AC 2009-524: THE CENTER FOR SUSTAINABLE ENGINEERING: WORKSHOPS AND THE ELECTRONIC LIBRARY

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Center for Sustainable Engineering: Workshops and the Electronic Library

The Center for Sustainable Engineering (CSE) is a consortium that includes Carnegie Mellon University, the University of Texas at Austin, and Arizona State University, established in 2005 with support from the National Science Foundation and the Environmental Protection Agency. The mission of the CSE is to assist engineering educators in the U.S. as they make the transition to a new engineering paradigm that espouses the concept of sustainability. Numerous definitions exist for this and related concepts; perhaps the most commonly cited definition is for Sustainable Development as given by the Brundtland Commission, namely "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Today we often use a three-pronged definition that calls for economic, environmental, and social sustainability, where sustainability in all three dimensions is necessary to ensure that the needs of future generations will be met.

The CSE has conducted four workshops (two in 2006, two in 2007) for engineering professors to help them enhance the sustainability content of their courses. Two more workshops have been scheduled for summer 2009. There has also been one planning workshop held in 2008 to discuss the long-term goals of the Center. In addition, the CSE Electronic Library has been established for peer-reviewed educational materials that are accessible at no cost to engineering educators around the world. In this paper, we discuss the four faculty workshops in 2006-7, evaluations of these workshops, and the Electronic Library. For additional information, the reader is referred to Davidson et al.[1]

Workshops

Each workshop has roughly 30 faculty member participants plus another 15-20 individuals including speakers, staff members, and graduate student assistants. The demographics of the workshop participants are shown in Table 1. For 2009, the Table lists expected participants who have been accepted at this year's summer workshops. Note that the participants are roughly evenly divided between untenured and tenured faculty, and that there are a substantial number of women attendees. The Minority column provides the number of Black and Hispanic attendees.

Table 1. Information on workshop participants.

Year of Workshops	Tenured	Untenured	Male	Female	Minority
2006	28	33	44	17	4
2007	28	30	39	19	5
2009	28	35	40	23	5

The workshops include plenary sessions as well as breakout group discussions, and the topics covered have been similar although not identical in all of the workshops. Prior to the workshop, each accepted participant must submit a syllabus for a course they teach in which they are planning to incorporate material on Sustainable Engineering (SE). These courses then become

part of the discussion at the workshop, so that topics discussed at the workshop can be applied to real courses rather than being discussed in abstract.

The sessions planned for the 2009 workshops are as follows. After an introduction defining the workshop goals at the first session on Day 1, there is a discussion on "What is Sustainable Engineering?" and then a panel that addresses how engineering programs at colleges and universities around the U.S. have been implementing Sustainable Engineering (SE) into their curricula. This is followed by a talk on introducing SE into a large freshman course.

The afternoon begins with breakout groups on four topics chosen on the basis of participant interests. In past years, these topics have included Energy, Green Buildings, Industrial Ecology, Infrastructure, Materials and Manufacturing, Transportation, and Water Resources. Members of each group discuss elements of SE programs and courses they are familiar with, e.g., at their home institutions, and the group identifies best practices among those discussed. The groups then reconvene in a plenary session, and a member of each group presents their best practices. This is followed by open discussion.

A session on Developing Learning Objectives in Sustainable Engineering is held next. The workshop divides into the same breakout groups after this session, and each member presents his or her syllabus and plans to incorporate SE into the course. Then there is open discussion within the group, and suggestions are made for each course. The groups reconvene in a plenary session at the end of the day, and instructions are given for overnight "homework": each participant is asked to develop learning objectives for his or her course, based on the guidelines given in the session on learning objectives, and based on suggestions made in the breakout group discussions.

Day 2 begins with brief presentations of learning objectives completed overnight from two members of each group with particularly effective learning objectives, a total of eight presentations, followed by open discussion. These presentations are followed by discussion on what made these learning objectives effective, and suggestions on what all participants can do to develop outstanding learning objectives.

The workshop then turns its attention to tools used by engineers in practicing SE, such as material and energy flows and balances, carbon calculators, and life cycle assessments (LCA). A session briefly introduces these tools and focuses on different methods of conducting LCA, along with presentation of LCA software available for use in engineering classes.

The workshop divides into the same breakout groups as before, and each group discusses SE tools and especially LCA. The group agrees on ways in which these tools can be used in their topic area. The groups then reconvene, and a representative from each group presents the suggestions for the benefit of the full workshop.

In the final two sessions, there is a discussion of funding opportunities for education and research in SE, followed by a tutorial on contributing to and using educational materials in the CSE Electronic Library. A summary of the key points throughout the workshop is then presented, followed by time for written evaluations by all workshop participants.

