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Special Issue

Part I

Trends in Agricultural, Biosystems and Biological Engineering Education (III)

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quantitative, qualitative and idea-eliciting. Significant improvements in test scores were observed for both quantitative and qualitative learning categories. An evaluation triangle was designed to visualize the changes in the three learning categories for the pre- and post-test scores. The exercises were deemed helpful by participating students in enhancing their understanding of the subject matter. The proposed outcome-based procedure showed great potential in objectively testing the effectiveness of Web-based modelling tools in undergraduate education, albeit that more testing on larger class size is needed to further substantiate the observed improvement. Designs of the pre- and post-test questions are also important for accurate evaluation and must take into account students' academic demography as well as the topics being taught.

Keywords: multimedia teaching; teaching evaluation; learning tools; enhanced learning

In 1998, the Agricultural Engineering programme at Iowa State University turned to the pedagogical innovation termed 'learning communities' in an effort to enhance student retention and to bring coherence and meaning to our first-year student curriculum. Not only has the learning community helped us to increase our first-year, first time student retention in the major of Agricultural Engineering (AE), it has helped us to address many of our AE programme objectives including students' abilities to function on multi-disciplinary teams, communicate effectively and have knowledge of important contemporary issues. Results of the AE learning community assessment efforts suggest that students are overwhelmingly satisfied with the programme.

Keywords: agricultural engineering; biosystems; learning communities; interdepartmental, assessment

Ecological engineering is an emerging field of study that lacks mature, unique engineering sciences, that typify traditional engineering disciplines developed from engineering physics, engineering chemistry, engineering biology and engineering mathematics. An academic programme in Systems and Engineering Ecology at the University of Georgia has been initiated that follows the model of established engineering disciplines and draws significantly from general systems science, systems ecology, engineering and the mathematics of network theory to:
(1) build insight into the behaviour and properties of ecosystems as holistic units;
(2) develop invariant properties of ecosystems as networks;
(3) establish science-based design processes for the practice of ecological engineering.

Keywords: ecological engineering; curriculum; systems; network

In January 2004, a Biosystems Engineering design elective entitled 'Design of Assistive Technology Device' was offered for the first time. The course was team-taught by one instructor from the Department of Biosystems Engineering and two instructors from the Department of Occupational Therapy. The course covered the application and design of technology for individuals with disabilities; emphasizing the development of the requisite knowledge, skills and attitudes to evaluate, design and implement client-centred assistive technology services. Students were involved in the clinical assessment process, designed an assistive technology device, evaluated a prototype of the assistive technology device and prepared a written report describing the assistive technology device. Overall, this was a positive experience. The engineering students enjoyed the novel course material and appreciated the input from the diverse teaching team. Based on the quality of the project reports submitted, it can be concluded that the students gained an understanding of the process associated with designing assistive technology for individuals with disabilities. The logistical issues associated with teaching a course involving resources and instructors from two separate campuses can be overcome. The collaborative model presented by this course suggests a way for former agricultural engineering departments to offer courses in areas outside the expertise of their own educational background.

Keywords: collaborative teaching; interprofessional teams; assistive technology; rehabilitation engineer; client-based learning project

At the present time it is common practice to begin teaching teamwork skills to first year students. Teamwork skills have been identified by industry and the Accreditation Board for Engineering and Technology (ABET) as critical to engineering success in the workplace. There are many factors that are associated with learning effective team performance. In this study, we are interested in a simple question—does peer evaluation influence team performance and if so, how? To answer this question, we used qualitative and semi-quantitative questions in individual surveys of Bio/Ag students who have completed our first year student and sophomore design courses where (a) in the first year team performance was not directly assessed, and (b) in the second year team performance was evaluated by peers and professor, and the evaluation was part of the design project grade. The major finding of the study was: while students connected logically with the idea of peer evaluation at the end of a project, they report that this evaluation did not influence their performance. However, the students welcomed structured peer feedback during the project. Together, this finding suggests that professors should structure peer-feedback during a project, with peer-evaluation at the end of the project.

Keywords: teamwork; peer evaluation; open ended survey; ABET

In preparation for our accreditation visit in 2002 by the Accreditation Board for Engineering and Technology (ABET), faculty at the University of Arkansas Biological and Agricultural Engineering Department assembled a powerful, interactive electronic package designed to provide easy access to information needed. The self-study document, which is part of the package, includes our educational objectives, our assessment plans for programme outcomes, copies of all course syllabuses, links to examples of student work and documentation of our feedback loops in action. The package has been organized on a CD-ROM with hundreds of links to help the reader navigate through the material efficiently. Not only was the package useful for accreditation review, it has become an important tool used by the faculty for making changes in our programme. By routinely updating the package, we will facilitate steady and continuous quality improvement.

