

The International Journal of Engineering Education

Contents

- M. S. Wald** 1 Editorial
Engineering Education Research and Policy
- J. E. (Tim) Holt** 2–7 The Status of Engineering in the Age of Technology: Part II. Principles of Practice
The social construction of technological action in the contemporary world demands of the engineering profession a fundamental commitment to pluralism. Long identified and characterised by an allegiance to instrumental problem-solving within a scientific worldview, the profession must now acknowledge and embrace equally legitimate and forceful ways of ordering our world based on the central principles of responsible choice in human affairs. The profession therefore faces a culture change in its educational foundations. This paper suggests that the growing emphasis on practice-based curricula is a proper and timely response to the educational dilemma facing the profession. It constructs a model of engineering practice to guide these developments, in which practice encompasses four core elements that issue from its essential pluralism. Practice, in turn, is seen as shaped and instructed by four corresponding, underpinning disciplines through an operationalising set of principles of practice. This principle-based model of practice, although expressed quite simply, offers clear directions for culture change in engineering education. It also presents a major challenge.
- M. M. N. Megat Johari, A. A. Abang Abdullah, M. R. Osman, M. S. Sapuan, N. Mariun, M. S. Jaafar, A. H. Ghazali, H. Omar and M. Y. Rosnah** 8–16 A New Engineering Education Model for Malaysia
The role of Malaysian engineers in the development of industries, infrastructures and ensuring the general well-being of the country cannot be underestimated. However, since engineers have been left out of top leadership positions, there is a perception that they have a marginal role in the country's progress. Lacking in the non-technical skills, which are necessary for top management or leadership positions, has been singled out as contributing to this dilemma. It is also cited that they have also yet to be active in research and development or to be involved in business on a global scale. A study on the engineering education models worldwide has shown that engineers need to have the interpersonal skills to deal with the public effectively as well as to be technically competent. There is a variation of emphasis and levels of technical competencies aimed in these models; stretching from a broad-based to specialised education. In facing the challenges of the future, it is envisaged that engineers must still possess the necessary technical competencies but should also be trained with a stronger emphasis in engineering science so that they are flexible enough to be involved in several engineering disciplines. To prepare engineers to be leaders in the development of a nation, they must be trained with various industrial skills such as communication, management, law, politics and environment. These engineers must also be trained in humanities, including ethics and professionalism, and be exposed to global scenarios and future trends. The engineering education model developed for Malaysia is expected to be capable of achieving global recognition and accreditation for excellence in engineering practice as well as educating future leaders. This includes strengthening the scientific and professional competency base of the engineering studies, and the inclusion of various humanistic, industrial, practical, global and strategic skills. The model envisages a four-year degree programme, as opposed to the current three years.
- Ronald M. Pratt** 17–21 Optimizing Student Performance under a Government Mandated Quota System—A Case Study at the National University of Malaysia
A unique situation encountered in Malaysia's state university system occurs because government policy mandates student ethnic and/or racial distributions to reflect ambient society. Due to cultural variations, this creates an unusual environment in which to educate our next generation's engineers. In particular, the challenge to the educator is to motivate all the students, regardless of their background, while hopefully closing performance gaps between different ethnic groups. In this paper we analyze some relevant factors and specific problems that arise, as well as some possible solutions. Case studies are from undergraduate, levels I and II thermodynamics courses. While government intervention is especially rigid in this Malaysian scenario of balancing the Malay, Chinese, and Indian ethnic groups, similar situations exist globally as we experience the fortunate trend of diversification of the engineering student body.
- Michael M. Bernitsas** 22–31 Engineering for the Marine Environment at an American Research University
Education and research are of equal importance in a leading research university in the USA, in terms of expenditures, use of laboratories, and human resources. Education requires supporting a comprehensive curriculum in BSE, MSE, M.Eng. and the advanced PE degrees of Marine Engineer and Naval Architect to prepare professionals for a lifelong career; and supporting a graduate curriculum in MSE./Ph.D. to educate researchers and future educators. Innovative research requires the ability to compete successfully for funded fundamental research across engineering boundaries, educates research professionals, and helps faculty to evolve. Demands from marine industry ranging from practical engineering to innovative research are broad and not necessarily compatible with our responsibility to educate engineers with knowledge of fundamentals and adequate flexibility to be successful professionals for the next 40–50 years. In our field, both research and education require daily use of experimental facilities that are large and expensive to upgrade and maintain. The discipline of Engineering for the Marine Environment is unique, broad in terms of applications, small in terms of human resources, and internationalized. Recent changes in politics, the economy, the nature of engineering, as well as advances in information technology complete the challenge. Definition of the challenge and this paper presents a solution suitable for the University of Michigan as a paradigm.
- Engineering Design*
- Ravi P. Ramachandran, Anthony J. Marchese, Raul Ordonez, Carlos Sun, Eric Constans, John L. Schmalzel, Heidi L. Newell, Harriet Benavidez and Julie Haynes** 32–38 Integration of Multidisciplinary Design and Technical Communication: An Inexorable Link
The Engineering Clinic is an eight semester sequence, based on the medical school model, taken by every engineering student at Rowan University. In these clinics, students and faculty from all four engineering departments work side-by-side on laboratory experiments, real world design projects and research. The solutions of these problems require not only proficiency in the technical principles, but, as importantly, require a mastery of written and oral communication skills and the ability to work as part of a multidisciplinary team. In the sophomore year, communication (written and oral) and design (semester long multidisciplinary design project) are integrated. The

course is team-taught by faculty from the College of Communication and the College of Engineering. This paper describes a recent design and communication experience in which students designed and built a market-ready guitar effects pedal prototype in a single semester. Achievement of integration is by formulating a high quality technical design and convincing the customer about the design benefits. Students appreciate that design and communication skills are very useful for entrepreneurship. Further exemplification is by quantitative assessment results.

