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Special Issue: Educational Applications of
Product Lifecycle Management Systems
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In this paper we present a computer-supported simulation game intended for teaching the planning aspects of Product Lifecycle Management (PLM). The game deals with product lifecycle planning dynamics in the Engineer-To-Order (ETO) industry. The ETO environment that serves as the working case allows the eliciting of important PLM concepts: unified product development multi-project planning and manufacturing planning, links between PLM software and ERP systems, and emphasis on the PLM holistic approach. The game is designed as a series of group sessions in which the different planning decisions appear progressively so that in the last session a complete lifecycle planning problem is completed. The sessions act as a series of practical cases encouraging group discussions. The computer system consists of two main components: a discrete event simulator and a planning decision support system. The simulator guides the game and stochastically generates the different events that cause the need for planning decisions in the working case. The planning decision support system makes it possible to emulate the resolution of the day-to-day tasks.
Keywords: product lifecycle planning; computer simulation games; engineer-to-order

Product Lifecycle Management (PLM) is a solution for managing the entire lifecycle of a product from its conception, through design, production, and delivery, to service, and disposal or recycle. While most of the Enterprise Systems—ERP (Enterprise Resource Planning), SCM (Supply Chain Management), CRM (Customer Relationship Management) and CAD (Computer Aided Design) systems—are separate software packages, current PLM solutions draw and integrate various functionalities and tools from these various Enterprise Systems. This nature of PLM poses unique challenges for teaching PLM. This paper shares an experience of developing and teaching a course in PLM with Enterprise Systems. Students carry out a semester-long project of developing new products. At each stage of the new product development process, students learn to apply the state-of-the-art information tools, particularly the Enterprise Systems. In addition to course schedule and content, two instructional materials used in the course will be described: (i) Enterprise Systems Configuration and Business, and (ii) Engineering Change Management. Lessons learned and future plans for enhancement are also discussed.
Keywords: Product Lifecycle Management; Enterprise Systems; ERP; new product development; engineering change management; engineering education

In the new scenario of global competitiveness, companies are forced to outsource and distribute product manufacturing in order to minimize costs and delivery times. Hence, engineering education must encourage students to work according to this trend by taking advantage of recent developments in Product Lifecycle Management systems (PLM). We have reviewed past educational efforts to educate future engineers with these skills, and the CAX techniques applied in education to achieve them. We also present a new PLM experience conducted in a senior Computer Integrated Manufacturing (CIM) course for graduate students, where a collaborative product development project was carried out. Through the project experience, the students acquired abilities related to design and manufacturing in a collaborative environment, using CAD/CAE/CAM and PLM software tools. The project let the students learn by practicing through activities such as 3D design, drawings, plastic injection analysis, cutting-tool and fixture selection, cutting parameter selection and CNC simulation. At the end of the project, the new designs were prototyped and the best model machined in a CNC machining center. We have established positive and negative aspects of the PLM experience and students' impressions.
Keywords: collaborative engineering; product lifecycle management; engineering education; computer aided tools; integrated design and manufacturing

The high degree of competitiveness among companies in the automobile sector together with ever stricter regulations means that manufacturers have to produce designs that are more and more complex and demanding and need to take account of all the stages of a vehicle's life cycle and study them in depth. In this sense, due to increasing environmental awareness, it is becoming necessary to consider the energy cost of each stage of the vehicle's life cycle as part of the design process. This paper presents how both points are

integrated when teaching young engineers on the Master's course in Automotive Engineering at Madrid Polytechnic University (UPM), using PLM SmarTeam software and the life cycle energy analysis program GaBi 4. This teaching is based on practical applications for a hybrid vehicle designed and constructed at the INSIA, taking energy and environmental cost as design criteria for the vehicle.

Keywords: PLM; energy analysis; environmental impact; automobile

Part II
Special Issue: Assessment (2)
Guest Editor: Gloria Rogers
ABET, Inc.

The approach taken by the College of Business and Technology at East Tennessee State University uses multidisciplinary teams to develop an assessment process that unifies the organization's culture to focus on assurance of learning. The theoretical literatures in change management processes and organizational culture are the foundations for the design of the assessment process that spans seven diverse departments and satisfies the requirements of multiple disciplinary accreditors. Lessons learned and recommendations for others are shared.

