

## **AC 2009-2438: INDUSTRIAL ECOLOGY AND SUSTAINABILITY: DECIPHERING CORPORATE ENVIRONMENTAL POLICIES**

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## Industrial Ecology and Sustainability: Deciphering Corporate Environmental Policies

Sustainability or sustainable development as the term often appears, is a concept that has evolved over time, but its first significant appearance was in a widely disseminated report published in 1987.<sup>1</sup> Its meaning, though not explicitly defined as such, appeared in Garret Hardin's famous essay "The Tragedy of the Commons" in 1968.<sup>2</sup> Hardin symbolized a common resource that was exploited and eventually consumed by individuals who did not understand that, in the aggregate, a community resource was being destroyed by too many people demanding too much from a declining resource.

By the early 1990's, a newer term, industrial ecology evolved, wherein the interrelationships among industry, environment and society were recognized. The term gained substantial credence when the text *Industrial Ecology* was published first in 1995 followed by a second edition eight years later.<sup>3</sup> Subsequently, the International Society for Industrial Ecology sponsored the publication of a new scientific periodical entitled the *Journal of Industrial Ecology*, starting in 1997. Selected applications of industrial ecology appeared in a special issue of a companion periodical, the *Journal of Cleaner Production*.<sup>4</sup>

As interest in the field developed and grew,<sup>5</sup> the popular press began to take notice and articles appeared in which the term "greening" was a major focus. "Beyond the Green Corporation" was a featured article in *Business Week* in 2007.<sup>6</sup> As corporations began to feel pressure from shareholders and stakeholders to demonstrate their sustainability activities, annual financial reports to the public started to contain information about corporate environmentally related activities. Eventually, this information began to appear in separate annual documents typically called the "Corporate Sustainability Reports" or similarly titled documents. These documents, along with a variety of information about a given corporation, generally appear on a corporation's web site.<sup>7</sup> A book is available which provides an example of one way to quantify a company's sustainability activities, resulting in an overall value called the "Pacific Sustainability Index."<sup>8</sup>

Determining which, if any, of a corporation's activities that are listed in a sustainability report or on a website truly represent sustainable initiatives, can be a challenge. In some cases, a company may claim certain activities which, upon closer scrutiny, do not appear to be substantial. Such questionable corporate actions have become known as "green washing."

Engineers have developed strong interests in sustainable development. Terminology to this effect has been added to the Code of Ethics promulgated by the American Society of Civil Engineers.<sup>9</sup> Engineering approaches to this evolving and expanding field have been chronicled in two documents<sup>10,11</sup> that provide engineers with overviews of the kind of activities in which they can and should participate to facilitate more sustainable practices in engineering and in the global society as a whole.

Given this growing interest in industrial ecology, it is only natural that engineering and science students seek to learn more about the topic, especially in the context of formal academic courses. Students at Yale University and Arizona State University, have the benefits of Professors Thomas Graedel and Braden Allenby, respectively, who built courses utilizing their text content and broad awareness of the growing field. Expanding beyond this important base of initial courses in industrial ecology, students at the University of Florida requested a similar course to prepare them for eventual entry into the evolving field of sustainability, either as a career in itself or in a capacity that blended engineering design along with sustainability.

Using the Graedel and Allenby text as a logical starting place, a course was developed and continues to evolve that combines industrial ecology principles from the text<sup>3</sup> with the contents of corporate sustainability reports and other sources of material that deal with corporate activities in the sustainability arena. Most of the information necessarily comes from publicly available documents due to the inaccessibility or disinterest of some corporate level employees when it comes to responding to inquiries for information. Very useful current business sustainability-related information used to supplement the ongoing course lectures is extracted from a variety of periodicals that are published at daily (*The Wall Street Journal*), weekly (*Business Week*) or biweekly (*Fortune*) frequencies.

The learning objectives for students in the Industrial Ecology course are to learn: (1) concepts of sustainability as they apply to society and corporations; (2) factors and risks that influence sustainability; (3) the thoughts of influential authors through reading a separate book on a course topic and then writing about it in a scholarly way; and (4) good scholarship through preparing a case study [individually or as a member of a small group] which discloses actions that corporations have taken, will take or should take to make themselves more sustainable.

Since industry ecology is billed as the science of sustainability,<sup>3</sup> the course emphasizes corporate sustainability in terms of water resources [availability for corporate needs and concern over not causing contamination], energy resources [energy supply, efficiency, move to alternative energy sources, carbon emissions], and materials availability [mineral resources, emergence of nanomaterials] and management responses to sustainability initiatives [environmental management systems, ISO 14001, life cycle assessments].

