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Service Learning in Engineering and Science for Sustainable Development

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INTRODUCTION

Appropriate technologies have a central role in the alleviation of poverty in the developing world. However, research and development of these technologies are generally apportioned relatively modest support by the world's academic institutions in part because the operation of many of these appropriate technologies is dependent on relatively well-understood science and engineering concepts accessible even to undergraduate college students. *The International Journal for Service Learning in Engineering* (*IJSLE*) provides an outlet for university students that undertake project-based service learning assignments on appropriate technologies to publish their work. Service learning is the various pedagogies that link some form of community service with academic study so that both parts symbiotically strengthen one another.[i] Professors at all of the world's institutions can capitalize on this opportunity to assist students to learn engineering and science more effectively by offering them a chance to make concrete contributions to the optimization of appropriate technologies for sustainable development.

THE NEED FOR SUSTAINABLE DEVELOPMENT

The need for development is as great as it has ever been, but future development cannot simply follow past models of economic activity, which tended to waste resources and produce prodigious pollution. The entire world is now paying to clean up the mess and enormous quantities of valuable resources have been lost for future generations because of the Western model of development. For the future, the entire world population needs ways to achieve economic, social, and environmental objectives simultaneously. In order to meet this goal international co-operation to overcome technical problems is necessary to irradiate poverty and help all the world's people develop as we move towards a global society.

The global picture is sobering[ii]:

- Around 1.2 billion people live on less than $1 a day and 2.8 billion people live on less than $2 a day.
- 968 million people in the world lack access to improved water sources (i.e. safe drinking water and basic sanitations).
- more than 30,000 children under the age of five die each year from preventable causes - equivalent to ~ 11 million unnecessary deaths.

This enormous challenge to our generation is growing -- the world's population will probably increase by about half (another 3 billion people) by 2050. How do we engineer our future development so that all people have basic human needs met and a clean, healthy and safe world in which to grow and prosper? ***This is the challenge of sustainable development.***

The global community has recognized that we must face the challenge of sustainable development immediately and do so with education. The United Nations has labelled this the "Decade of Education for Sustainable Development" (2005-2014). Teaching sustainability has become the most important goal in education in this century. Yet science and engineering education has not even begun to meet the global needs. For example, in this issue Al-Khafaji and Morse discuss a recent international survey of engineering students, which found widespread and startling knowledge gaps about many core aspects of sustainable development. They then show one model in which service learning can be applied to both successfully teach sustainable design to university students and simultaneously solve the concrete technical problems of sustainable development.

Although a body of academic work devoted to sustainable development with other such models has begun to amass, much of the research conducted at universities is not specifically designed to help resolve the developing world's problems. The vast majority of resources, both mental and economic, are concentrated on scientific and technological research focused on quantifying sustainability indicators and the frontiers of science and social theories – pushing the envelope on large and complex problems. However, the less grand questions of how to actually implement sustainable practices across a range of contexts, particularly for small-scale appropriate technologies or applications in developing nations is often apportioned significantly less resources for inquiry.

APPROPRIATE TECHNOLOGY

Appropriate technologies must be **able to be easily and economically constructed from readily available materials by local craftspeople.** Appropriate technologies must meet environmental, cultural, economic, and educational resource constraints of the localized community. For example, in this issue Weiss, George, and Walker describe the process of redesign for a manual shredding machine used to harvest breadfruit in the Republic of Haiti. Their methodology examined each function of the shredder assembly to determine if parts could be eliminated or combined and if there were simpler ways to meet the performance criteria without sacrificing quality. This work resulted in a machine that was easier to build in a developing country, used materials that were more commonly available, had a reduced number of parts, was more robust, was easier to clean and keep sanitary, and cost less to make! Similarly, in this issue Ros, Lee, Bruce, Fan, Quan, and Pai describe the establishment of a computer laboratory to provide an education resource to encourage learning and creativity for a children's center in Guatemala. They utilized the appropriate technology of the Linux operating system, a free and technically superior alternative to commercial software. Design and implementation of the project covered not only technical areas but also social aspects of computer technology. Although some such research has been done on a number of appropriate technologies, the diffusion of these innovations has greatly lagged the demand in the developing world.

IJSLE AND OPPORTUNITIES FOR STUDENTS

The creation of the IJSLE provides an opportunity for students to directly contribute to sustainable development and have their work published and spread internationally. A quarter of a century has now passed since Logan suggested science could play a major role in sustainable development by contributing to the interdisciplinary field of appropriate technology.[iii] Yet the majority of appropriate technology research has been accomplished by time-consuming trial and error methods in the field by individuals without technical backgrounds. The ability of undergraduate students to solve such real-world problems is generally neglected.[iv] Yet college student are both capable and enthusiastic real-world problem solvers if they are freed to undertake structured self-directed assignments.[v] The operations of many of these appropriate technologies are governed by physical laws taught in introductory physics and engineering classes. In addition to a solid foundation in the scientific method and engineering principles, students have access to the scientific literature in the university libraries, which is often not available to developmental agents in the field. The students also have access to some relatively sophisticated scientific equipment (e.g. computer-integrated thermocouples), which can be used for controlled studies of appropriate technologies. By studying appropriate technologies students can perform the basic research necessary to optimize such devices and gain a better understanding of physical principles and engineering practice.

SERVICE LEARNING GROWTH IN SUSTAINABILITY

Service learning pedagogy research has been maturing quickly. It is now well established that service learning has a positive impact on students' academic learning, moral development, improves students' ability to apply what they have learned in the "real world", and improves academic outcomes as demonstrated complexity of understanding, problem analysis, critical thinking, and cognitive development.[vi,vii,viii,ix,x] It is therefore not surprising that in the last decade there has been rising interest in service learning in science and engineering. There is also a growing list of examples of engineering service learning to teach sustainable design principles, most notably discussed at the American Society for Engineering Education Conferences and the Annual Conferences on Frontiers in Education.

The IJSLE will assist in the growth of this burgeoning field by recruiting new members from the academic community to help harness the knowledge and skills of our university students to assist their own learning while helping global sustainable development. IJSLE will include the work of those at the D-Lab at MIT, Engineering Projects In Community Service at Purdue and other EPICS programs, Engineers Without Borders at Colorado, Engineers Without Frontiers at Penn State, Engineers for a Sustainable World and the growing list of excellent engineering and science programs world wide that are using appropriate technology as a means of service learning for student education and sustainable development.

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