Keywords: accreditation methodology; ABET; curriculum matrix

Problem-based learning (PBL) is an instructional strategy that challenges students to 'learn and apply a process' to real-world issues by using a problem situation to focus the learning activities. This paper describes a case of PBL for a group of students in the Bio-Resource Optimization course. With minimal help from the instructor, the students brainstormed on potential problem areas to choose a specific problem for their course project. This paper describes the problem adopted by the team and the results of their work. Results showed that PBL is an effective tool for learning.

Keywords: PBL; bio-resource; food science; resource constraints; modeling

One of the fundamental skills required of biosystems and agricultural engineers is an ability to interact with systems that affect the production and processing of biological materials. This involves monitoring and controlling parameters within complex biological systems. Also, there is often a need to link multiple systems over a network to allow control and feedback data to be shared at several points. These monitoring systems and more sophisticated embedded networks are enhancing the ability of biosystems and agricultural engineers to solve problems by facilitating real-time data collection and enabling control actions. The use of microcontrollers in industry applications is growing steadily each year. Currently, worldwide microcontroller unit sales are increasing at a rate of 13% to 17% annually. This growth is reflected in biosystems and agricultural engineering by an increased use of microcontrollers in all aspects of the profession. Food and bioprocessing groups are utilizing microcontroller resources to improve the accuracy and efficiency of process control machines. Microcontrollers are also increasingly used for environmental control, where they have been implemented into distributed control systems. Applications are increasing in all areas of specialization where cost effective and precise control is required. In order to fulfill the departmental mission to provide students with the highest quality and most diverse learning experience possible, the University of Kentucky Department of Biosystems and Agricultural Engineering has developed a course to introduce the basic operation and industrial use of microcontrollers and embedded network systems. The fundamental goals of the course were to teach students the basic operating principles of microcontrollers and communication protocols, and to introduce practical microcontroller uses in industry. Laboratory assignments were tailored toward applications in biosystems and agricultural engineering including analog data acquisition, environmental monitoring, and process control. Principle concepts of motor and valve control were also discussed as they relate to real-world control applications.

Keywords: microcontroller; instrumentation; data acquisition; embedded systems; controller area networks

The Ecological Engineering Group within the Biological and Agricultural Engineering Department at the University of Arkansas applies the principles of ecology and engineering to prepare students to investigate and restore ecosystems degraded by human activity, focusing on the smallest unit of ecosystem management—the watershed. Ecological engineering teaching intertwined with research activities include investigation of the response of aquatic systems to nutrient enrichment from diffuse and point sources, control of biotic and abiotic processes on water quality, combining these investigations to enhance ecosystem management and develop decision support systems. Students are given an opportunity to apply their classroom knowledge to real-world watershed projects. Integration of teaching and research has enabled students to fully publish their research findings in undergraduate research journals.

Keywords: ecological engineering; nonpoint source pollution; watershed management; ecosystem

Design skill is an integral part of an engineer's education. Hence, incorporating a design course into agricultural engineering education in Africa will create agricultural engineers who are not only technically strong, but also innovators. The need for well-planned design input for agricultural engineering students is evident, by looking at the changing scenario in the world of work. It is envisaged that a formal course would serve better than occasional pieces of design-related information cited in individual subjects. A new core course on Design Methodology intended for agricultural engineering students in Africa is proposed and a framework of implementation and evaluation is presented. A design cycle consisting of needs analysis, concept hunt, environmental conditions, function-analysis, ergonomic and aesthetic parameters is described. The course incorporates elements of research, conceptualization and decision making. It is also expected to stimulate thinking, group discussions and creativity in general. The course would enable the students to conceive, formulate and take up design-orientated final year projects. The course proposed here may be introduced in agricultural engineering programmes throughout Africa to improve students' education. Whether they pursue careers in industry or academia, this course will prepare agricultural engineers in Africa to be engaged in problem solving from the moment they enter the professional field.