Lectures are based on topics originating in the text<sup>3</sup> as well as from the periodical sources indicated above. Students are expected to ask questions based on the assigned readings and are alternatively asked questions in the lecture sessions by the instructor. Interaction in a lecture setting, while not always easily accomplished, keeps the daily interest factor relatively high [end of semester course evaluations have given positive responses to this type of approach; see last paragraph for a summary of typical student responses that have been provided in their anonymous evaluations]. Significant out of class assignments are part of the overall student investment in the course.

Course topics include (1 - 4 lectures per topic are typical); some originate from material in the text; others are the author's original material): Industrial Ecology: The Greening of Corporations; Water Sustainability (Global and Florida); Industrial Product & Process Design; Designing for Energy Efficiency, Environmental Management Systems (Guest Lecturer); Biological Ecology and Technology; Materials, including Nanomaterials (Guest Lecturer); e-Waste and the Status of Resources; Society, Culture, Governments and Laws; Life Cycle Assessments (Guest Lecturer); Energy and Climate Change; Alternate Energy Decision Strategies (Guest Lecturer); Agriculture: Corn, Food and Ethanol); Green Marketing (Guest Lecturer); Endocrine Disruptor Compounds; Elements of Green Engineering; Reading Book Reviews (student presentations based on their outside reading book reviews - see reference footnote 12) and Case Studies (student presentations based on their corporate case studies - see reference footnote 13).

As indicated above, in addition to the required course text, each student is required to read a separate sustainability oriented book and write a review and commentary on it. Depending on the number of lecture periods available near the end of the semester, selected students are asked to provide evaluations of their separate reading books and, where more than one student has selected the same book, a student panel provides feedback to the class. Students have indicated that the separate reading book [chosen from a provided list<sup>12</sup> with opportunity to add new selections to the list] is a valuable aspect of the course and this assignment adds a different learning experience separate and apart from the course lectures and text.

An additional out of class assignment also mentioned earlier involves the preparation of a case study on: a specific industry [Tier 1: 3-4 member student group; two groups selected the following team-based topics: the sugar cane industry and The ExxonMobil Corp. compared with Petrobras. The latter was chosen due to the registration of two Brazilian exchange students this year]; two competing companies within an industry [Tier 2: two students]; and individual companies [Tier 3: individual student].<sup>13</sup> The outcome of the student evaluations of given industry or company sustainability actions [an extensive set of case study preparation guidelines is provided] appears in the form of a written case study document. Further, selected students from each of the three Tiers are asked to present their topics to the entire class. Student feedback in anonymous end of semester course evaluations has shown this exercise to be informative, valuable and an important part of the course. The case studies put corporate sustainability in context of actual corporate actions and more or less tie the various components of the course together. Students also want to show that their "adopted" corporations are more sustainable than their competing companies.

Student feedback at our university consists of anonymous course evaluations that are completed during the last class period in every semester. Students are provided with a double-sided form; side 1 consists of several questions related to their evaluation of the instructor with a final overall score (ranked from 1 (low) to 5 (very high) while side 2 provides the student with an opportunity to respond to questions and provide suggestions for improvement, etc. The forms are returned to the instructor sometime after the

semester grades are posted. Numerical rankings based on the side 1 responses appear on the Provost's web site; the narrative responses are provided only to the course instructor.

Overall, during the past few years, the course instructor has received scores in the range of 4.2 - 4.7 while the course has received ratings in the range of 4.0 - 4.7. Some of the student comments are provided here, either directly or in abridged format: use more current articles and don't use the text; course makes us aware of how we can make a difference and how to promote ecological friendly initiatives in the workplace; provide industry speakers (note - most guest speakers have been from the university faculty, based on their expertise and our geographic location is not convenient to representatives of industry. This year (2009), we did have an officer of a local/regional utility discuss that utility's approach to selecting a new power plant fuel system, etc.); should be a required course (course is presently an elective); guest speakers were great; the course was not so discipline specific so that students not in the instructor's home department could take it and do well, in the absence of specific pre-requisites; instructor should tone down the "political" science and stick to sustainability science, especially in the matter of climate change (note - comment made as the 2008 Presidential campaign was starting to overwhelm the daily news cycle).