Keywords: multidisciplinary teams; change management; culture change; overcoming resistance; continuous improvement

The process, motivation, mechanisms, as well as examples of some of the material used in assessment at the Computer and Information Sciences Department at East Tennessee State University, are presented. More details, and the supporting forms mentioned can be found at the website www.cs.etsu.edu/department/assessment.htm

Keywords: assessment; outcomes; objectives; educational outcomes; computer science

We have demonstrated how program-level student learning research can be designed to satisfy institutional expectations along with specialized and regional accreditation criteria without duplication of effort. A centralized university quality management system conserves faculty effort by organizing program level learning research in patterns that satisfy multiple forms of evaluation criteria, such as continuous improvement documentation, peer-review of research planning quality, monitoring of planning currency, faculty participation in assessment, and sharing learning assessment information among university community members and external constituents.

Keywords: accreditation; learning assessment; continuous improvement systems

The Faculty Course Assessment Report (FCAR) presents a methodology that allows instructors to write assessment reports in a standardized format that is conducive for use in both course and program outcomes assessment. The FCAR document is structured as a sequence of reporting categories that include what course modifications were made, the outcomes assessment information obtained, reflection on the part of the instructor, and suggestions for course and/or program improvement. Through this method, the instructor documents critical portions of the "closing the loop" process while being guided through a systematic review of the course. The FCAR approach facilitates program-level assessment through use of a "components" category containing collected evidence in support of the set of metrics used with the program outcomes. For each component, the instructor provides a vector that categorizes aggregate student performance on a set of assignments along with details regarding the assignments used for acquiring the data. When the FCAR document is submitted, the assessment coordinator enters all of the reported performance vectors into a spreadsheet or database; this information is then organized into tables presenting the set of performance vectors for each metric. The evaluation of the program outcomes can now be quickly processed by inspection of the tables. If one or more performance vectors indicate non-compliance, one can refer back to the associated FCAR; an examination of the component in question, along with the reflection and course improvement sections, provides appropriate background information that can be used to understand the nature of the non-compliance and present appropriate solutions.

Keywords: assessment; evaluation; faculty course assessment report; FCAR; modifications; outcomes; performance vector; reflection

The importance of good communication skills is becoming increasingly relevant to engineers in today's globally competitive environment. The Accreditation Board for Engineering and Technology (ABET), recognizing this phenomenon, introduced six professional skills along with the various hard skills in their new accreditation criteria EC2000 for all engineering programs. At the Milwaukee School of Engineering (MSOE), rubrics were developed to aid in assessing the oral presentations made during the capstone senior design sequence. These rubrics have been applied by various senior design professors each quarter to assess all the mid-quarter presentations. The analysis (using the Spearman Rank Correlation Test and a Rater Disagreement Metric) of data collected over four quarters indicates that by repeatedly applying, analyzing and refining a rubric, it is possible to minimize the often subjective means of evaluating communication skills and move towards more objective evaluations. Over the past three years, multiple evaluators have shown strong agreement in the quality of student presentations. However, they have not yet arrived at a complete consensus indicating that we as yet do not have a completely reliable and objective tool and more work needs to be done in this area.

Keywords: assessment; oral communication; rubrics; inter-rater reliability

Part III
Contributions in: Electromagnetics, Control Engineering, Agricultural Engineering, Fluid Mechanics, Web-based Learning, Design Methods, Global Projects, Students' Satisfaction and Motivation

E. G. Bakhoum   962–968   Experimental Demonstration of a Fundamental Concept in Electromagnetics

Engineering and physics students usually have difficulty grasping that voltage in electrical circuits is actually a measure of energy. This paper describes an advanced experiment that was designed at the University of West Florida for directly demonstrating that the voltage between two given points in an electrostatic field is a measure of the energy required to move a unit charge between those points. In the experiment, a computerized vehicle transports a charged metal plate between two electrodes connected to a voltage source, while directly measuring the energy exerted in moving the plate. Assessment of the students' understanding of the concept after they perform the experiment has shown an improvement from about 10% (of the total number of students) to nearly 98%. Since the experiment helps the students perform actual measurements and verify a theoretical concept, its impact is more profound than otherwise teaching the concept through simulations.