Brian E. Thompson

39–49 Studio Pedagogy for Engineering Design

Pedagogy is presented to teach engineering design in a studio setting that mimics clinical residency but is not identical to industry, competitions, or research projects, because faculty place emphasis on student development not results. This approach contributes to a realignment of Engineering Education with engineering practice through a focus on design, and its development was influenced by pressures on engineering schools to make increasingly efficient use of resources in a technology-rich environment. Motivations for this studio approach, the structure of an engineering studio, and the instructional techniques used to deliver engineering-design lessons in a studio context are presented.

Mechanical Engineering

Robert R. Raine, Keri Moyle, Gordon Otte and John Robertson 50–57 A Cost-Effective Teaching and Research Dynamometer for Small Engines

A dynamometer suitable for use with model aircraft type engines that enables the measurement of performance, efficiency and emissions under controlled conditions is described. The low cost of both the engine, dynamometer and the fuel measurement system described make it ideal for teaching and undergraduate research projects in situations where a more expensive system may not be suitable. The paper also presents some results from an undergraduate project that demonstrate the capabilities of the equipment.

John W. Nowak, Helmut H. Korst and Todd M. Leicht

58–65 Feasibility Study for a Two-Stage Axial Flow Automotive Cooling Pump

Seniors in the Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign have to select a capstone design project in which student teams (groups of 3–4) under the guidance of senior faculty members carry out a theoretical analysis in preparation for designing, manufacturing and testing a working prototype. The results have to be submitted to the industrial sponsor and the departmental faculty in form of a written report (and in oral presentation) for discussion and critical evaluation. As an example, we selected a feasibility study for an alternative (and unconventional) design of an automotive cooling pump, which required considerable deviations from established guidelines for optimal design parameters.

Manufacturing Engineering

Syed H. Masood and Mazen Al-Alawi

66–77 The IRIS Rapid Prototyping System Selector for Educational and Manufacturing Users

The development of a number of different rapid prototyping (RP) technologies with wide-ranging capabilities, features and applications has created a problem of selecting an appropriate RP system for engineering educational institutions as well as manufacturing organisations intending to adopt this new technology. This paper presents an IRIS Rapid Prototyping System Selector (IRPS) for selection of a rapid prototyping system from among a wide range of RP systems commercially available from the RP manufacturers worldwide. The search routines give access to a large database built on entity relationship techniques to enable fast retrieval of information. The system is designed to be user-friendly, flexible and expandable, and can also be used as an educational tool for RP systems education due to its large information base on each specific RP machine.

Engineering Mathematics

Alan Horwitz and Arya Ebrahimpour

78–88 Engineering Applications in Differential and Integral Calculus

The authors describe a two-year collaborative project between the Mathematics and the Engineering Departments. The collaboration effort involved enhancing the first year calculus courses with applied engineering and science projects. Two enhanced sections of the differential (first semester) and integral (second semester) calculus courses were offered during the duration of the project. The application projects involved both teamwork and individual work, and we required use of both programmable calculators and Matlab for these projects. Some projects involved use of real data often collected by the involved faculty. The paper lists all the projects, including where they fit within the course topics. Some selected projects are described in detail for both the differential and the integral calculus courses. The paper also summarizes the results of the survey questions given to the students in two of the courses followed by the authors own critique of the enhancement project.

Karim Y. Kabalan, Ali El-Hajj, Shahwan Khoury and Fadi Yousuf

89–97 Root Computations of Real-coefficient Polynomials using Spreadsheets

Two spreadsheet solutions of the roots of linear real-coefficient polynomials of any order are presented. The first procedure is a combination of the Routh-Hurwitz method and the bisection method. The second procedure is based on Bairstow's method. Both procedures are reliable in determining the real, complex-conjugate, distinct, and repeated roots of the polynomial. The user simply enters the coefficients of the polynomial and the initial guesses, and the n roots will be calculated and displayed on the worksheet within specified precision. Examples are given in both cases for illustration and for comparison.

Marine Engineering-Software

Robert Latorre and Jose Marcio Vasconcellos 98–105 Introduction of Software Packages in Naval Architecture, Marine and Ocean Engineering Courses

Graduates from UNOs Naval Architecture and Marine Engineering NAME program enter professional employment with both commercial companies and government agencies. A series of meetings with their employers has led to a shift in what is needed by engineering graduates in the area of computer capability. This paper discusses the industry input, how we are meeting this challenge, the student perceptions and the evolution of the UNO-NAME software introduction.