Keywords: design; agricultural engineering; Africa

The Agricultural Machinery Research and Design Centre (AMRDC) at the University of South Australia has evolved over the past 25 years from a single mechanical engineering consultancy to a major national agricultural engineering research and postgraduate education centre. The paper traces the history of the development of AMRDC and focuses on the path of expansion of activities from cultivation machine design, tillage tool research, seed placement and plant growth interactions, to the move into horticulture and food processing machinery. Today's equipment includes the Tillage Test Track (a 250m continuous soil bin), the Seed Placement Test Rig (an indoor soil bin with interchangeable soils and a growth chamber) and Trial Plot Seeder. A post harvest processing facility is also briefly described.

Keywords: agricultural machinery research; agricultural engineering; horticulture; food processing

The course discussed in this paper, Instrumentation and Data Acquisition, had been taught for two years at Purdue University when the Federal University of Viçosa invited the instructor to teach that course in Brazil. Based on the instructor's experience in teaching the course there, this paper offers suggestions on how to successfully address the problems associated with teaching a hands-on laboratory course away from the home institution where the course was established. The problems included content adaptation, equipment availability, laboratory setup, scheduling, instruction methods, language barrier, funding, and a few other problems. Advantages and compromises associated with the international adaptation of the course are discussed. It is hoped that this paper will help create a model for international teaching collaboration.

Keywords: teaching abroad; globalization; course adaptation; laboratory setup

Part II

Contributions in: Manufacturing Engineering, Industrial Engineering, University-Industry Cooperation, Remote Laboratories, Transport Engineering, Electrical Engineering and Fluid Mechanics

Cost estimates are fundamental criteria to make design and manufacturing decisions in engineering. The achievement of an estimate requires knowledge and skills. Traditionally, engineers give more relevance to performance and technical requirements than to cost. Education plays an important role in this matter. A process-centred approach is presented to train professionals on cost estimating.

Training in cost estimating and the relevance of using a generic process as the core around which training material is provided are discussed. The six pedagogical variables defined in the development of a web-based, cost estimating training solution are presented. The developed solution makes use of three training techniques: by doing, by lectures and by discussions.

Keywords: process-centred training; web-based training; cost estimating training

The engineering education community has long recognized that graduates not only need to possess sound technical knowledge in their chosen disciplines but also need to be better educated in the areas of communication skills, teamwork, leadership and other professional skills. Despite the recognized importance, it is not easy to develop and implement a curriculum that fosters such skills. Also subsequent outcome assessment of the achieved skill levels poses many challenges and demands much creativity. This paper describes a joint experience between Syracuse University in USA and Carlos III University in Spain. The experience shows that an industry-scale ERP solution can be used to develop professional skills for engineering students and improve academic curricula. Although ERP solutions have been used in higher education, this is probably the first time that an ERP system is utilized primarily for fostering professional skills. Findings from this experience are discussed as well as several opportunities for further development.

Keywords: ERP, global economy, international collaboration, professional skills.

Laboratory classes are an integral part of undergraduate engineering education, providing a valuable alternative to lectures and tutorials. Recently there has been a trend towards providing these laboratory classes through remote access—where the students are separated from the hardware and interact through a technology-mediated interface. This trend is driven by a demand to provide increased flexibility and opportunities in the delivery of laboratory classes to students, but it has the unintended consequence of affecting the learning outcomes for students in the laboratory class. Remote laboratories are characterised by two key factors—a separation, both physical and psychological, between the students and the laboratory hardware; and a technology-mediated interface that is used to close this distance. Both of these factors have been shown in the literature to affect the way in which students learn, changing the contexts in which they construct their knowledge. The impact of these factors is such that remote laboratory classes are not simply a logistical alternative to in-person laboratories—rather, they are a pedagogically different learning experience, and they must be acknowledged as such.

Keywords: remote laboratories; evaluation; media; transactional distance; presence

The paper presents the initial findings of the UK-based Accelerating Change for Built Environment Education (ACBEE) initiative. An empirical investigation of first phase ACBEE case studies of excellence has been carried out to unpack the type and level of industry–higher education engagement within UK built environment courses. These range in nature from continuing professional development and whole courses down to individual modules taught at undergraduate, postgraduate or corporate levels. The method comprised of the structuring and classification of the case studies through the use of setting and content codes. These were tabulated and subsequently analysed to determine the characteristics of engagement. This has resulted in the development of an initial outline classification framework of the type and level of industry/higher education engagement derived from the case study analysis.

Keywords: Industry engagement, industrial partnerships, collaboration, classification.