Keywords: voltage-energy relationship; experiments in electromagnetism; potential difference; work in electrostatic fields

N. Aliane   969–978   Use of Spreadsheets in Control Engineering Education

Spreadsheets constitute a powerful modeling tool and an easy computer programming language. Spreadsheets' ubiquity, their low cost, their flexible programmable environment, as well as their plotting capabilities, make them attractive as an educational tool. Their capability is illustrated below through several examples ranging from classical control theory to more advanced topics such as optimal control or state-observer. Some of these examples are developed as classroom activities, whereas others are designed as interactive learning modules for illustrating specific control topics. Our approach focuses exclusively on the standard use of spreadsheets; that is, no macros nor macro language support are used. Pedagogical issues related to the use of spreadsheets in the classroom are also discussed.

Keywords: control engineering education; computers in education; spreadsheets

S. R. Turns, L. L. Pauley and **S. E. Zappe**   979–997   Active and Collaborative Learning in a First Course in Fluid Mechanics: Implementation and Transfer

Although many instructors may see the benefits of active and collaborative learning strategies, they may be reluctant to use them in their classes because they lack information on how to apply such strategies to specific mechanical engineering subjects. Here we present twenty-three in-class exercises that are useful for instruction in a first course in fluid mechanics. These exercises range from activities that consume a large portion of a class period to those that require just a few minutes, or less. Survey results show that our students are highly receptive to these exercises, welcoming them over a traditional lecture format. We also show that these exercises can be adapted readily by others and present limited evidence illustrating their effectiveness in improving student learning.

Keywords: active learning; collaborative learning; fluid mechanics; classroom instruction; pedagogy

C. Fernández, E. Soria, A. J. Serrano, J. D. Martín-Guerrero, R. Magdalena and **M. Martínez**   998–1004   Simucapra: Educational Software Application for Animal Nutrition based on MATLAB

This paper proposes the pedagogic use of MATLAB software in a field where its use is not common, Animal Science (AS). Although it is usual to develop and validate different mathematical models in AS, the use of this software package has not yet become a standard. This paper presents the use of this software for teaching Animal Nutrition, one of the main subjects in the Agricultural Engineering degree at the Technical University of Valencia, Spain. Two software applications implemented in MATLAB are presented. These applications cover different laboratory lessons of the subject. One of the main advantages of using this software is its GUIDE interface, which can create easy-to-use packages. Moreover, MATLAB offers an unbeatable computing power and a large number of free toolboxes. In addition, it has great capabilities of importing (or exporting) data generated by other widely used programs.

Keywords: MATLAB; animal nutrition; educational software

M. Stefanovic, M. Matijevic, and **V. Cvijetkovic**   1005–1012   Web-Based Laboratories for Distance Learning

Experimental installation of the 'Electrical simulator of typical physical process' exercise in the field of automatic control is developed and presented . The structure of this laboratory exercise includes goals, possible educational tasks, structure and learning objectives. The initial educational results of implementation of web-based laboratory and remotely-controlled laboratory exercise in engineering and control engineering education are also presented. The effect of web-based laboratories is quantified by student feed-back in both organization and effects of implementation.

Keywords: web laboratories; engineering education; remote control; automatic control

M. C. Kasapbaşı and **H. S. Varol**   1013–1019   Knowledge Management Integrated Web-Based Information Security Course Tutoring System

In this study a model and software package called WebCoach, which operates as a learning content management system (LCMS), has been developed. It is a web based tutoring system that uses knowledge management techniques to convert the tacit knowledge of experienced lecturers and experts into explicit knowledge. The instructional contents, quizzes and assessments, glossary of terms for information security course were prepared, compiled and organized by this tutoring system. They can be used and reused as learning objects to support learning. WebCoach fulfils the requirements for e-learning standards. It has been applied at Istanbul Commerce University within the information security course. Course grades and student questionnaires for two groups of undergraduate computer engineering students were analysed in the course of this study. The control group did not have access to WebCoach, while the same course was taught via WebCoach to the experimental group. The teaching methodology of the control group was based on a classical narrative model. It was observed that the students using WebCoach achieved better results compared with the control group students, for example, 86% of the students were satisfied with the WebCoach system.