Additional comments included: suggest how industries mitigate risks associated with their operations; how can we clean up the EDCs that are polluting waterways; because there is a related engineering design course also taught in the Department, this course is more oriented to engineers from other disciplines and also environmental science students; how can one analyze an industrial system; the selection of outside reading books was good and the text was good; I'll buy from those companies whose case studies demonstrated that they were good sustainable companies.

To summarize - the field of Industrial Ecology is still evolving, despite its 15 - 20 year history. This discipline now includes an international society, at least two important journals fully devoted to the topic and others that carry related content, one or two key texts that embody the principles of the field and an expanding cohort of wide circulation books intended for broader audiences that cover either broad topics or certain specialized aspects of sustainability. Student interest is high; undergraduate major fields are developing as components of university curricula along with undergraduate and graduate program minors which add value to students' major fields of study. There is no question that the future of human societies on the planet demands a dedication to sustainable practices like never before. To the extent that university academic programs can contribute to these present and future oriented activities, a course on industrial ecology is an important addition to a university curriculum.

1. Bruntland, G., et al., World Commission on Environment and Development, *Our Common Future*, Oxford University Press, Oxford, 400 pp. (1987)

2. Hardin, G. "Tragedy of the Commons." *Science*, 162, 1243-1248 (1968).

3. Graedel, T. and Allenby, B. ***Industrial Ecology***, 2nd Ed. Prentice Hall Pearson Education, Inc., Upper Saddle River, N.J., 363 pp. (2003).
4. Korhonen, J., Huisingh, D. and Chiu, A.S.F. "Applications of Industrial Ecology - An Overview of the Special Issue." ***Journal of Cleaner Production***, 12, 803-807 (2004).
5. McDonough, W., Braungart, M., Anastas, P. And Zimmerman, J. "Applying the Principles of Green Engineering to Cradle to Cradle Design." ***Environmental Science & Technology***, 37 (23), 434A – 441A (2003).
6. Engardio P. "Beyond the Green Corporation," ***Business Week***, pp. 50 – 60, January 29 (2007).
7. Coca-Cola Corporation. "2007-2008 Sustainability Review." Atlanta, GA, 65 pp. [http://www.thecocacolacompany.com/citizenship/pdf/2007-2008\\_sustainability\\_review.pdf](http://www.thecocacolacompany.com/citizenship/pdf/2007-2008_sustainability_review.pdf). Accessed January 31 (2009)
8. Morhardt, J. E. ***Clean, Green & Read All Over***, ASQ Quality Press, Milwaukee, WI, 315 pp. (2002).
9. Martin, M. and Schinzinger, R. ***Ethics in Engineering***, 4th Ed. McGraw-Hill, New York, 339 pp. (2005).
10. Ellis, M.D. Ed. ***The Role of Engineering in Sustainable Development***, Am. Assoc. of Engineering Societies and the World Engineering Partnership for Sustainable Development, Washington, DC, 106 pp. (1994).
11. Committee on Sustainability, Technical Activities Committee. ***Sustainable Engineering Practice: An Introduction***, Am. Society of Civil Engineers, Reston, VA, 127 pp. (2002).
12. Outside reading book list includes but is not restricted to the following books: ***Green to Gold*** by Esty and Winston; ***Cradle to Cradle*** by McDonough and Braungart; ***The Ecology of Commerce*** by Hawken; ***The Sustainable Company*** by Laszlo; ***Hot, Flat and Crowded*** by Friedman; ***Sustainable Value - How the World's Leading Companies as Doing Well by Doing Good*** by Laszlo; ***Our Stolen Future*** by Colburn, Dumanoski and Myers; ***You Can't Eat GNP - Economics as if Ecology Mattered*** by Davidson; and ***The Omnivore's Dilemma - A Natural History of Four Meals***, by Pollan.
13. Examples of choices for case studies: Tier 1 industries - electric power, chemical process, beverage, fast food, alternate energy, pharmaceutical, automobile, aerospace, retail and department store, water and wastewater utility and agricultural [corn, sugar, etc.]; Tier 2 and 3 industries (as competitors or individually) - Apple and Microsoft, IBM and H-P, BP and Chevron, Caterpillar and Deere, Citigroup and JP Morgan Chase, Coca-Cola and Pepsico, ExxonMobil and Petrobras, International Paper and Weyerhaeuser, Target and Wal-mart, McDonald's and Burger King, Proctor & Gamble and Unilever, Darden and Yum! and many other combinations.