This paper presents the framework of a microcontroller-based approach for a computer architecture laboratory course intending to reinforce the educational level of non-electrical/electronic students, placing the emphasis on hardware and software design issues for embedded computers. The difficulties encountered in this approach are related to a) focusing students' attention on efficient use of the laboratory's equipment instead of tutoring, a common risk in technological courses, b) overcoming the comprehension barriers that are a consequence of the educational level of the students. The former issue is addressed by the design of appropriate equipment for the laboratory, the latter by a pedagogical strategy that is based on representational and interpretational picture examples. The proposed methodology proved to help in bridging the gap between the design problem and the students' semi-formal design view, without missing the essential details of the tutoring.

Keywords: computer architecture; microprogramming; microcontrollers; system design; illustrations.

This paper describes a novel approach to laboratory teaching of Fourier analysis and related topics using readily available software running on an ordinary PC. In the past, the requisite spectrum analyser has been prohibitively expensive, but recent developments in audio acquisition cards and software mean that such experiments are no longer out of reach of all but the most well endowed departments. The experiments described are designed to familiarize students with the spectrum analyser and some measurements that can be made with it. Typical tests possible deal with its principles of operation and with its application to the visualization and measurement of frequency spectra and may be extended to encompass illustrations of frequency response.

Keywords: electronics laboratory; fourier analysis; frequency spectra; spectrum analysis; visualization

There is relatively little emphasis on experiential learning as real-world experience in transport studies. It is difficult to apply to classroom learning because the risks and costs of experimenting with transport policies and concepts in the real world are prohibitively high. To counter this, simulation has proved to be capable of compressing time and space with great cost saving. At the University of Hartford, micro-simulation tools have been integrated into transportation engineering undergraduate courses for the first time to see how the traditional traffic engineering learning experience can be enhanced. A simulation learning environment was created to help students learn the principles of simulation and then develop an intuitive understanding of traffic flow theory and advanced control strategies. Students have also worked with two traffic simulation tools, CORSIM and VISSIM, and used them to understand the interactive dynamics among driver behaviors, vehicle characteristics and advanced traffic control management strategies in urban and freeway transport networks. They could also test hypotheses about the effects of various driver behavior, land use, and network decisions on the resulting traffic levels and make decisions on improvements for the future network. As part of the learning experience offered by this course, students applied the skills and knowledge gained from the classroom to a real-life service-learning project. The project was to take the learned traffic model theories and use simulations to evaluate traffic operations along an important urban corridor in Hartford, Connecticut, in terms of the existing, future, and improved future scenarios. The study results were presented and communicated to the local public. It is believed that the technology-enhanced learning activities of the simulation can reduce the emphasis on instructor-led "chalk and talk" by enabling students to explore complex traffic modeling processes in computerized learning environments. The new learning experience also enables students to think critically about transport problems and solutions.

Keywords: simulation; traffic simulation; transportation engineering education; service-learning project

Undergraduate fluid mechanics courses typically deal with the analytical or integral solutions for the governing equations of motion. The shift to graduate fluid mechanics frequently corresponds to the use of the differential equations of motion and their subsequent solution using computational means. Often there is a disconnect in regards to the problems when moving to the higher level courses. The goal of this paper is to provide a connecting thread between the two levels of learning. This is accomplished by comparing one-dimensional (1-D) and two-dimensional (2-D) simulations of the Plane Poiseuille, Plane Couette and Couette-Poiseuille problems against their analytical solutions. For the incompressible Navier-Stokes equations relevant to these problems, the Semi-Implicit Method for Pressure-Linked Equations (SIMPLE) is utilized as the numerical method. The 1-D SIMPLE method helps to illustrate the 2-D solution algorithm and introduce the reader to pressure correction methods. The end result of the paper is a linking of undergraduate and graduate knowledge through the use of the SIMPLE method in increasing order of complexity.

Keywords: computational; fluid mechanics; Navier-Stokes; pressure-correction; analytical; undergraduate; graduate; incompressible.

Embedded resistors are planar resistors that are fabricated inside printed circuit boards and used as an alternative to discrete resistor components that are mounted on the surface of the boards. The successful use of embedded resistors in many applications requires that the resistors be trimmed to required design values prior to lamination into printed circuit boards. This paper describes a simple emulation approach utilizing conductive paper that can be used to characterize embedded resistor operation and experimentally optimize resistor trimming patterns. We also describe a hierarchy of simple modeling approaches appropriate to both college engineering students and pre-college students that can be verified with the experimental results, and used to extend the experimental trimming analysis. The methodology described in this paper is a simple and effective approach for demonstrating a combination of measurement methods, uncertainty analysis, and associated engineering model development.

Keywords: embedded resistors; embedded passives; trimming