Keywords: web-based education; knowledge management; learning content management system; learning objects; tacit knowledge codification and organization

Q. A. Memon and **S. A. Khoja** 1020–1028 Semantic Web Approach to Academic Program Assessment

Generally, the engineering program assessment process in line with an accreditation body involves some cyclic and tiring paperwork before any weakness is identified in the system. Additionally, the current state of such systems is that the assessment data are spread over many sub-systems, and there is no way to use them intelligently for better academic process management. It has been a desire of academic institutions to develop these processes in such a way that program management is also facilitated through an integrated system connecting all stakeholders of the program. This paper describes an electrical engineering program assessment process that has been developed and implemented using web semantics to provide intelligent services through an integrated system. The integrated system provides a value-added semantics layer where activities such as annotation, querying and reasoning can be carried out to support management. The framework is developed with a case study of a United Arab Emirates (UAE) University program assessment process to show how semantic web technologies can be used to facilitate program management.

Keywords: semantic web; program assessment; program administration; web technology

M. G. Green, D. Jensen, C. C. Seepersad 1029–1045 Design for Frontier Contexts: Classroom Assessment of a New Design
and **K. L. Wood** Methodology with Humanitarian Applications

A new design method for frontier contexts is given a classroom assessment. The method adds the formal consideration of the design context to traditional customer needs assessment. Testing under both controlled and classroom conditions shows the new method is extremely effective, easy to use and well received by students. Implementation at three US schools has shown positive results signifying broad applicability in education as well as field practice. Here we present the essence of the method, results of testing and examples.

Keywords: customer needs; latent needs; task clarification; design methods; developing countries; assistive technology

C. S. Sankar, P. K. Raju and **H. Clayton** 1046–1058 Preparing Students for Global Research Experiences: US–India Summer
Projects

The National Academy of Engineering report, Educating the Engineer of 2020, calls for system-wide efforts to align our nation's engineering curriculum and engineering profession with the needs of today's global, knowledge-driven economy for the purpose of increasing student interest in engineering careers. We developed an innovative global internship program for which students researched real-world problems in another country and then documented their research experiences by means of multi-media case studies. This paper describes the methodology, collaboration among US and Indian universities in order to conduct the internship programme, the project timeline and execution, an overview of the projects and an evaluation of the value of the experience to the participants. The evaluation shows that the students perceived that they are more informed about global issues, are better prepared to deal with the future, obtained real-world experiences, and improved their higher-order cognitive skills due to their participation in this project.

Keywords: global internship project; case studies; real-world experiences; engineering education research; interdisciplinary

N. Fang 1059–1067 Electronic Classroom Response System for an Engineering Dynamics
Course: Student Satisfaction and Learning Outcomes

The Classroom Response System (colloquially called "clickers") is an innovative instructional technology that provides the instructor with immediate feedback and real-time assessment on student learning in the classroom. This paper reports recent efforts of adopting clicker technology in Engineering Dynamics, a high-enrollment, high-impact, core engineering course. Both qualitative (questionnaire surveys and focus group interviews) and quantitative (descriptive statistics, correlation analysis, regression analysis, and ANOVA) research methods are employed. The results show that students are satisfied with clickers in their learning of Engineering Dynamics and that there exists a statistically significant correlation between student clicker performance and exam performance.

Keywords: classroom response system; engineering dynamics; student satisfaction; learning outcomes

K. M. Y. Law and **K. B. Chuah** 1068–1974 What Motivates Engineering Students? A Study in Taiwan

This study investigates the factors motivating learning among engineering students. A questionnaire based research framework that addresses the learning motivating factors and their links to students' motivation was employed. Statistical analyses are applied to investigate the factors that motivate engineering students to learn. The findings provide insight into the development of teaching inventories for engineering students. To enable students to learn effectively, a supportive setting with enabling factors and a cooperative learning environment is appreciated. Based on the study of the motivating factors and their impact on the learning motivation of engineering students, suggestions are made as to what can be developed to promote students' motivation.

Keywords: learning motivation; influencing factors; engineering students; Taiwan