengthen students’ understanding of science and their capacity for responsible work and citizenship.



**Figure 1.**

Figure 1 represents the SENCER approach, one that positions the learner in the real world and teach scientific principles through complex, unsolved problems of civic consequence. SENCER Summer Institutes, regional workshops, and on-line resources enable faculty members to develop these problem-centered approaches to science teaching. More than 300 faculty members from 330 campuses have participated in SENCER programs, and over 100 people are serving as SENCER Fellows, Senior Associates, or Senior Scholars.

In terms of adaption and adoption, this project has accomplished much in a reasonably short time frame. For example, instructors involved in SENCER have made available to the wider education community over 35 model SENCER courses. Course topics include “Coal in the Heart of Appalachian Life,” “Environment and Disease,” “Nutrition and Wellness,” “Addiction: Biology, Psychology, and Society,” “Global Warming,” and “The Power of Water.” SENCER scholars also have published background papers on key issues and have launched a new international journal, *Science Education and Civic Engagement* (<http://www.secej.net>). All of these (and more) are documented on the SENCER web site, [www.sencer.net](http://www.sencer.net) and also housed in the digital library at <http://serc.carleton.edu/sencer/index.html>.

No “theories of change” have been formally articulated as part of the SENCER project. However, given the initiative’s activities to date, such theories can be inferred. Clearly, the project has set as a goal to create high quality professional development experiences for faculty members, course materials and resources, presumably with the change strategy “if we build it, they will come.” SENCER is about more than materials production, however. The intellectual content of this project is high and in and of itself presents a compelling vision. Papers produced by SENCER, notably David Burns’ “Knowledge to Make Our Democracy”

(<http://www.sencercer.net/About/pdfs/KnowledgeToMakeOurDemocracy.pdf>) underlie both the project's approach and the urgency of making changes that will benefit not only our students, but also the larger society.

What would success look like to those in the SENCER community of practitioners and scholars? One way to answer this question is to examine the set of principles that lie at the heart of the project. These principles, the “SENCER Ideals,” speak to both the pedagogy and content of SENCER courses (Table 1). SENCER courses invite students (as well as their instructors) to engage in the complex social issues that locally, regionally, and globally face us today. Although the project was initially conceived for students with majors other than science, technology, engineering, and mathematics, members of the SENCER community have also begun to apply these ideals to STEM majors' courses and pre-service teacher education. Success includes the continued expansion of the SENCER approach in these areas. Although none of these efforts specifically call out sustainability, nonetheless the course reform work accomplished to date has many connections to the imperative of healthy communities and to choices we make for living on the planet today and tomorrow. Success for SENCER courses inevitably also would lead to more informed citizens in our nation, prepared to grapple with complex issues for which scientific knowledge plays a key role in the decision-making process.

**Table 1. The SENCER Ideals**

Source: <http://www.sencercer.net/About/pdfs/SencercerIdeals.pdf>

- SENCER robustly connects science and civic engagement by teaching “through” complex, contested, capacious, current, and unresolved public issues “to” basic science.
- SENCER invites students to put scientific knowledge and scientific method to immediate use on matters of immediate interest to students.
- SENCER helps reveal the limits of science by identifying the elements of public issues where science doesn't help us decide what to do.
- SENCER shows the power of science by identifying the dimensions of a public issue that can be better understood with certain mathematical and scientific ways of knowing.
- SENCER conceives the intellectual project as practical and engaged from the start, as opposed to science education models that view the mind as a kind of “storage shed” where abstract knowledge may be secreted for vague potential uses.
- SENCER seeks to extract from the immediate issues, the larger, common lessons about scientific processes and methods.
- SENCER locates the responsibility (the burdens and the pleasures) of discovery as the work of the student.
- SENCER, by focusing on contested issues, encourages student engagement with “multidisciplinary trouble” and with civic questions that require attention now.
- By doing so, SENCER hopes to help students overcome both unfounded fears and unquestioning awe of science.

Originally affiliated with the Association of American Colleges and Universities, SENCER now has its home in the National Center for Science and Civic Engagement at the Harrisburg University of Science and Technology. David Burns, who with Karen Oates was the initial architect of the project, is the Director and Principal Investigator. A growing group of SENCER alumni have received external grant support from organizations such as the Teagle Foundation, the NSF, and NIH to support the continuing development of work begun with SENCER. Most recently, SENCER alumni from Harold Washington College, Roosevelt University, and Kapi'olani Community College received grants from the NSF and NIH.

## Appendix F.

### Center for Sustainable Engineering

contributed by Jean MacGregor, with Cliff Davidson, Carnegie Mellon University

Carnegie Mellon University (Cliff Davidson), the University of Texas at Austin (David Allen), and Arizona State University (Brad Allenby) established the Center for Sustainable Engineering in 2005, supported by the National Science Foundation and the Environmental Protection Agency. Sustainable Engineering may be defined as engineering for human development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Bruntland Commission, 1987). The Principal Investigators believe that this is the only project of its type in the United States.

As the global population grows and standards of living improve, there will be increasing stress on the world's limited resources. Thus engineers of the future will be asked to use the earth's resources more efficiently and produce less waste, while at the same time satisfying an ever-increasing demand for goods and services. To prepare for such challenges, engineers will need to understand the impact of their decisions on built and natural systems, and must be adept at working closely with planners, decision makers, and the general public. Sustainable Engineering emphasizes these and related issues.

Examples of Sustainable Engineering include:

- Using methods that minimize environmental damage to provide sufficient food, water, shelter, and mobility for a growing world population
- Designing products and processes so that wastes from one are used as inputs to another
- Incorporating environmental and social constraints as well as economic considerations into engineering decisions

The goal of the Center is to develop and implement activities to enhance education in Sustainable Engineering at colleges and universities around the world. A number of specific activities are under way:

1. Summer workshops (2 days in length) are being offered to assist engineering faculty (from across the engineering specializations) who wish to add Sustainable Engineering to their courses. The workshops help participating faculty members improve their teaching, evaluate their courses, obtain funding for educational innovations, and become part of a growing network of educators in Sustainable Engineering. Cliff Davidson reports that most faculty members attend as individuals; a few come in pairs. They largely represent the fields of civil and environmental engineering, with much smaller numbers from mechanical and chemical engineering and materials science. To date, 90 faculty members have participated in these workshops.
2. A website is being established with peer-reviewed educational materials on Sustainable Engineering. <http://www.csengin.org/index.html>
3. An assessment of Sustainable Engineering programs and courses around the U.S. is being conducted to benchmark the status of education in this emerging discipline. To determine the status of sustainable engineering education at four-year colleges and universities in the U.S., the Center will collect information on courses and curricula, sustainability centers and institutes, conferences related to sustainability, and other activities related to Sustainable Engineering. To the extent possible, all 1500 accredited engineering programs and departments in the U.S. will be assessed. Detailed information about the content of courses will be obtained, such as the key concepts, types of educational activities, and written materials. In addition, a number of practicing engineers in the U.S. will be contacted to help identify sustainable engineering skills needed by graduates as they begin to practice their profession. This assessment will be completed in late fall or winter (2008-09).