Faculty members from well over 100 colleges and universities have participated in these workshops, with a distribution from across the country. Figure 1 shows the locations of

institutions where at least one faculty member has participated in a CSE workshop. The institutions are listed below the Figure; these include institutions of faculty members who came to workshops in 2006 or 2007, as well as those accepted for the 2009 workshops.

Evaluations

Each workshop has been evaluated using anonymous surveys distributed at the end of each day. Participants were asked to rate each workshop session as "Very Valuable," "Moderately Valuable," "Minimally Valuable," and "Not Valuable," with scores of 4, 3, 2, and 1, respectively. In addition, participants were asked to provide comments on the most useful aspects of the day's workshop sessions and on what sessions could be modified or improved. Finally, participants were asked to rate the overall workshop from several perspectives. These included the extent to which the workshop facilitated (a) sharing of ideas, materials, and methods, (b) developing learning objectives in SE, (c) networking with others interested in SE, (d) clarifying understanding of the field of SE, and (e) expanding teaching in SE. The rating categories were "A Great Deal," "Some," "A Little," and "Not At All," with scores of 4, 3, 2, and 1, respectively.

At the time of this writing, scores have been summarized only for the 2007 workshops. For evaluations of the workshop sessions, the individual sessions had scores ranging from 2.8 ± 0.70 to 3.8 ± 0.58, with an overall average of 3.4 ± 0.23. This means the average session was rated between "Moderately Valuable" and "Very Valuable." The comments from participants were generally quite positive, with a number of constructive suggestions for improvement. For evaluations of the overall workshops, the average score was 3.3 ± 0.35, indicating that the average extent to which the workshop facilitated the various activities was between "Some" and "A Great Deal."

Electronic Library

The intention of establishing the Electronic Library is to enable high quality education materials to be available at no charge to engineering educators around the world. All submissions to the Electronic Library are subjected to peer review, much the same as articles submitted to research journals. The submissions can include class handouts, lecture notes, homework assignments, projects, educational software, and other types of educational materials.

The Electronic Library has only recently been established. To date there are thirty modules posted, with many more out for review. This repository is part of the Engineering Pathway website of the University of California at Berkeley. All of the modules can be accessed through the CSE website at http://www.cse.org, or through the Engineering Pathway website at http://www.engineeringpathway.com by selecting Advanced Search followed by Higher Education Search, and choosing the Center for Sustainable Engineering collection.

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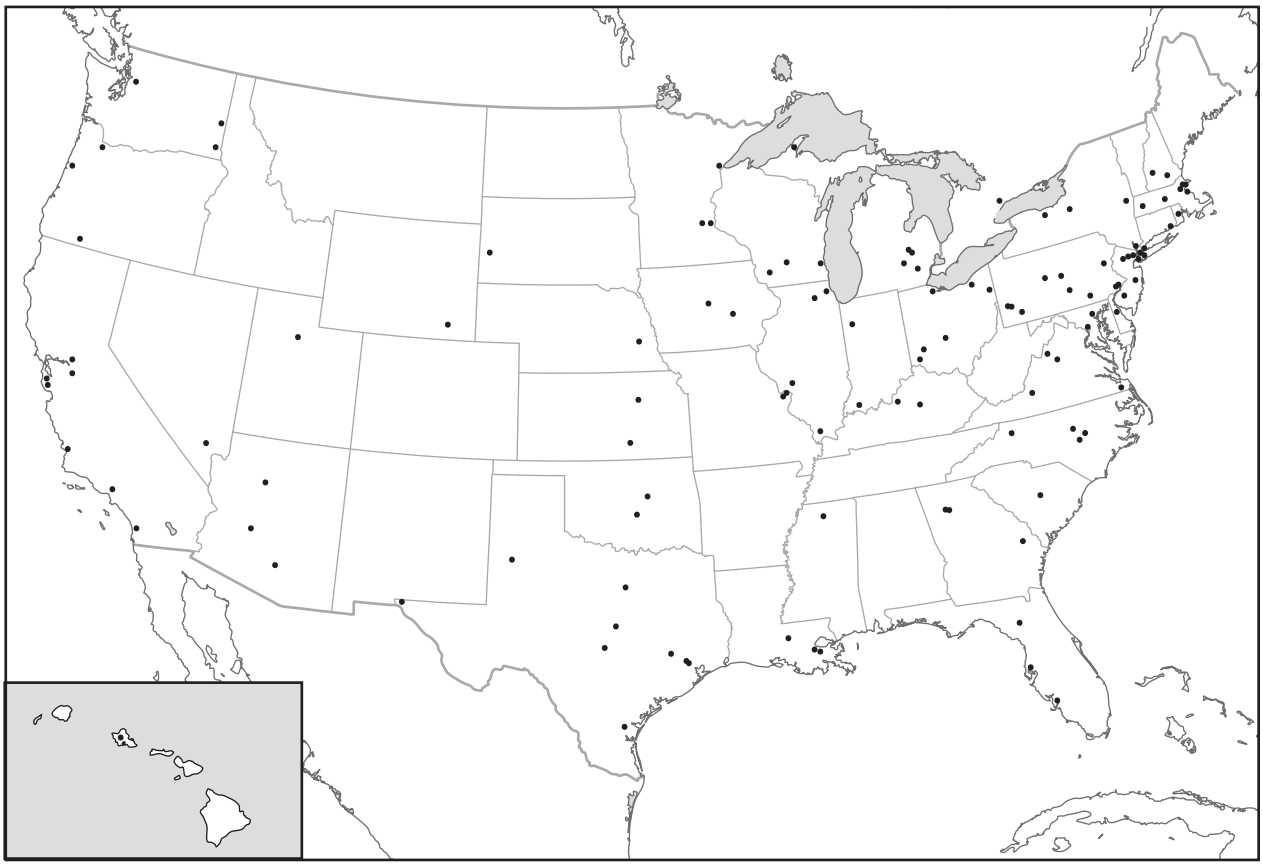
does not necessarily reflect the views of the agency, and no official endorsement should be inferred.

Literature Cited:

1. C.I. Davidson; C.T. Hendrickson; H.S. Matthews; M.W. Bridges; B.R. Allenby; J.C. Crittenden; Y. Chen; E. Williams; D.T. Allen; C.F. Murphy, S. Austin, Adding Sustainability to the Engineer's Toolbox: A Challenge for Engineering Educators, *Environmental Science and Technology*, Vol. 41, pages 4847-4850, 2007.

Locations of Institutions with Faculty Members Attending CSE Workshops



Arizona
Arizona State University
Northern Arizona University
University of Arizona

California
California Polytechnic State University
California State University, Sacramento
California State University, Northridge
Santa Clara University
Stanford University
University of California, San Diego
University of the Pacific

Connecticut
U.S. Coast Guard Academy

Delaware
University of Delaware

Florida
Florida Gulf Coast University
University of Florida
University of South Florida

Georgia
Georgia Institute of Technology
Georgia Southern University
Mercer University

Hawaii
University of Hawaii at Manoa

Illinois
Illinois Institute of Technology
Northern Illinois University
Southern Illinois University - Carbondale
Southern Illinois University - Edwardsville

Indiana
Purdue University
University of Evansville

Iowa
Iowa State University
University of Iowa

Kansas
Kansas State University
Wichita State University

Kentucky
University of Kentucky
University of Louisville

Louisiana
Louisiana Tech University
University of New Orleans

Maryland
Loyola College in Maryland
University of Maryland - College Park

Massachusetts
Worcester Polytechnic Institute
Northeastern University
University of Massachusetts
Boston University
Massachusetts Institute of Technology

Michigan
Kettering University
Michigan State University
Michigan Technological University
University of Michigan
University of Michigan, Flint

Minnesota
University of Minnesota, Twin Cities
University of Minnesota, Duluth
University of St. Thomas

Mississippi
University of Mississippi

Missouri
St. Louis University
Washington University

Nebraska
University of Nebraska, Lincoln

Nevada
University of Nevada - Las Vegas

New Hampshire
Dartmouth College
University of New Hampshire

New Jersey
Princeton University
Rowan University
Rutgers University
Stevens Institute of Technology

New York
City University of New York
Manhattan College
Rensselaer Polytechnic Institute
Rochester Institute of Technology
Syracuse University
U.S. Military Academy

North Carolina
Duke University
North Carolina A&T State University
North Carolina State University
University of North Carolina at Chapel Hill

Ohio
Air Force Institute of Technology
Case Western Reserve University
Ohio State University
University of Cincinnati
University of Toledo
Youngstown State University

Oklahoma
Oklahoma State University
University of Oklahoma

Oregon
Oregon Institute of Technology
Oregon State University
Portland State University

Pennsylvania
Bucknell University
Carnegie Mellon University
Drexel University
Elizabethtown College
Lafayette College
Penn State - Main Campus
Penn State - Greater Allegheny Campus
University of Pittsburgh
Villanova University
York College of Pennsylvania

Rhode Island
University of Rhode Island

South Carolina
Clemson University

South Dakota
South Dakota School of Mines

Texas
Prairie View A&M University
Rice University
Texas A&M University, Kingsville
Texas Tech University
Trinity University
University of Houston
University of Texas at Arlington
University of Texas at Austin
University of Texas at El Paso

Utah
University of Utah

Virginia
James Madison University
Old Dominion University
University of Virginia
Virginia Polytechnic Institute

Washington
Gonzaga University
University of Washington
Washington State University

Wisconsin
Marquette University
University of Wisconsin, Madison
University of Wisconsin, Platteville

Wyoming
University of Wyoming

Canada
University of Toronto

Puerto Rico
University of Puerto Rico at Mayaguez
Inter-American University